A PROCESS MODEL FOR DEVELOPING CONTENT FOR CERTIFICATION PROGRAMMES: THE CASE OF INFECTION CONTROL NURSES IN HONG KONG

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WAI FONG CHAN

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CERTIFICATION OF ORIGINALITY

I hereby declare that this thesis entitled “Building a model of certification: The case of infection control nurses in Hong Kong” is my own work and that, to the best of my knowledge and belief, it reproduces no material previously published or written, nor material that has been accepted for the award of my other degree or diploma, except where due acknowledgement has been made in the text.

_____________________________ (Signed)
Wai Fong CHAN

"More importantly, an objective measurement system should be established on the competency items for certification purpose."

Stated by
the Chief Infection Control Officer, Hospital Authority, Hong Kong
March 2010

ABSTRACT

Abstract of thesis entitled
"A Process Model for Developing Content for Certification Programmes:
The Case of Infection Control Nurses in Hong Kong"
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A trend in nursing specialization over the world is for nurse specialists to be regulated by certification systems or other credentialing schemes. In Hong Kong, there is no certification system yet for regulating nursing specialist practice, including infection control nurses. Infection control practice, which is mainly concerned with combating hospital-acquired infection, is context-specific. There is a need in Hong Kong for a certification programme for infection control nurses. The content of this programme would need to be revised periodically, as practices change over time.

The aim of this research is two-fold: to establish the content and content-weighting for a certification programme for infection control nurses in the current context of Hong Kong; and to build a process model that informs the development of a content blueprint of a certification programme for regulating the practice of a group of specialists.

A three-phase research design was used. In Phase One, the content and rating scale of the survey questionnaire to be used in Phase Two were created. A list of draft core competency items in categories was established by Delphi experts. The list of proposed core competency items was finalized after its validity and reliability were tested by content experts and former infection control nurses. The functioning of the rating scale of the proposed questionnaire was tested by Rasch measurement. In Phase Two, the views of infection control nurses were collected on the perceived importance of core competency items of infection control practices. A list of core competency items was established by a cross-sectional survey and Rasch measurement. Phase Three established a content blueprint of the certification programme for regulating the practice of Hong Kong infection control nurses. A list of critical (i.e. the most important) competency items for establishing the content blueprint of the certification programme for Hong Kong infection control nurses was decided by local infection control experts and the Rasch-based safety margin. The content weights of individual core competency items were translated by the results of the Rasch measurement in Phase Two.

The expert-defined critical competency consisted of 25 competency items. The Rasch-based safety margin added 10 more items, resulting in 35 critical competency items. The content blueprint of the certification programme for infection control nurses of Hong Kong is similar in several aspects to the

United States blueprint.

The process model of certification content blueprint development that was created for this study is composed of two key elements, namely the core competency identification cycle and Rasch measurement. The core competency identification cycle requires three inputs--from the literature, experts and practitioners--to establish a comprehensive list of core competency items. Rasch measurement yields the core competency scale (identifying the fitting items and determining the importance levels to individual core competency items), defines the true critical competency from the expert consensus and establishes the content weights in the certification content blueprint. This process model can guide the development of content blueprints of certification programmes for other healthcare professionals in other contexts.

LIST OF PRESENTED AND PUBLISHED WORK

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Publication

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Last but not the least, this thesis is dedicated to my father, the late Mr. Shiu Ling Chan, who passed away in a public hospital in December 2010 due to a hospital-acquired infection.

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CHAPTER 1

INTRODUCTION

1 Personal Interest in Infection Control

I am a registered nurse in Hong Kong and I have been practising infection control in several public hospitals in the territory since 1997. Hospital infection control was only established widely in public hospitals in Hong Kong after the outbreak of Methicillin-resistant *Staphylococcus aureas* in 1985 (Yung & Seto, 1989). The infection control service in my training hospital also started in 1985. I first noticed this service during my clinical practicum as a student nurse. I was at that time greatly impressed by the way infection control could prevent the transmission of infections in the hospital. I deeply believed that is very meaningful, and that I decided to dedicate into this specialty. During my practice in infection control, I found out that some infection control nurses might not be competent, and the title "infection control nurse" was too generalized to include those nurses who did not perform designated duties of infection control nurses. As various certification programmes are successful in establishing competency control in other nursing specialties, I believe that a certification programme for infection control nurses would ensure the ongoing effectiveness of infection control specialty and inform others who are the competent professionals as well. This belief led directly to the work of this thesis.

2 Specialist Practice of Infection Control

2.1 Definition

Infection control, originates from hospital setting, is a global issue. Inefficient infection control practices facilitate the spread of pathogens. This affects hospitals and community health and diseases can spread rapidly in healthcare settings during outbreaks (World Health Organization, 2011a). Hospital infection control is not a direct patient care service; rather it is what health care workers do to prevent infections. It includes:

- establishing practices to prevent and contain infections;
- monitoring improper practices that can lead to spread of infections and how;
- educating healthcare workers; and
- continuously updating practices and monitoring their effectiveness.

This applies to routine hospital care as well as during infection epidemic. Under the current practice in Hong Kong, there are only a small number of specifically trained infection control nurses working in different infection control teams, led by infection control officers who are doctors.

2.2 History

Hospital Infection control, although a relatively young specialty, has been established in most countries in the world. Usually the triggering force to establish an infection control system in a country was infection crisis. For example, the first infection control nurse was appointed in the United Kingdom in 1959 because of the outbreak of Methicillin-resistant *Staphylococcus aureus* (Gardner, Stamp, Bowgen & Moore, 1962). The hospital infection control service of the United States was created, for similar reasons in the 1970s (Goldrick, 2005). Also, in Victoria, Australia, their infection control service was established after the emergence of the “super-bug” (Victorian Specialty Interest Group Members, 1982). Infection control in Hong Kong was also set up in 1985 when outbreak of Methicillin-resistant *Staphylococcus aureus* occurred (Yung & Seto, 1989). After experiencing the life-threatening outbreaks of severe acute respiratory syndrome and other emerging infections, World Health Organization notices that there is a huge gap between the knowledge and implementation of infection control practices (World Health Organization, 2011a). Although World Health Organization is now taking a more active role in combating infectious diseases in a global perspective, infection control work in hospital still plays a major role to prevent the spread of infections in hospitals and community.

2.3 Benefits

After the implementation of infection control in hospitals for over 50 years, the cost-effectiveness of the infection control service is apparent in two aspects. First, it reduces healthcare costs of individuals or the healthcare system by reducing the need of treatment, hospital stay and re-admission due to hospital-acquired infection (French & Cheng 1991; French, Wong, Cheng & Donnan, 1989; Goldrick, 2005; O'Boyle, Jackson & Henly, 2002; Raine, 1991; Stone, Larson & Kawar, 2002). Second, it reduces indirect costs, such as patient mortality, by reducing and preventing hospital-acquired infection (Correa & Pittet, 2000; French & Cheng, 1991; Plowman et al., 2001; Umscheid et al., 2011).

2.4 Nurses' Work

The major goal of infection control service is to control the spread of infections in hospitals. Nurses, as the frontline workers in this service, perform a number of critical functions. They collect infection data, analyse it, and disseminate the findings to other healthcare workers and administrators concerned. This helps to devise solutions, and implement improvements. Therefore infection control nurses need a wide range of skills, knowledge and experience, especially in patient care practices and communication, as negotiation and liaison work are crucial to their effectiveness. Although they have a common goal and direction, the practice of infection control nurses in different countries or regions varies because of different cultural norms, the nature of nursing education, disease epidemiology, client needs, resources and healthcare structures.

3 Need for Certification

The practice of infection control is changing and evolving over the years. The importance of infection control was fully recognized after the epidemic of the severe acute respiratory syndrome in 2003 and the influenza pandemic in 2009. The outstanding work of Hong Kong infection control nurses was highly appreciated during these crises. The specialty expanded rapidly after the outbreak of severe acute respiratory syndrome with new infection control nurses. Although training was offered, a regulating system to ensure their competency in the dynamic healthcare environment is warranted because of evolving practices. In Hong Kong, post-basic specialization in nursing first started in 2006 (Hong Kong Academy of Nursing Preparatory Committee, 2008). However, up till now, there is still no certification system in any specialty of nursing practice for regulation purposes (Wong, 2009). Direct incorporation of infection control certification programmes from other countries to Hong Kong is not a solution as practices vary in different regions or countries. Such a system is needed to ensure patient safety and foster ongoing professional development.

Patients, healthcare workers and healthcare authorities, all can benefit from a good certification programme that ensure good infection control practice. A valid certification programme is one that can reflect the practice in the field. As infection control practice is local-context specific, a certification programme for regulating the practice must be local context-specific as well (Gillis & Griffin, 2005). Although some Hong Kong doctors and nurses passed the examination of the certification programme in the United States, this really only implies that they are competent to work in the United States (Memish, Soule & Cunningham, 2007). Given that certification programmes offered by other countries are not designed for the Hong Kong context, a specific certification programme for infection control nurses of Hong Kong is needed.

There currently are only three certification programmes or similar schemes for regulating the specialist practice of infection control in the world. These include the certification examination organized by Certification Board of Infection Control and Epidemiology, Inc. in the United States, the credentialing package held by Australian Infection Control Association and the certification examination conducted in Korea. These are developed countries with well established healthcare system. Apart from regulating the practice of generalists, the values of certification, regulation of specialist practices as recommended by International Council of Nurses, is also highly recognised (International Council of Nurses, 2001). Although United States welcome infection control practitioners all over the world to sit for their certification examination, the infection control practitioners in Australia and Korea developed their own certification programmes because they realize that certification and the specialist practice of infection control should be local-context specific.

4 Content Blueprint of Certification Programme

A certification programme is used to regulate the practice of specialists. A content blueprint of a certification programme is a framework for developing the certification programme (Counts, 2008; D'Costa, 1986), which includes the content and its proportion, named as "content weight", of the whole certification programme. It is usually developed by researchers or experts in education. The blueprint of the certification programme links the professional practices and the content of the certification programme. It is desirable that the blueprint developer is familiar with the professional practices. Involving field experts to give input on the professional practices and the related content weights is crucial. Once the certification programme is developed, the programme needs to be revised periodically to keep its content up-to-date.

The same principle applies to a local-context specific certification programme to regulate the specialist practice of infection control nurses in Hong Kong. Specific, up-to-date infection control practice must be included as a primary key element. Local practice is another key element.

Once the certification system has been launched, its programme has to be revised periodically. In order to keep the certification programmes up-to-date, a simple and time-saving process for development of certification programme is necessary. A process model of certification blueprint development is the solution. The model integrates the interlinking process between specialist training, refresher and certification. Furthermore, it provides building blocks to develop training programmes, and continuing professional educational programmes for the same group of specialists. Ensuring that the knowledge and skills of infection control nurses are up-to-date is of paramount importance. Certification, one kind of credentialing scheme, is commonly used to regulate the practice of nursing, and healthcare specialists, and can be used similarly for infection control nurses.

The goal of this research is to create a content blueprint of infection control certification programme that is local-context specific in Hong Kong. Based on the research results, a model of certification can be created.

5 Development of Certification Content Blueprint for Infection Control Nurses of Hong Kong

5.1 Objectives

Based on the needs of professional regulating process for nurse specialists, I plan to develop a content blueprint of certification programme for infection control nurses of Hong Kong. This research is divided into three phases. Phase One is the preparatory work for Phase Two to prepare the proposed core competency of infection control nurses. Phase Two develops the core competency that infection control nurses require. The overall objectives of the two phases of studies are:

1) to propose a comprehensive list of core competency items of infection control nurses of Hong Kong;

2) to identify a list of core competency items comprehensively for infection control nurses in Hong Kong; and

3) to establish the perceived levels of importance of individual core competency items among local infection control nurses.

Having developed a core competency item list, Phase Three created a content blueprint by defining critical competency and the content weight of each critical competency item. Its objective is therefore to determine which core competency items are most important. These would become the critical competency items for the certification content blueprint to determine their content weights.

5.2 Methodology and Procedures

This research was an investigative study to establish an infection control certification content blueprint for the Hong Kong context. Quantitative methods as well as qualitative judgements by experts and practitioners were used. Methods included:

- Phase One: literature review, Delphi survey, content validity survey and pilot test on practitioners to work out the internal consistency and test-retest reliability;
- Phase Two: a cross-sectional survey on practitioners and Rasch analysis;
- Phase Three: expert consensus, Rasch-based calculation and weight proportioning.

Phase One was the preparatory phase for Phase Two. In Phase One, competency categories and core competency items were drafted based on literature review and Delphi survey. Then, content validity survey was conducted on the draft core competency items. Using the draft core competency items, pilot survey on practitioners was conducted to check the internal consistency and test-retest reliability. Then, the proposed core competency is developed.

Phase Two was a cross-sectional survey. A questionnaire on proposed core competency was administered to collect views of all infection control nurses in Hong Kong. The survey requested the participants to record his/her assessment of the importance level of each proposed core competency item. The collected data were ordinal data. In Phase Two, Rasch measurement was used to identify the content and determine the importance levels of individual core competency items. The results form a core competency scale and the importance levels of individual items in an interval scale was established. The conversion of ordinal raw data to a linear scale facilitated the translation of the Rasch measurement results directly to the content weights of the content blueprint in Phase Three (Spray & Huang, 2000; Wang, 2009).

According to the importance level of each core competency item identified in Phase Two, expert consensus in qualitative view was used in Phase Three to define the most important items among the comprehensive core competency list developed in Phase Two. By utilizing the Rasch-based safety margin and transferring importance levels to content weights, a content blueprint was derived.

6 A Process Model of Developing Content for Certification

This research aims at developing a content blueprint of a certification programme for infection control nurses in Hong Kong. The content blueprint contains a list of critical competency items with their respective content weights. The development process forms a process model for deriving the content blueprint of certification programmes (Figure 1-1). The model describes firstly the identification of professional core competency based on professional practice. The core competency is defined by a list of core competency items with their respective importance levels. This core competency identification process is ongoing to ensure the core competency is up-to-date. Then, critical competency (a list of most important core competency items) with respective content weights is defined to form the certification content blueprint. The core competency identification cycle is the core element in the model. The concept of core competency identification in this research, derived from D'Costa (1986), was designed for and can be adopted by all healthcare professionals.

7 Conceptual Map of Certification Content Blueprint Development

Most of the practice analyses for the professionals were conducted specifically for identifying the content of certification blueprint (Curchoe, Fabrey & LeBlanc, 2008; Goldrick et al., 2002; McMillan, Heusinkveld, Chai, Miller-Murphy & Huang, 2002). However, professional certification and professional training in the healthcare field are interlinked. As illustrated in Figure 1-1, a healthcare generalist becomes a specialist after receiving training for the specialty and gaining relevant clinical experience. The specialty certification programme is used to assess the abilities of these specialists. The contents of training and certification are generated from the same professional core competency of that particular group of specialists. For certification purposes, only the most important (critical) competency items are included and tested (D'Costa, 1986). As illustrated in Figure 1-1, a conceptual map of certification content blueprint development for the healthcare field is shown. The core competency, derived from the core competency identification cycle, contributes to specialist training and continuing education. From the core competency, critical competency, the most important core competency items, with their weights were determined that contributes to subsequent certification content blueprint development. Based on the blueprint, programme developers can develop the certification programme for regulating the practice of specialists.

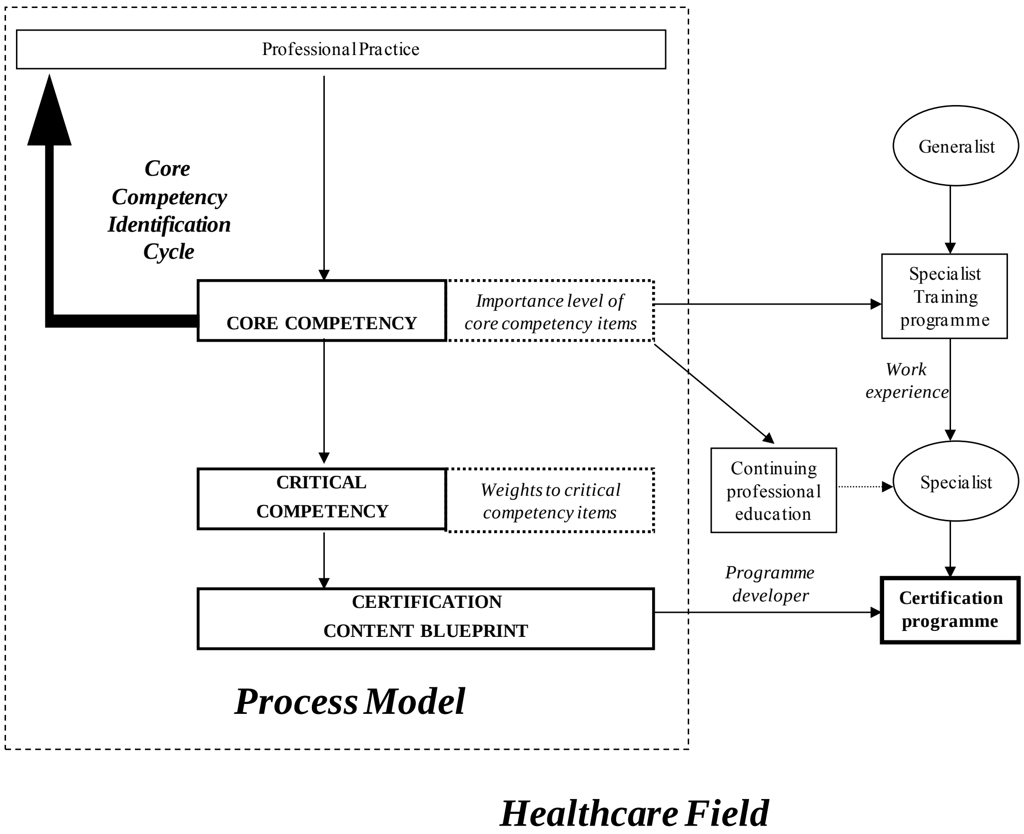

Figure 1- 1: A conceptual map of certification content blueprint development

8 Organization of the Thesis

This thesis is organized into 11 chapters. This first chapter (Chapter 1) provides a brief introduction to my research. Chapters 2 and 3 review the literature on infection control and certification, respectively, in various geographic areas. Chapter 4 provides a background of infection control in Hong Kong. Chapter 5 discusses the idea of competency and its related issues that are the foundation concept of this research. Chapter 6 delivers the conceptual framework and design. The methodology is then elaborated in Chapter 7. Chapters 8, 9 and 10 report the findings of Phases One, Two and Three respectively. The final chapter (Chapter 11) concludes the results including the core competency and the process model, and discusses the implication, limitation and recommendation of this research.

CHAPTER 2

LITERATURE REVIEW ON INFECTION CONTROL

1 Introduction

This literature review on infection control will present a map of current thinking on certification. First, I will give a brief idea on the establishment of infection control service. Then, I will examine the context of infection control practices in different countries as well as Hong Kong. After that, problems of hospital-acquired infections will be explored and how infection control can help in these areas will be elaborated. The chapter concludes that infection control is an important nursing specialty that certification is needed to ensure patient safety, and that local-context specific infection control practices require a local-context specific certification programme.

2 The Beginnings of Infection Control in Hospitals

Unlike the other nursing specialties, infection control has been in existence only for less than sixty years. The commencement of infection control practice in healthcare system varied in different countries or regions.

The United Kingdom has been the pioneer in hospital infection control since the 1950s (Emmerson, Spencer, Cookson, Roberts & Drasar, 1997). In the 1950s, Staphylococcal infection was a pandemic in the United Kingdom. The Standing Nursing Advisory Committee in the United Kingdom Ministry of Health suggested in 1951 that nurses should play a purely supportive role in administering the problems of cross-infection (Worsley, 1988). The Ministry of Health then recommended the appointment of an infection control officer and an infection control committee in all acute hospitals in January, 1959. This new scheme was introduced when the incidence of Staphylococcal infection occurred in the nursing staff in Torbay Hospital (Gardner, Stamp, Bowgen & Moore, 1962). At that time, the bacteriological investigations were sent out for processing at a public health laboratory in Exeter, which was over 20 miles away from the hospital. The proposal was made to appoint a member of the nursing staff to coordinate the handling of these specimens. The hospital further hoped that this new appointment could have helped to reduce the frequency of septic infections in nursing staff, thus saving their work time (Gardner et al., 1962). Luckily, a suitable nurse was available at that time - Miss E M Cottrell, a theatre superintendent in several hospitals. Thus, the first infection control nurse, called Infection Control Sister at that time, was appointed in April 1959 in Torbay Hospital in the United Kingdom (Emmerson et al., 1997; Gardner et al., 1962; Worsley, 1988; Infection Prevention Society, 2009). In the following year, another infection control nurse, Miss A Forman, a member of nurses' teaching department was appointed in Royal Devon and Exeter Hospital.

The infection control nurse was a newly appointed liaison officer responsible for the promotion of new lines of communications for dealing with the problems of cross-infection (Gardner et al., 1962). The duties of this infection control nurse included:

1) collection and preparation of adequate records;

2) prompt recognition and disposal of infected patients;

3) improvement of the liaison between matron and ward sisters;

4) checking the performance of ward techniques;

5) supervision of infection record; and

6) routine checks of Staphylococcal carrier rates, assessment of environmental contamination, efficiency of preventive measures and research investigations.

These duties remain the foundation of the duties of infection control nurses today.

In the 1960s, an alarming number of Staphylococcal infections were identified in the United States (Nguyêñ et al., 2000; Russell, 1995). The Centers for Disease Control and Prevention of the United States recommended in 1970 that hospitals should establish the positions of infection control nurses and hospital epidemiologists (Scheckler et al., 1998). The infection control activities in the United States were still limited, however, until the mid-1970s, when thousands of hospitals in the country established infection surveillance and control programmes to control the problem of Staphylococcal infections (Goldrick, 2005).

In Australia, infection control practice is not confined to nursing practice. The professionals involved there have been called infection control practitioners, since 1996 (Reed, Gorrie & Spelman, 2003). At that time, Murphy and McLaws (1999) conducted a survey among infection control practitioners from the membership of the Australian Infection Control Association in 1996 showing that the working experience of infection control practitioners ranged from one to 25 years, reflecting that infection control practices had been in operation in Australia for at least some 25 years as of 1996. It suggests that infection control activities in Australia started in the 1970s (Reed et al., 2003). Although mixed disciplines are still practising infection control nowadays in Australia, nurses are the first healthcare professionals to set up hospital infection control activities initially in the country (Victorian Specialty Interest Group Members, 1982). As in the United Kingdom, nurses doing infection control works in Australia were called Infection Control Sisters at that time. According to a survey for infection control nurses in Victoria State of Australia in the 1980s, the presence of infection control nurses was solely because of the problem of Methicillin-resistant *Staphylococcus aureas*. Its commencement again shows that infection control nurses are important personnel to combat hospital-acquired infection.

In Korea, the first infection control doctor and the first infection control nurse were appointed at Seoul National University Hospital in 1991 (Oh, Chung, Kim & Cho, 2006). Before 1995, only four hospitals had their full-time infection control nurses. Full-time infection control nurses were appointed in 12 more hospitals in 1995 when the hospital accreditation system was first launched. The law, specifying that hospitals with more than 300 beds have responsibility for infection surveillance and controls, was passed in 2002, and was promulgated in 2004. This law also made the quality of infection control service accredited by these hospitals themselves every three years.

Taiwan started its infection control activities earlier than Hong Kong. Infection control was pioneered by the Chang Gung Memorial Hospital Taipei Complex in 1976 when a doctor returned from infection control training at Virginia Hospital in the United States (Leu, 1995). A laboratory-based infection control programme was launched initially. In 1982, Dr. Richard P. Wenzel, a renowned infection control expert from the United States, was invited to train up a physician and two nurses to lead the infection control programmes. In 1985, a large outbreak of *Salmonella paratyphi* involving around 100 neonates happened in a hospital in the northern region (林, 2003). Not knowing how to control this devastating outbreak, Taiwan had to seek assistance from other country, inviting Ms. Nakashina, an infection control expert from the United

States. After this unpleasant experience, a series of infection control training for doctors, nurses and laboratory technicians were organized. A further structured system for infection control was established under regulations.

An infection control programme was introduced in Hong Kong in the 1980's (Seto, 1989). Before 1985, only one private hospital and one public hospital had one infection control nurse respectively. An outbreak of Methicillin-resistant *Staphylococcus aureas* occurred in the nursery of a general hospital in 1985 and it prompted the development of infection control (Yung & Seto, 1989). Since then, with the support of the Medical and Health Department and cooperation of universities, infection control programmes were implemented in many public hospitals (Seto, 1989). However, resources for these programmes were still limited (Chan, 2005).

Across different countries, their commencement of infection control activities in healthcare system was at different times from the 1960s to the 1990s. However, it is interesting to find that they were often introduced in a place during infection crises, such as during Methicillin-resistant *Staphylococcus aureas* outbreaks in the United Kingdom, the United States of America, Australia and Hong Kong.

3 Service Providers

In the beginning, the service of infection control in healthcare systems was not well-developed and lacked long-range direction. In the 1950s, the health authorities in the United Kingdom established a system whereby a single person was assigned the role of reviewing information on the prevalence of sepsis in hospitals and coordinating preventative measures (Gardner et al., 1962). In order to ensure that the person who performed these duties possessed the requisite authority, he or she always held senior position. Although May reckoned in 1958 that spending around half an hour every day would be sufficient to fulfill the duty, professionals running infection control in two hospitals in Devon commented that this workload was an underestimation (Gardner et al., 1962). In 1955, Colebrook proposed that an infection control officer with duties on bacteriological and epidemiological aspects would be appropriate (Colebrook, 1955).

As Gardner et al. (1962) argued, it came to be believed that infection control in general hospitals should also involve the active prevention of cross infection. According to the Central Health Services Council Subcommittee Report (1959) published in the United Kingdom, an infection control service should have the following three functions (Gardner et al., 1962):

1) keeping the responsible members of the hospital staff informed of the incidence of sepsis;
2) advising them on preventive measures; and
3) checking the efficacy of these measures.

However, it was soon discovered that a nurse in charge of a ward was too busy to accomplish all of these duties without assistance.

"Guidance on the Control of Infection in Hospitals" was published in the United Kingdom in 1995 and emphasized that the infection control service should be a matter of teamwork (Emmerson et al., 1997) and this is how it is today. The composition of the team consists of an infection control officer and infection control nurse(s). The roles of these members are elaborated as follows.

3.1 Infection Control Officer – The Leader

An infection control officer is a medical doctor who is a senior member of the hospital staff with sufficient authority is preferred (Ayliffe, Fraise, Geddes & Mitchell, 2000). They are called an infection control doctor in the United Kingdom.

Being the leader of the infection control team, the infection control officer has a special interest and training in hospital infection and possesses up-to-date knowledge (Ayliffe et al., 2000). In the United Kingdom, the infection control officer is required to hold the Diploma in Hospital Infection Control or an equivalent. Ayliffe and colleagues (2000) say that the right person for the job of an infection control officer is a medical microbiologist because not only the knowledge of infectious diseases is part of their professional training, but also they routinely work in the surveillance and record systems of hospitals. In Hong Kong, there is no specified training requirement for infection control officers. Clinical microbiologists are usually appointed as the infection control officers of large hospitals. For small hospitals where clinical microbiologists are not available, a physician is usually appointed.

The appointment of an infection control officer in the United Kingdom is initiated by the Trust Board (Ayliffe et al., 2000). In Hong Kong, the infection control officer is usually appointed by the top management or authority of the hospital, such as the Hospital Chief Executive or Hospital Infection Control Committee.

In daily operations of hospitals in the United Kingdom, the infection control officer works closely with the infection control nurses, the other team members (Ayliffe et al, 2000). The infection control officer assesses the risks of infection, advises on preventive measures and checks the efficacy of the measures. The purview covers the whole hospital, including the clinical departments, laundry, sterile services department, pharmacy, domestic and engineering departments. The infection control officers may give information or advice informally or formally, as in relevant meetings. Although the infection control officers of hospitals in Hong Kong assume responsibility for infection control in the entire hospital, all of them perform their infection control duties on a part-time basis.

3.2 Infection Control Nurse – The Major Workforce

According to the system of United Kingdom, the infection control nurse is a full-time member of the infection control team, which is responsible for all infection control activities in the hospital (Ayliffe et al., 2000). The full-time appointment enables the infection control nurse to offer clinical input in wards and departments and to be easily accessible as a source of advice and support. The infection control nurse is managerially accountable to the infection control officer and professionally accountable to the director of nursing. In some countries, such as the United States, the duties of infection control nurses may be assigned to disciplines other than nurses, such as laboratory staff, and they are called infection control microbiologists, infection control scientific officers and infection control practitioners accordingly. In Hong Kong, while infection control officers of the infection control teams work part-timely, as in the United Kingdom, infection control nurses work full-time, dominating the infection control service of the hospital and becoming the major workforce of the service.

According to Ayliffe and colleagues, infection control nurses should be registered nurses or licensed nurses with a wide range of clinical experience in general nursing practice (Ayliffe et al, 2000). They should be skillful in communicating with all levels of staff, and be able to balance patient care with serving their own needs. Infection control nurses should be familiar with hospital microbiology and laboratory procedures, for example, specimen collection, so that they can easily communicate with laboratory personnel. In the United Kingdom, they are also required to complete specialist training courses for infection control nurses or equivalent at diploma or university degree level. In Hong Kong, a two-week training programme from the university is recommended.

In summary, infection control nurses are responsible for doing the surveillance, analysing data, disseminating the findings to the stakeholders and working out improvement programmes, with regard to infection control. Their functions cover the whole field of infection control and provide hospital-wide service in collaboration with other departments on infection control issues (Ayliffe et al, 2000). Infection control nurses usually visit the wards regularly and discuss the problems with staff. Originally, infection control nurses were required to visit the laboratory every morning to collect the data. With the enhancement of computerized laboratory data and retrieval systems, infection control nurses now collect the data in their office instead. Thus, computer skills are also important for infection control nurses nowadays.

4 Country-Specific Practices

A simple hand hygiene routine devised by Dr. Ignaz Semmelweis (1818-1865) is the earliest infection control practice (Pittet, 2005). Hand hygiene was introduced to students and physicians in 1847 in the maternity clinic of the Allgemeine Krankenhaus (general hospital) in Vienna. The women giving birth to their babies assisted by students and physicians were found to have higher mortality than those assisted by midwives. It was observed that the mortality was due to transmission of “cadaverous particles” from autopsy to the delivery rooms on the students’ and physicians’ hands. After enforcing the hand hygiene practice before every patient contact, the mortality rate dropped dramatically. Nowadays, Dr. Semmelweis is known as the father of hand hygiene.

The concept of infection control practice was further extended by Ms. Florence Nightingale (1820-1910) after her publication of “Notes on Hospitals” in 1863 (Pittet, 2005). The book pointed out the direct relationship between sanitary conditions and post-operative complications. It introduced the concept of ward construction and its air control. Nightingale was the first person to suggest nurses to conduct a survey on hospital-acquired infections in hospitals. She is, thus considered as the first nurse epidemiologist.

Nowadays, infection control practice mainly addresses hospital-acquired infections in Hong Kong. Although the term “healthcare-associated infections” has now replaced “hospital-acquired infections” in many context (World Health Organization, 2011b), “hospital-acquired infection” is used here because this research has focused on the practices of infection control nurses in hospitals. Because of the variations in geographic locations, infectious disease epidemiology and resources of healthcare settings, infection control practice of different countries varies and is thus “local-specific” (Mehtar, 1995). In the following sections, I examine infection control practice in three developed countries, namely the United Kingdom, the United States of America and Australia.

4.1 United Kingdom

In the United Kingdom, when the first infection control nurse was appointed in 1959 (Emmerson et al., 1997; Gardner et al., 1962; Infection Prevention Society, 2009; Worsley, 1988), she was the liaison officer responsible for the promotion of new lines of communications for dealing with the problems of cross-infection (Gardner et al., 1962).

Today, infection control nurses of the United Kingdom do more than liaison and communication works. Ayliffe et al. (2000) recommends the daily activities of an infection control nurse:

1) identify possible potential infection hazards in patients, staff or equipment;

2) compile records of infected patients during ward visits and discussion;

3) advise prompt isolation of infected patients as appropriate;

4) compliance check on policy and procedures;

5) liaison between laboratory and ward staff and advise on infection control problems;

6) collaborate with occupational health staff in managing infected staff;

7) collaborate with community nurses and advise on infection problems;

8) liaise with public health medical officer;

9) communicate with other healthcare partners as appropriate;

10) staff education;

11) liaise with nurse managers about difficulties in carrying out infection control procedures;

12) attend relevant meetings, such as nursing procedures, clinical audit, risk management, equipment purchasing, reuse of single-use item, occupational health, etc.

13) develop and update infection control policies and guidelines;

14) advise on purchase, decontamination and renovation, etc.;

15) collaborate with sterile supplies manager as appropriate.

4.1.1 Competency for Infection Control Nurses in the United Kingdom

The first standard of the United Kingdom for infection control nurses was reported in the joint report of the Department of Health and Public Health Laboratory Service Hospital Infection Control Working Group in 1995 (King, 2005). The report stipulated that infection control nurses should attend a training course in Education and Infection Control that was approved by the English National Board (Ayliffe et al, 2000; King, 2005). However, infection control nurses commented that there were inconsistencies between infection control training and the course content. Based on a competency-based approach adopted by the Nursing and Midwifery Council and their definitions of nursing practice, the Infection Control Nurses Association (now the name has been changed to Infection Prevention Society) developed a list of core competencies for infection prevention and control (first edition) in 2000 (Infection Control Nurses Association, 2004). With the publication of the self-assessment tool in 2001, infection control nurses then began to define their training needs by referencing the Infection Control Nurses Association competencies. Feedback from users of infection control nurses was collected continuously after implementation. The revised document combined the core competencies and self-assessment tool was published in 2004 (Infection Control Nurses Association, 2004). In the second edition, core competencies have been grouped into 15 areas as listed in Appendix 3-1.

The core competencies self-assessment for infection control nurses is a scoring system to work out a strengths-versus-opportunities ratio for each competency area (Infection Control Nurses Association, 2004). Each competency area includes several items. There are five level descriptors for rating each item; they are “expert”, “highly developed”, “refining”, “developing” and “not applicable”. For competency area, the number of “expert” and “highly developed” would be summed to yield a single “individual strengths” score; while the number of “refining” and “developing” ratings would be summed to yield a single “learning opportunities” score. These two scores yield the strengths-versus-opportunities ratio for a competency area. Lower ratio indicates strength, while higher ratio indicates greater need.

The second edition of core competencies describes four domains of competency areas, namely specialist knowledge, healthcare governance, learning and teaching, and leadership and management, and, within these domains, a total of 15 competency areas (Infection Control Nurses Association, 2004). “Infection crisis” and other daily practice falls on “specialist knowledge” domain. The “health governance” domain includes research and development, compliance monitoring and risk management, etc. The domain of “learning and teaching” includes the learning of the practitioner and education delivery for other healthcare workers. “Leadership and management” domain describes how to escort the team services and other administrative duties for the infection control nurses.

The United Kingdom acknowledges that the effectiveness of infection control nurse relies heavily on liaison between other healthcare workers; hence they specify skill in communication as a core competency. Besides the hospital colleagues, infection control nurses of the United Kingdom also act as a liaison with patients and the public. Activities of surveillance, risk management and programme evaluation are their fundamental practices. Their risk management is proactive and more cautious. Infection control nurses of the United Kingdom respond immediately to the preliminary laboratory report, while infection control nurses of the United States, who investigate infections only after the surveillance data is available or confirmed by the laboratory (Mehtar, 1995). Staff education is more prominent than in other countries as more time is allocated. Team and service management is the basic administrative duties. Professional development activities, such as continuing education and research, are also required. More than liaison and communication works, policy development and consulting have been recommended by Ayliffe et al. (2000) but not advised in their second edition.

4.2 United States of America

4.2.1 Study on the Efficacy of Nosocomial Infection Control (SENIC)

On the other side of the globe, in the United States, the Study on the Efficacy of Nosocomial Infection Control (SENIC), which was conducted by the Centers for Disease Control and Prevention in the 1970s, is the first publication in the United States describing the infection control practice in an acute care setting (Haley, Culver, White, Morgan, Emori, Munn & Hooton, 1985;

Goldrick, 2005). After surveying infection control practitioners in the United States in the period 1976-77, they grouped infection control practices under five main headings, namely, surveillance, policy development, training, epidemic investigations and consulting (Goldrick, 2005; O'Boyle, Jackson & Henly, 2002). Surveillance is the major activities of infection control practitioners in the United States, and they spend 50% of their daily work time on it (Mehtar, 1995). Epidemic investigations are the follow-up work of surveillance. Training is a significant infection control practice but the time allocated to it for infection control practitioners in the United States (25%) is less than for infection control nurse of the United Kingdom (35%) (Mehtar, 1995).

4.2.2 SHEA and APIC Consensus papers in the United States

The Society for Healthcare Epidemiology of America (SHEA) and The Association for Professionals in Infection Control and Epidemiology, Inc. (APIC) published a consensus paper to elaborate the functions of infection control and epidemiology for acute hospitals in 1998 (Scheckler et al., 1998). The paper recommends that infection control, through problem identification, data collection and analysis, interventions utilizing changes in policies and procedures, and continuing data collection for monitoring outcomes, be considered the main function. According to the paper, the means to achieve effective infection control include:

1) data management, such as surveillance of infections;

2) development of policies and procedures;

3) implementation of interventions; and

4) staff education and training.

Apart from the abovementioned infection control practices, other activities include monitoring of antibiotic usage, consultation on microbiology laboratory, product evaluation, facility design, coordination of other quality assurance programmes and research activities. According to these perceived functions, SHEA/ APIC developed a list of essential activities of infection prevention and control for healthcare facilities, as summarised in Table 2-1.

Table 2- 1: Summary of essential activities for infection control and epidemiology in acute hospitals by the Society for Healthcare Epidemiology of America (Scheckler, Brimhall, Buck, Farr, Friedman, Garibaldi, Gross, Harris, Hierholzer, Martone, McDonald & Solomon, 1998)

1)	Managing critical data and information
2)	Setting and recommending policies and procedures
3)	Compliance with regulations, guidelines, and accredition requirements
4)	Employee health
5)	Intervening directly to prevent transmission of infectious diseases
6)	Education and training of healthcare workers

The activities recommended by the 1998 SHEA/ APIC consensus paper are similar to the core competencies listed in the 2004 publication (the second edition) by the Infection Control Nurses Association of the United Kingdom. For example, both explicitly include surveillance, compliance checking, staff training and outbreak investigation. The 1998 SHEA/ APIC consensus paper also mentions other activities, such as employee health and setting policies. However, the coverage of these two aspects varies between the two documents. For examples, the core competencies of Infection Control Nurses Association in United Kingdom require infection control nurses manage the immunization programmes and support the Occupational Health Department only, while the employee health activities in 1998 SHEA. APIC consensus paper is described in a more comprehensive approach. On the other hand, the policy setting in the United Kingdom is only described when applying specialist knowledge in decontamination but it serves as an activity category in SHEA/ APIC consensus paper.

A year later in 1999, SHEA and APIC published another consensus paper on essential activities of infection control and epidemiology in out-of-hospital settings (Friedman et al., 1999). In this paper, the out-of-hospital settings referred to are: extended care (long-term care facility, rehabilitation facility, skilled nursing facility and hospice), ambulatory care (outpatient surgery, dialysis centre, infusion centre) and home care with intravascular or other device-related care. The recommended activities are similar to those of the acute hospitals published in 1998 (the 1998 SHEA/ APIC consensus papers). The activities are summarized as below:

- surveillance and report of adverse events;
- developing the policies and procedures;
- compiling regulations, guidelines and accreditation requirements;

- employee health;
- infection prevention and outbreak control;
- staff education;
- training for infection control personnel; and
- resources for infection control personnel.

4.2.3 APIC/ CHICA-Canada Professional and Practice Standards for Infection Control and Epidemiology

In the same year (1999), the Boards of APIC and Community and Hospital Infection Control Association–Canada (CHICA-Canada) published professional and practice standards for the infection control profession, entitled “APIC/ CHICA-Canada Infection Control and Epidemiology: Professional and Practice in 1999” (Horan-Murphy et al., 1999). There are two components of the standards, namely professional standards and practice standards. These standards are the authoritative statements reflecting the expectations of the profession and the public and describing the desired outcomes that the infection control professionals are responsible. The practice standards consist of nine sections related to infection control practices as listed below:

1) infection prevention and control practice;
2) epidemiology;
3) surveillance;
4) education;
5) consultation;

6) performance improvement;

7) programme management and evaluation;

8) fiscal responsibility; and

9) research.

The concept of quality improvement/ compliance checking is introduced under the section “performance improvement”. Activities of developing policies and procedures are grouped under “infection prevention and control practice”. Activities in relation to “research” are a stand-alone section. “Consultation” section refers to activities of a higher level service provision. Concepts of management, which come from the sections of “programme management and evaluation” and “fiscal responsibility”, are put into the practice standards. However, the section of “outbreak investigation” is not included in these practice standards. Only epidemiological principles are mentioned (under “epidemiology” section). The professional standards describe accountability, qualifications, professional development, leadership and ethics; summary of these standards may be found in Appendix 3-2.

4.2.4 Practice Analysis Survey in the United States

The practice analysis survey conducted by the Certification Board of Infection Control and Epidemiology, Inc. (CBIC) is an independent exercise that serves as the basis for the content of the certification examination for infection control professionals in the United States (Memish, Soule & Cunningham, 2007). The first such practice analysis survey for infection control practitioners was conducted in 1982. This survey was based on the information from the APIC eight educational standards as published in 1981, namely, epidemiology and statistics, microbiology, infectious diseases, sterilization, disinfection and sanitation, patient care practices, education, management and communication and employee health. Since then, the practice analysis survey has been conducted periodically to follow the changing practice of infection control practitioners closely. The second practice analysis survey conducted in 1992 included, for the first time, a random sample of Canadian infection control practitioners. In 1996, the practice analysis survey further expanded its sample frame to include all healthcare settings in the United States and Canada (Turner, Kolenc & Docken, 1999). In 2001, in order to meet international needs, the practice analysis survey also invited some other international infection control professionals to participate, while in the United States and Canada only those who were eligible for the certification examination could participate. With the publication of the 1999 APIC/ CHICA-Canada standards, as discussed before, both professional and practice standards were incorporated into a single practice analysis survey (Goldrick, 2005). At the time of preparing this research, the most recent practice analysis survey was conducted in 2005 (Curchoe, Fabrey & LeBlanc, 2008). In this survey, 162 work tasks in seven categories were identified. The seven categories are:

1) identification of infectious disease processes;
2) surveillance and epidemiologic investigation;
3) preventing/ controlling the transmission of infectious agents;
4) employee/ occupational health;

5) management and communication;

6) education; and

7) research.

Further details of the evolution of infection control practices in North America are shown in Table 2-2.

Table 2- 2: Evolution of infection control practice in North America

Year	1976	1982	1987	1992	1996	2001	2005
Project	SENIC[1]	PAS[2]	PAS[2]	PAS[2]	PAS[2]	PAS[2]	PAS[2]
Investigator	CDC[3]	CBIC[4]	CBIC[4]	CBIC[4]	CBIC[4]	CBIC[4]	CBIC[4]
Sample infection control practitioners	USA	USA	USA	USA/ Canada	USA/ Canada	International	USA/ Canada/ Saudi Arabia
No. of task	-	60	67	95	127	147	162
Categories	5	8	8	5	5	6	7
	Surveillance			Surveillance/ epidemiologic investigation	Surveillance/ epidemiologic investigation	Surveillance/ epidemiologic investigation	Surveillance/ epidemiologic investigation
	Epidemic investigations	Epidemiology and statistics	Epidemiology and statistics				
		Infectious diseases	Infectious diseases	Infectious process	Identification of infectious disease process	Identification of infectious disease process	Identification of infectious disease process
		Microbiologic practices	Microbiologic practices	Transmission of infection	Prevention/ controlling transmission of infectious agents	Prevention/ controlling transmission of infectious agents	Prevention/ controlling transmission of infectious agents
	Training	Education	Education	Education	Education	Education and research	Education
							Research
	Policy development	Patient care practices	Patient care practices				
		Sterilization/ disinfection	Sterilization/ disinfection				
		Employee health services	Employee health services			Infection control aspects of employee health	Employee/ occupational health
	Consulting						
		Management/ communication	Management/ communication	Management/ communication	Programme management/ communication	Programme management/ communication	Management/ communication

[1]Study on the Efficacy of Nosocomial Infection Control
[2]Practice analysis survey
[3]Centers for Disease Control and Prevention
[4]Certification Board of Infection Control

The results of periodic practice analysis surveys clearly evidence the change in infection control practice over time (Table 2-2). In addition, infection control practice has been also spreading to a broader range of healthcare facilities (Goldrick, 2005). From being hospital-based previously, the infection control now is practiced in rehabilitation, long-term care, day care centres and even in home care. This shows the significance of the 1999 SHEA/ APIC consensus paper for out-of-hospital settings and the demand for infection control services in various healthcare facilities beyond hospital-based settings in the United States (Friedman et al., 1999).

4.3 Australia

Although Australia in the southern hemisphere is far away from North America, a number of position statements and standards of infection control practitioners from the United States and Canada have been adopted into Australian practice under the publication of the Australian Infection Control Association in 2006 (Hobbs, 2007). Few studies on the daily practices of Australian infection control practitioners have been published. A small scale study conducted by Victorian Specialty Interest Group members published in 1982 found that infection control nurses functioned in seven areas: policy formulation, statistics, environmental monitoring, meetings, being a resource person, staff screening (may be related to outbreak situations) and teaching (Victorian Specialty Interest Group Members, 1982). The largest scale survey was conducted of the members of the Australian Infection Control Association in 1999 (Murphy & McLaws, 1999). However, the list of infection control tasks was not clearly reported. Another study was conducted for infection control practitioners in Queensland, but it lacked detailed descriptions of their practice (Gardner, Jones & Olesen, 1999). The other study was conducted for infection control practitioners in Victoria (Hobbs, 2007). Developing a curriculum (DACUM) technique was employed to identify the tasks of infection control practitioners. Ten key tasks were identified. They are:

1) perform administrative duties;

2) develop policies and procedures;

3) minimize infection transmission risks;

4) coordinate surveillance activities;

5) manage adverse events (organization level);

6) manage outbreaks;

7) coordinate immunization programme;

8) undertake educational activities;

9) continuing professional development; and

10) provide expert advice.

The author reported that the ten identified duties were comparable with the national survey conducted by Murphy and McLaws (1999) of the members of the Australian Infection Control Association. Staff health was included in the tasks of "minimize infection transmission risks" and "coordinate immunization programme" and this was not identified as the concern of infection control practitioners in the study of Murphy and McLaws (1999). This difference is not surprising since the two studies were conducted ten years apart and a change of practice can be expected.

4.4 Other European Countries Outside the United Kingdom

In most European countries, their native languages are not English. Hence, most of their publications are probably not written in English and not published in English journals. In spite of a thorough literature search on practices of infection control nurses in European countries, the yield was limited. As far as known, infection control activities existed as early as in the 1970s (Jepsen, 1995).

Dr. Ignaz Semmelweis was an important European who used infection control in his obstetric clinic, Vienna General Hospital, Austria in the 19th century (Widmer, Hugo & Pittet, 1999). He identified the relationship between the hand antisepsis and puerperal fever of post-natal mothers in 1847. In the 1970s, infection control activities such as routine surveillance and large-scale trials were not carried out in Europe. Instead, they mainly relied on the microbiology laboratory and hospital hygiene.

In 1972, a resolution on hospital hygiene was adopted by the Council of Europe (Jepsen, 1995). A decade later, in 1984, the Council recommended a strategy for preventing nosocomial infection control to its member states. The recommendation was not recognized or supported, until the European Forum of Medical Associations of Europe recommended that the national medical associations should take the lead in developing quality of care. The issues were then discussed in January 1993 in Utrecht at a joint session including the member from the regional office of Europe from the World Health Organization.

Infection control practices became more prevalent in Europe after they were imported from the United States in 1970s. They quickly developed in Western Europe when more resources were allocated (Widmer, Sax & Pittet, 1999). Following the model of the United States, many European countries developed nationwide surveillance networks to assess infection control problems, as the first step in establishing infection control practices (Emmerson, 1995). Several well-known surveillance systems have been developed. For examples, the German Nosocomial Infection Surveillance System (KISS) was established in 1996 (Nationales Referenzzentrum für Surveillance von nosokomialen Infektionen, 2010), and a national network for the surveillance of nosocomial infections called PREZIES was launched in the Netherlands (PREZIES national network for the surveillance of nosocomial infections, 2008). The latter system involves co-operation between participating hospitals, the Dutch Institute for Healthcare Improvement CBO and the National Institute for Public Health and the Environment (RIVM). Belgium also maintains a national nosocomial infection surveillance programme on surgical site infections and bloodstream infections (Jepsen, 1995).

In France, infection control has been in operation for twenty years since 1988 (Hajjar, 2008). Initially, all the public hospitals were required to set up infection control committees and this requirement was extended to private hospitals in 1999. The first national infection control programme was launched in 1995, and gradually established over a nine-year period. By 2004, 69% of healthcare settings had developed their infection control teams. Prevalence surveys on healthcare-associated infection were conducted in 1996 and 2001. The regional surveillance networks were transformed into a national surveillance system. The second national programme was started in 2005 for three years when more objective performance indicators had been developed.

A region-wide surveillance network, the Hospital in Europe Link for Infection Control through Surveillance (HELICS), was set up in 2004 for inter-country comparison within Europe (Wilson, Ramboer & Suetens, 2007). It standardized surveillance protocols, including surveillance of surgical site infections, intensive care unit-related infections and prevalence survey of hospital infections (Hospital in Europe Link for Infection Control through Surveillance [HELICS], 2010).

Although most of the national surveillance initiatives in Europe make reference to the system of the United States, European countries have also pioneered some works in infection control, including antibiotic control in Scandinavian countries, digestive decontamination for high-risk critically ill patients and promotion of hand antisepsis instead of traditional hand washing (Widmer et al., 1999).

4.5 Summary

Table 2-3 summarises the infection control practices in major countries after reviewing competencies, standards and results of studies relating to infection control nurses. The practices of the United Kingdom are taken from Infection Control Nurses Association [ICNA] (2004). The North American practices refer to 1999 APIC/ CHICA-Canada standards (Horan-Murphy et al., 1999) and supplemented by the practice analysis survey reported in the certification handbook (Certification Board of Infection Control and Epidemiology, 2005). The Australian practices come from Hobbs's report on practices of Victorian infection control nurses (Hobbs, 2007). Surveillance, outbreak management, education, consultation and continuing professional development are five common areas (shaded). Variability or omissions are found in various categories, highlighting differences in practices in different countries. In other words, infection control practices are local-context specific. This is also true in nursing practices. When realizing the local-context specific characteristics of the nursing practices, critical care nurses in Canada abandoned the core curriculum from the United States and developed an essential competency lists to define their own curriculum, which is local-context specific (Fitch et al., 1996). Same opinion of Bonner and Steward (2001) that generalization of their Australian context advanced practice competency standard for nephrology nursing competency to worldwide was not appropriate. Due to the local-context specific practices, the competencies required by the professionals are also local-context specific (Albanese, Mejicano, Mullan, Kokotailo & Gruppen, 2008).

Table 2- 3: Comparison of infection control practices in major countries

Infection control practices	United Kingdom (ICNA, 2004)	North America	Australia (Hobbs, 2007)
Surveillance	Formulate and conduct surveillance	Develop and conduct surveillance[1]	Coordinate surveillance activities
Management	Resource/ service management	Fiscal responsibility[1] Programme management	Perform administrative duties
Performance evaluation	Monitor effectiveness	Performance improvement[1]	
Employee health	Support OH Department Initiate immunization programme	Immunization Occupational exposure Work restriction[2]	Coordinate immunization programme/ occupational exposure
Outbreak management	Risk management	Outbreak investigation[2]	Manage outbreaks Manage adverse events
Education	Facilitate others to learn	As educational resource[1]	Undertake educational activities
Infection prevention and control practice	In clinical/ non-clinical areas	Develop policies and procedures[1]	Develop policies and procedures Minimize infection transmission risks
Demonstrating knowledge and skills	Decontamination Microbiology Immunology	Identify infectious diseases[2]	Microbiology Surveillance Analytic skills, etc.
Consultation	Act as expert resource	Provide consultation[1]	Provide expert advice
Leadership	Proactive service Lead teamwork	Shape practices Influence policymakers[1]	
Partnership with patient and public	Provide information resources		
Continuing professional development	Life-long learning	Update knowledge Advance the field[1]	Association member Attend workshop
Research	Apply findings Conduct research	Evaluate findings Participate in research[1]	Publish journal articles

[1]Horan-Murhphy et al., 1999
[2]Certification Board of Infection Control and Epidemiology, 2009
Common areas across countries

5 Recommended Activities in Hong Kong

In Hong Kong, an infection control programme, known as hospital infection control service, was first introduced in the 1980's (Seto, 1989). At the beginning, hospital infection control nurses developed their practice according to service needs. Subsequently, the Scientific Committee of Infection Control of Centre for Health Protection (SCIC-CHP) published recommendations for a hospital infection control system in Hong Kong in 2005 (Centre for Health Protection, Scientific Committee on Infection Control, 2005). This SCIC document suggests key areas of hospital infection control activities based on the SHEA/ APIC consensus papers (Scheckler et al., 1998) and a capacity survey conducted by Centre for Health Protection in 2004 (Centre for Health Protection, Scientific Committee on Infection Control, 2005). The key areas are:

1) surveillance;
2) active prevention of infectious disease outbreak;
3) education and training for healthcare workers;
4) employee health;
5) antibiotic stewardship programme;
6) others, such as decontamination, waste management and product evaluation; and
7) collaboration with Centre for Health Protection.

The infection control activities recommended in this SCIC document (2005) are service-oriented to merely give a direction to infection control teams in the hospitals. Although infection control nurses are the main workforce in a hospital infection control team, elements on their practice and professional development were omitted in this document.

Nevertheless, this SCIC document inspires the development of infection control in Hong Kong. Under the section of “education and training for healthcare workers”, the SCIC document highly recommended hospital infection control teams to develop a network of knowledgeable frontline staff, such as infection control link nurse (ICLN) system, to assist infection control teams in monitoring. The concept of infection control link nurses was initially proposed in the United Kingdom (Ching & Seto, 1990). It has been successfully incorporated into a service programme of urinary catheter care in a teaching hospital in Hong Kong. This service programme was evaluated when a new guideline for urinary catheter care was introduced. It was found that the prevalence of incorrect practices was significantly lower in the wards with infection control link nurses than those without (control wards). With this favorable finding, more resources have been allocated to the infection control link nurse system of hospital infection control services thereafter. As such, infection control teams have to set up and manage this system by re-allocating more of their resources in infection control management. After the severe acute respiratory syndrome epidemic in 2003, many hospitals began to revise their hospital structure in infection control, and extra hospital resources were allocated for infection control management. Staff education has become the foremost duty of hospital infection control nurses. Besides infection control link nurses, the “link system” has been further extended to other disciplines, such as doctors and allied health staff.

6 Problems of Hospital-Acquired Infections

The major role of infection control in hospital is to prevent the occurrence of hospital-acquired infections. Hospital-acquired infections are hazards of patients (Krapohl, Manojlovich, Redman & Zhang, 2010). A systematic review of healthcare-associated infections found that the prevalence of hospital-acquired infections ranged from 5.7% to 19.1% in developed countries (World Health Organization, 2011b). In 2005, the National Healthcare Safety Network (NHSN) was established under the Centers for Disease Control and Prevention in the United States. This network merged with the previous surveillance systems including National Nosocomial Infection Surveillance (NNIS) system, which was a nosocomial infection monitoring system (Edwards et al., 2009). One of the objectives of National Healthcare Safety Network (NHSN) is to “facilitate the development of surveillance and analysis methods that permit timely recognition of patient safety problems and prompt intervention with appropriate measures” (Edwards et al., p.783), and hospital-acquired infections have been considered as patient safety problems. These problems introduce significant burden in patients, healthcare workers and the healthcare systems worldwide (World Health Organization, 2008).

6.1 Length of Hospital Stays

A national survey targeting patients who had undergone surgery across 106 Belgium acute hospitals was conducted in 1984. In this survey, apart from focusing on the outcomes of surgical wound infections, bacteraemia and urinary tract infections, it looked into the associations between these infections and other parameters (Mertens et al., 1987). They found an association between increased hospital-acquired infections and increased length of hospital stay.

The first government report on post-operative infection in the United Kingdom in 1960 reported that 9.4% of surgical site infections were detected in the hospitals (Selwyn, 1991). An average of additional 7.3 days of hospital stay was found in the infected patients compared with non-infected ones.

A survey in Hong Kong found that patients with hospital-acquired infections stayed an extra 23 days in hospital (French & Cheng, 1991). Projecting this number to an annual statistics of hospitalization means an extra 42,000 bed-days per year.

Similarly, Plowman et al. (2001) reported that additional lengths of hospital stays ranged from 1.9 days for bloodstream infections to 37.8 days for multiple infections.

Another review of hospital-acquired bloodstream infection reported that such infection in the United States of America prolonged hospitalization by two weeks (Correa & Pittet, 2000). The recent report of World Health Organization estimated that healthcare associated infections cause 16 million extra days of hospital stay in Europe (World Health Organization, 2011b).

From all these results, hospital-acquired infections can be a burden, whereas the resources of a hospital, and even of a healthcare system, can be drained by the increased length of patient-stay. On the other hand, patients are further suffered when hospital-acquired infections occurred during their hospitalization.

6.2 Re-Admission of Patient

Apart from lengthening the hospital stay, hospital-acquired infections may induce the re-admission of patients after their discharged. Sreeramoju, Montie, Ramirez and Ayeni (2010) conducted a prospective cohort study over three-month period of patients who were re-admitted to the hospital. They found that among 797 re-admissions, 114 (14.1%) were related to hospital-acquired infections. These infections were: surgical site infection (50.8%), pneumonia (14%), vascular device associated bloodstream infection (9.4%), *Clostridium difficile* associated diarrhoea (4.4%); and other infectious causes (21%). The patient re-admission burdens the healthcare system, increases the workload of healthcare workers and deteriorates the quality of life of patients.

6.3 Patient Mortality

It is estimated that around 100,000 people die of healthcare-associated infection annually in American hospitals (Saint et al., 2010). In a public hospital of Hong Kong, a seven single-day prevalence survey on patients with hospital-acquired infections was conducted (French & Cheng, 1991). The authors found that an infected patient had 7.4% of an excess mortality rate compared with the non-infected patient. Projecting this rate to the annual statistics in that particular hospital means 130 lives lost per year due to hospital-acquired infections.

A report reviewing hospital-acquired infections in the hospitals of the United States in 2007, found that the death rate of patients was associated with hospital-acquired infections. In addition, it further concluded that catheter-associated bloodstream infection and ventilator-associated pneumonia caused more than two-thirds of deaths, five times higher than the mortality than other hospital-acquired infections (Umscheid et al., 2011).

6.4 Healthcare Costs

The previous discussion on length of hospital stay, re-admission and patient mortality related to hospital-acquired infections, ultimately induces the healthcare costs. Based on the national prevalence surveys of hospital infections in the United Kingdom, the costs of hospital-acquired infections are approximate ￡1 billion each year (Watterson, 2004).

Plowman et al. (2001) conducted an incidence analysis of all the patients admitted to one hospital in the period of 1994-95. The result showed that 7.8% of admitted patients acquired one or more infections during their in-patient hospital stay. Additional length of hospital stay varied in different infections. A bloodstream infection on average required an additional 1.9 days while multiple infections needed 37.8 days. Bloodstream infection was considered as a serious infection with high morbidity and mortality (Niven, Fick, Kirkpatrick, Grant & Laupland, 2010). Although the four patients with bloodstream infection in this incidence analysis did not show much increase in extra hospital stay, two (50%) died during their hospitalizations. The cost of a bloodstream infection was estimated to be 4.3 times of the cost of hospitalization without bloodstream infection, while this additional cost was ￡5,397 (Plowman et al., 2001).

Additional costs for hospital-acquired infections were also analysed in this study (Plowman et al., 2001). Urinary tract infection was found to incur the lowest additional cost among all infections. It was estimated to be ￡1,327 per infection (1.8 times of the cost of having no infection). Multiple infections incurred the highest extra hospital cost of ￡9,152 per patient (6.6 times of the cost of having no infection). On average, patients with infection needed to pay an extra ￡3,154 (2.9 times of the cost of patient without hospital-acquired infection). The study hospital only consisted of 70% specialties among the national public hospital services in England. The authors projected that an extra cost of £930 million could be induced due to hospital-acquired infections in the studied specialties in public hospitals in England.

Plowman et al. (2001) provided a detailed cost analysis for incidences of hospital-acquired infection. In Hong Kong, there is no corporate statistics about hospital-acquired infections in public hospitals for the past few years. The statistics from Plowman et al. (2000) can be applied to Hong Kong's similar incidences of hospital-acquired infection to estimate their costs in public hospitals. Based on the hospital usage statistics in acute and rehabilitation services in public hospitals in the financial year of 2009/10, there were 928,609 in-patients in one year (Hospital Authority, 2010). According to Plowman et al. finding, 7.8% of in-patients acquiring infections during their hospitalization, there would be 72,432 (928,609 x 7.8%) in-patients with hospital-acquired infection in Hong Kong's public hospitals in a year. On average, such patients would generate additional 7.6 days of hospital stay, resulting in 550,483.2 (7.6 x 72,432) extra days of hospitalization a year. As reported in the Hospital Authority Annual Report 2009/10, the cost of one hospital day for acute and rehabilitation services averaged HK$3,590. Thus, the annual extra cost for hospital-acquired infection in acute and rehabilitation services would be approximately HK$1,976,234,688 (HK$3,590 x 550,483.2). This is a huge burden for the healthcare system in Hong Kong.

Murphy (2002) reported that epidemic surgical site infections increased the healthcare costs in her hospital. Based on a comparison of the baseline infection rates and the epidemic rates, the numbers of preventable infections were calculated. During a one-month period of epidemic surgical site infections in coronary artery bypass graphy, 133 surgical site infections were identified as preventable, and the cost of this epidemic was estimated to be US$4,165,959. In another survey on a 6-month period of gastric bypass epidemic surgical site infection, nine infections cost an extra of US$334,323.

Now, the results of these surveys and studies show clearly that hospital-acquired infections cause problems. They make patients sick further and risk their lives. They are also costly in monetary terms, for patients, for hospitals and even for the whole healthcare system.

7 The Importance of Infection Control

Most hospital-acquired infections can be prevented (World Health Organization, 2008). Literature suggests that 65-70% of the catheter-associated bloodstream infections and catheter-associated urinary tract infections can be avoided by evidenced-based infection control practices (Umscheid et al., 2011). For ventilator-associated infections and surgical site infections, up to 55% of these cases are preventable (Umscheid et al., 2011). An effective infection control programme can reduce hospital-acquired infections thereby reducing morbidity and mortality, and reducing the costs to patients, hospitals and the healthcare system (Emmerson, 1995).

7.1 Reducing the Risk of Hospital-Acquired Infections

In modern hospital care, using different invasive devices on patients is common, but it appears to be a major source of hospital-acquired infections. A national survey in 106 Belgium acute hospitals conducted in 1984 examined surgical wound infections, bacteraemia and urinary tract infections in patients who had undergone surgery (Mertens et al., 1987). It was found that the prevalence of different infections was strongly associated with the devices situated in the specified sites, such as intravascular lines and urinary urethral catheters. These findings were supported by other study which established that hospital-acquired infection rates of intensive care units were the highest compared with other specialties because of their high utilization of devices (Lee, Chiu, Chow, Lam & Lai, 2007; Moro, Stazi, Marasca, Greco & Zampieri, 1986; Smyth et al., 2008). The National Nosocomial Infection Surveillance (NNIS) system of the United States also confirmed that use of devices, such as urethral catheters, ventilators and central lines, is the major determinant of hospital-acquired infection rates (Emmerson, 1995). This was also reported by the World Health Organization that high frequency of infection was associated with the use of invasive devices (World Health Organization, 2011b).

In order to lower the risk of device utilization, infection control advice to hospital frontline staff emphasizing the safe practice when using the devices is often useful.

Hand hygiene of healthcare personnel is a known risk factor of spreading organisms that cause infections, thus promoting hospital-acquired infections (Mertz, Dafoe, Walter, Brazil & Loeb, 2010). Many effective infection control programmes were designed to increase the hand hygiene compliance of staff in order to minimize this risk in healthcare settings (Mertz et al., 2010). With an increase of hand hygiene compliance from 65% to 88% in a neonatal invasive care unit, the hospital-acquired bloodstream infections dropped from 44.5% to 36.1%, with a drop of overall hospital-acquired infection rate from 17.3 to 13.5 per 1,000 patient-days (Helder, Brug, Looman, Van Goudoever and Kornelisse, 2010). All these effective measures are led by infection control service to direct the patient safety in healthcare.

7.2 Reducing Morbidity and Mortality

The SENIC (study) was conducted by the Centers for Disease Control and Prevention of the United States of America in mid-1970s and was reported in 1985 (Haley et al., 1985). It involved 500 randomly selected acute hospitals in the United States. Infection control programmes, manpower and infection rates were assessed comprehensively. As outcome indicators, infection rates were analysed at 2-month, 12-month and 5-year apart. The SENIC looked into different hospital-acquired infections, including pneumonia, surgical site infection, urinary tract infection and bloodstream infection over 5 years' time, and it compared the infection rates between hospitals with and without very effective infection control programmes. In relation to overall hospital-acquired infection rates, hospitals without infection control programmes showed an increase rate of 18%, while hospitals with very effective infection control programmes, including surveillance programmes, demonstrated a decrease rate of 32%. The impact of effective infection control programmes on individual infection rates, as reported by the SENIC, is summarised in Table 2-4.

Table 2- 4: Impact of very effective infection control programmes (SENIC) on hospital-acquired infection rates over 5 years (1970-1975)

Situation\ Infection	Pneumonia	SSI	UTI	BSI	Total
With very effective infection control programme	-27.4%	-34.9%	-30.5%	-35.1%	-32%
Without infection control programme	+9.3%	+13.8%	+18.5%	+25.5%	+18%

SSI = surgical site infection
UTI = urinary tract infection
BSI = bloodstream infection

Another study conducted in a district general hospital in the United States demonstrated the incidence of hospital-acquired infection reduced from 7.6% in 1978 to 3.9% in 1988 (Raine, 1991). This reduction could be explained mostly by the implementation of various infection control programmes in the past ten years.

Prevalence surveys of hospital infections are commonly conducted to assess the effectiveness of the infection control programmes. In Thailand, a prevalence survey in hospitals with over 200 beds in 1988 reported 11.7% of hospital-acquired infections (Danchaivijitr, Tangtrakoo, Waitayapiches & Chokloikaew, 1996). Infection control activities of those hospitals were markedly increased in 1992. They included a diverse range of activities, for examples:

- employing part-time infection control nurses while full-time infection control nurses were not available;
- setting up infection control committees;
- deploying part-time infection control nurses for launching infection control programmes, such as surveillance activities;
- enhancing knowledge acquisition and exchange between infection control personnel, such as presenting their research work;
- attending teaching sessions; and
- setting guidelines and exchange their experience in annual workshops.

A subsequent prevalence survey of 1992 showed a reduction of hospital-acquired infections from 11.7% (in 1988) to 7.3%.

Hospital-acquired infection is a major cause of morbidity and mortality in healthcare settings (Cole, 2007). The occurrence of hospital-acquired infections is the surrogate variable for morbidity and mortality of patients (Davey, Hernanz, Lynch, Malek & Byrne, 1991). As effective infection control programmes can reduce the hospital-acquired infections, it means that they can reduce patient morbidity and mortality.

Klevens, Edwards, Richards Jr, Horan, Gaynes, Pollock and Cardo (2007) reported that that the overall death rate of hospital-acquired infection was 5.8% in the United States. Different death rates were contributed by different infections from the highest in ventilator-associated pneumonia (14.4%) to the lowest in catheter-associated urinary tract infection (2.8%). Correa and Pittet (2000) also reviewed that the hospital-acquired infection was 27% attributable to a patient's mortality. Reducing hospital-acquired infection by effective infection control programme helps to reduce the patient mortality.

7.3 Reducing the Costs

Good infection control programmes for preventing infections is more cost-effective than treating hospital-acquired infections (Stone, Larson & Kawar, 2002; World Health Organization, 2008). Additional hospital stays (including extra days and re-admission), treatment costs, and patient lives related to hospital-acquired infections are healthcare costs. In a literature review on cost estimation of hospital-acquired infections conducted between 1990 and 2000 in the United States, attributable cost and intervention cost were audited (Stone et al., 2002). Attributable cost meant the cost induced by the hospital-acquired infection. Intervention cost defined as the effective infection prevention programme on that particular infection. Stone et al. (2002) revealed that the mean attributable cost for hospital-acquired infection was US$13,973 while its intervention cost was US$1,138, one-tenth of the mean attributable cost. The mean attributable costs for bloodstream infection and Methicillin-resistant *Staphylococcus aureus* infection were even as high as US$38,703 and US$35,367 respectively. However, their intervention costs were US$5,622 for bloodstream infection and US$4,808 for Methicillin-resistant *Staphylococcus aureus* infection. Cost saving was reported in the pneumonia intervention programme without any figures provided. In the review of Stone et al. (2002), the cost for effective infection prevention and control programmes was much less than the attributable cost of the hospital-acquired infections.

Surveillance and benchmarking activities are commonly utilized to promote effectiveness of infection control programmes. By reporting the infection rates and giving feedback to the staff concerned to increase their awareness, these simple activities can reduce the infection incidence substantially (Emmerson, 1995). In the United States, national surveillance system was organized by the Centers for Disease Control and Prevention, and the National Nosocomial Infections Surveillance (NNIS) system was developed in 1970 (Cardo et al., 2004). With the standardized surveillance protocol and voluntary reporting mechanism for acute care hospitals, this system defined benchmarks of all incidents of hospital-acquired infections within the country. It showed reduction in bloodstream infection rates in intensive care units from 1990 to 1999 (Centers for Disease Control and Prevention, 2000).

Based on the National Nosocomial Infections Surveillance (NNIS) system, the Government of Victoria State of Australia established a similar surveillance system to monitor the hospital-acquired infection, named as Victorian Hospital Acquired Infection System (VICNISS), in 2002 (VICNISS Hospital Acquired Infection Surveillance Coordinating Centre, 2010). According to a six-year surveillance, the system reported that a reduction trend of surgical site infections was noted in various surgical procedures (VICNISS Hospital Acquired Infection Surveillance Coordinating Centre, 2008). Surgical site infections are hospital-acquired infections. They attribute additional costs in healthcare (Stone et al., 2002). Reducing these infections can reduce the associated costs. Different infection control programmes, including surveillance activities, show effective in reducing the hospital-acquired infections. At the same time, the associated healthcare costs are lowered.

7.4 Promoting Staff Safety

Besides emphasizing patient safety in reducing the hospital-acquired infections, infection control practice also improve staff safety. Staff education to prevent transmission of organisms and diseases, including hand hygiene, the use of personal protective equipment and other precautions, serves the duel purposes of preventing hospital-acquired infection of patients and promoting staff safety to minimize their acquisition of infections. Other infection control activities include reducing occupational injury of healthcare personnel and promoting occupational health, such as precautions of sharps injury and blood and body fluid exposures, and staff vaccination programmes, benefit staff in occupational safety (Gilmore, 2003).

8 Local-Context Specific Practices to Share Common Goals

Infection control specialists have different practices in different countries, even though they have common goal of infection control. For example, infection control nurses in United States spend 50% of their time on surveillance activities, as compare to 15% in the United Kingdom (Mehtar, 1995). This may be due to the greater manpower in the United States. In contrast, the infection control nurses in the United States spend less time on staff education than those in the United Kingdom. The reasons of all these different practices may be due to the differences in culture, training, client groups, disease epidemiology, resources, healthcare structure, etc.

Hong Kong was a British colony before 1997, and its infection control practices followed the system of the United Kingdom since its initial establishment in 1959s. With easily accessible information worldwide, the infection control practices of the United States influenced the practices of Hong Kong, such as the surveillance models. However, resources for infection control service are often limited in Hong Kong, as compared to the healthcare system of the United States. The practices of isolation precautions in the United States, for example, cannot be directly adopted because of the lack of isolation rooms in the healthcare setting in Hong Kong. Hong Kong follows the system of United Kingdom and infection control teams are formed by members from different departments, infection control nurses from the nursing section and the infection control officer from the department of microbiology/ medicine. In North America and Australia, many hospitals have their own individual infection control departments. Budget planning is also different. In Hong Kong, budget for infection control is usually programme/ project-based instead of annually budget for the department in other countries.

Although infection control system in Hong Kong has its own specific characteristics, good and useful practices of other countries are integrated into ours from time to time to improve the practices of infection control in local setting. For examples, Hong Kong used to follow the laboratory surveillance system of the United Kingdom in early days. Later, we adopted the target surveillance strategy to the United States. Recently, the antibiotics stewardship programme of Europe for controlling the resistant organisms is used. In Hong Kong we developed our infection control link nurse system (Ching & Seto, 1990). This has been extended to other disciplines after severe acute respiratory syndrome crisis in 2003. The infection control link systems help in promulgating the infection control messages, education and monitoring frontline practices.

The basic goals and concepts of infection control are the same across different parts of the world, but the practices are always local-context specific. No matter the difference in practice, effective infection control programmes reduce the risk of hospital-acquired infections, reduce the patient morbidity and mortality, reduce the healthcare costs and improve staff health and occupational safety. These programmes are planned, organized and delivered by the infection control nurses who are the main workforce in the infection control team of hospitals. Being such an important specialty, a certification programme is necessary to regulate the practice of infection control nurses of Hong Kong. More importantly, the certification programme should be based on the local-context specific professional practice.

CHAPTER 3

LITERATURE REVIEW ON CERTIFICATION

After reviewing the literature describing current principles and practices of infection control in Chapter 2, I will here review certification programmes for infection control practitioners currently available throughout the world. I first introduce the basic concepts of self-regulation in nursing and certification. Values and implications of certification are reviewed. Then I briefly describe the certification programmes for infection control practitioners available outside Hong Kong. Finally I review the situation in Hong Kong with regard to other nurse specialist recognition programmes. After learning from the literature review, there is a pressing need for certification for infection control practitioners in Hong Kong, and that certification has to be local-context specific.

1 Self-Regulation in Nursing

In Hong Kong, there are two types of qualified nurses, namely Registered Nurses and Enrolled Nurses, which we may also call nurse generalists in contrast with nurse specialists. According to the Ordinance, any person who wishes to practise as a Registered Nurse or Enrolled Nurse in Hong Kong must be registered or enrolled with the Nursing Council of Hong Kong (The Nursing Council of Hong Kong, 2010a). A Registered or Enrolled Nurse has received a nursing training programme in a recognized training school and has passed the Licensing Examination for Registration/ Enrolment; or has received training through a pre-registration/ pre-enrolment nursing programme at a recognized training school, for example a university, and has been accredited by the Nursing Council of Hong Kong. A Registered or an Enrolled Nurse cannot practise nursing in Hong Kong unless he or she holds a valid practising certificate issued by the Nursing Council of Hong Kong. At present, there is no formal regulatory system for specialist or advanced level practice.

Nursing practice must ensure the safety of clients and attain a certain standard of quality of care. In order to protect the public from unsafe practices and ensure the quality of healthcare services, a regulatory system is required in nursing practice (International Council of Nurses, 1992). Meanwhile, this regulatory system also informs the public of their choice in services, fosters the development of the profession, creates accountability, confers identity and status, and promotes the socio-economic welfare of nurses. Such a regulatory system may apply to various parts of healthcare systems, including persons who provide healthcare services (so-called service providers), educational programmes for healthcare providers, and healthcare agencies that provide the services (International Council of Nurses, 2001). With respect to educational programmes and service-providing agencies, the process of a regulatory system is named accreditation. In relation to persons, i.e. service providers, the regulatory process is called licensure or certification (Pugliese, Larson, Foote, Jackson & Hierholzer, 1986). In healthcare, this regulatory system is commonly run by the healthcare professionals themselves (self-regulation)—for example, a nursing authority operating the system to regulate the practices of nurse generalists, and professional associations organizing various certification programmes to regulate different practices of nurse specialists.

The International Council of Nurses defines self-regulation as “governance of nurses and nursing by nurses in the public interest” (International Council of Nurses, 2001, p.10). It further explains that the aim of self-regulation is to provide evidence that the practitioners meet the expectations of the public in terms of the standard of practice (International Council of Nurses, 2001).

There are two components of self-regulation, namely mandatory and voluntary (International Council of Nurses, 2001). The mandatory component involves the statutory regulation for the nursing profession. The Nursing Council of Hong Kong is a nursing regulatory body operating under legislation. Members are mainly nursing professionals with a few lay members appointed by the Chief Executive of Hong Kong. The Council operates as a mandatory self-regulatory system for nursing in Hong Kong to ensure the minimum level of competency of the nursing profession for nurse generalists (The Nursing Council of Hong Kong, 2010a). It is responsible for issuing and renewing practising certificates of qualified nurse generalists (registered nurses and enrolled nurses). Since November 2006, a voluntary post-registration/ post-enrolment continuing education system has been set up to encourage nurses to adhere to the up-to-date practice in the dynamic healthcare environment. Nurse generalists are encouraged to update their knowledge and skills by participating educational activities (The Nursing Council of Hong Kong, 2009). Continuing nursing education is suggested for renewal of their practising certificates but the requirement of the continuing nursing education is only a voluntary component.

The voluntary component of the self-regulation, on the other hand, provides chances for the nursing profession and individual nurses to participate in self-regulatory activities (International Council of Nurses, 2001). For instance, a certification system is established by the profession in some countries to regulate the practice of nurse specialists. Optional continuing education is another voluntary component of the regulatory system. Meanwhile, the voluntary component of a regulatory system also serves for personal and professional accountability, such as by taking responsibility for individual and professional capacity building, or by participating in their governance process and personal obligations for the clients and profession. In Hong Kong, the Nursing Council of Hong Kong only provides mandatory regulatory activities for nurse generalists with a voluntary component for renewing practising certificates. So far, it has not yet provided any mandatory or voluntary regulatory system for nurse specialists.

2 Definition of Certification

Certification is one of the processes commonly used to regulate the practice of nurse specialists. According to International Council of Nurses, "Certification is a voluntary time-limited process by which a non-governmental organization within a profession or specialty grants recognition of competence to an individual who has met pre-established eligibility requirements and standards" (International Council of Nurses, 2005b, p.8).

The American Board of Nursing Specialties defines "certification" as the formal recognition of the specialized knowledge, skills and experience demonstrated by the achievement of standards identified by a nursing specialty to promote optimal health outcome (American Board of Nursing Specialties, 2009b). It is a validating process to confirm that an individual has the knowledge, skills, or competencies that are required in that particular nursing specialization (Knapp & Naughton, 2010).

3 Certification System in Nursing

Certification for nurse specialists in North America is well developed and well accepted (International Council of Nurses, 2001). Trained nurses that have been licensed by their nursing board may complete a pre-accredited educational programme, to become Advanced Practice Registered Nurses (APRN) (The APRN Consensus Work Group & the National Council of States Boards of Nursing APRN Advisory Committee, 2008). APRNs, are registered nurses who have completed the accredited graduate-level education programmes. They may work in four roles, namely as certified registered nurse anesthetist, certified nurse-midwife, clinical nurse specialist and/or certified nurse practitioner under the licensure. The four APRN roles are based on the population served including family/ individual across life span, adult gerontology, neonatal, paediatrics, women's health/ gender and psychiatric-mental health. Specialist practice certification is built on APRN licensure. That is, to be a nurse specialist, a nurse must first become a licensed APRN, equipped with the required competency of that specialty and then passed the specialty certification. In the United States, the specialty regulatory system is provided by professional organizations through certification. Certification in nurse anaesthesia was the first certification programme introduced in the United States in 1945 (American Association of Critical-Care Nurses & American Association of Critical-Care Nurses Certification Corporation, 2003). Other examples of certification programmes have been established for nurse specialists, such as medical surgical nurses, hospice and palliative nurses, school nurses, orthopaedic nurses, perioperative nurses, emergency nurses and infusion nurses (American Board of Nursing Specialties, 2009a).

The American Board of Nursing Specialties was established in 1991 to review the specialty nursing certification programmes. The purposes of American Board of Nursing Specialties development are advocating consumer protection, increasing the public's awareness of the meaning and value of specialty nursing certification, and enhancing the prestige, self-actualization, and professional advancement of certified nurses (Gaberson, Schroeter, Killen & Valentine, 2003).

4 Values of Certification

Many studies have investigated the perceived values of certification in nursing practices. They have found that certification is perceived as a process of influencing accountability, accomplishment, professional growth and specialized knowledge, and also as being recognized by employers, peers, and consumers (Byrne, Valentine & Carter, 2004; Niehuhr & Biel, 2007).

A large survey was conducted for certified nurses in the United States and Canada in 1999 (Cary, 2001). A sample of 19,452 certified nurses (nurse specialists in the United States and Canada) from the registries of 23 certifying organizations in the United States, participated in the survey. The results showed that the majority perceived the benefits of achieving certification as being recognized as an expert by colleagues (39%) and the public (32%). Salary increase only accounted for 19%. In personal aspects, certification enabled the certified respondents to experience personal growth (77%) and to feel more satisfied as a professional nurse (67%). In the practice aspects, certification enabled them to feel more competent in their skills as a professional nurse (65%), to feel they were seen as a credible provider (56%), to feel more accountable as a professional nurse (54%), and to experience more confidence in their practice (53%).

In the United States, the perioperative nurses (nurses working in surgical operating theatres) become nurse specialists (certified nurses) in their field by graduating from the corresponding certification programme. The role of scrub nurse (major role of perioperative nurses) has been expanded to the first assistant to the surgeon during surgical operations (Gaberson et al., 2003). In a survey on the perceived value of certification conducted for the certified perioperative nurses and first assistants, three groups of values were identified, namely personal value, recognition by others and professional practice. Personal value includes satisfaction, accomplishment, challenge, professional growth, professional commitment, confidence in clinical ability, accountability and autonomy. Recognition by others means employer recognition, recognition by other professionals, salary, marketability, peer recognition and consumer confidence. Professional practice includes clinical competence, practice standard, knowledge and professional credibility. These values were then developed as a tool to evaluate the perceived value of certification, named as Perceived Value of Certification Tool© (PVCT©). The items of the tool were re-classified afterwards to be intrinsic and extrinsic factors, as listed in Table 3-1 (Sechrist, Valentine & Berline, 2006; Niebuhr & Biel, 2007).

Table 3- 1: Items of Perceived Value of Certification Tool©

Items of Perceived Value of Certification Tool©
Intrinsic factor items
Enhances feeling of personal accomplishment
Provides personal satisfaction
Validates specialised knowledge
Indicates professional growth
Enhances professional credibility
Provides evidence of professional commitment
Provides professional challenge
Indicates attainment of a practice standard
Enhances personal confidence in clinical abilities
Indicates level of clinical competence
Provides evidence of accountability
Enhances professional autonomy
Extrinsic factor items
Increases marketability
Promotes recognition from peers
Promotes recognition from other health professionals
Promotes recognition from employers
Increases consumer confidence
Increases salary

The Perceived Value of Certification Tool© has been used in different surveys to assess how nurses perceive the value of certification. Sechrist et al. (2006) conducted a survey among certified, non-certified and managers of perioperative nurses, while the American Board of Nursing Specialties conducted a national study to validate the perceptions, values and behaviours of nurses related to certification (Niebuhr & Biel, 2007). Both studies showed that certification was valued by nurses, regardless of their certification status and work role. The agreement of statements in the tools was high in both surveys. The exceptional one was "certification increases salary". The low level of agreement in this statement matched previous study results (Gaberson et al., 2003).

Different studies have showed that the perceived values of certification is high among certified, non-certified and administrative nurses (Byrne et al., 2004; Gaberson et al., 2003; Niebuhr & Biel, 2007; Sechrist et al., 2006). As part of a project by the Nursing Credentialing Research Coalition of American Nurses Credentialing Center, an international survey of certified nurses across the United States of America, Canada and United States territories was reported by Cary (2001). A number of positive outcomes, predominantly in practice- and personal-related, were reported by certified nurses (Cliff & Martinez, 2004). In the coming sections, I am going to discuss the outcomes related to certified nurses.

4.1 Fewer Adverse Events

Cary's report (2001) showed only 4% of certified nurses experienced fewer adverse incidents in patient care after being certified. A study was conducted in 48 intensive care units of 29 hospitals to detect the relationship between the proportion of certified nurses and the ratio of six adverse events (Kendall-Gallagher & Blegen, 2009). The six adverse events were: medication administration errors, total falls, pressure ulcers, nosocomial central catheter-related bloodstream and urinary tract infections. Multivariate analyses showed that the proportion of certified nurses in the unit was inversely related only to the incidence of patient falls. The limitations of this study were noted. First, the incidences measured were small. To detect small difference in these few incidences, a much larger sample size would be needed. Second, the data was a set of secondary data of a previous retrospective cross-sectional survey.

The details of certification information were not available. In such circumstances, some other undetected relationships may have been missed.

Another study reported the proportion of certified nurses in an intensive care unit showed inverse relationship to the prevalence of pressure ulcers, central line catheter-related infection rate and bloodstream infection rate but none of these relationships were statistically significant (Krapohl, Manojlovich, Redman & Zhang, 2010). The negative results might be related to the non-experimental, cross-sectional, retrospective study design and limited sample size. The evidence on the relationship between certified nurses and adverse events is not strong but existed.

4.2 Better Clinical Outcomes

A systemic literature review on the linkage of specialty certification and clinical outcomes in the medical discipline was conducted in 1999 (Sharp, Bashook, Lipsky, Horowitz & Miller, 2002). In this review, 56 papers were finally found that met the study's inclusion criteria. In total, 33 separable relevant findings from 13 papers were identified. From the 33 findings, 16 showed positive association between certification status and desirable clinical outcomes. Three indicated worse outcomes among the certified doctors, while 14 could not demonstrate any association.

Frank-Stromborg et al. (2002) assessed the difference of patient outcomes between certified and non-certified oncology nurses. This study was conducted in a homecare agency. Seven certified nurses and 13 non-certified nurses were observed. No differences were found in the study on symptom management, including pain, fatigue and infection, and number of planned/ unplanned visits. Limitations of this study were also identified. First, it was a retrospective document review. The variables, such as pain, fatigue and infection, were not standardized. Some observations might not be documented by the care-givers. Second, the demographic of patients and their cancer-related variables were heterogenic. Third, this study was conducted in one agency: the results might represent the situation only of that particular setting. Last, the sample sizes of the certified and non-certified nurses were small. The result was not suggested to be generalized.

The higher proportion of certified rehabilitation registered nurses was found to be the significant predictor of shorter length of stay in 54 inpatient rehabilitation units (Nelson et al., 2007). The literature review showed that positive outcomes were demonstrated as being associated with certified nurses in some studies. The negative association detection was related to limitations of study design or sample size in most of the cases.

Measuring the relationship between competence of individual nurse and patient outcome or safety is sometimes difficult in certain care-providing areas. This is because nursing practice is characterized as a group. The patient outcome is the outcome of a group's practices instead of an individual practice (Kendall-Gallagher & Blegen, 2009).

4.3 Higher Recognition by Consumers and Supervisors

Regarding the patient perspective, the satisfaction of consumers was found to be higher for certified nurses, compared with non-certified nurses, in some studies. In the patient satisfaction survey regarding the service of oncology nurses, certified nurses received higher scores in overall satisfaction, pain experience satisfaction and nausea experience satisfaction than non-certified nurses, but the differences were not statistically significant (Coleman et al., 2009). Thus the differences observed may be explained by the insufficient sample size.

Another study was conducted by Craven (2007) to measure the change of patient satisfaction after increasing the ratio of certified nurses in the acute care medicine service. It was noted that by increasing certified nurses by 60% in the service, the patient satisfaction on nursing service in terms of excellent rating increased from 88.2% to 90.4%.

As mentioned in the study of Redd and Alexander (1997), although significant difference was not found due to the small sample size of the study, a tendency of higher scores by supervisors was noted in certified nurses than non-certified nurses in the areas of teaching and collaboration.

4.4 Increased Personal Growth

77% of certified nurses reported experiences of personal growth from the certification in Carl's international survey (2001). The study of Krapohl et al.

(2010) also found that there was a positive association between workplace empowerment and the proportion of certified nurse in intensive care settings.

It was found that, compared with the non-certified nurses, the certified candidates presented higher self-esteem (Redd & Alexander, 1997). With high self-esteem, certified nurses showed their confidence in different aspects, including communication, collaboration with others and clinical practice.

4.4.1 More Effective Communication and Collaboration with Other Providers

A collaborative service approach is common nowadays to deal with complicated healthcare problems. Cole and colleagues (Cole, Scoville & Flynn, 1996) presented their successful collaborative approach of care to include certified nurse midwives, advance practice psychiatric nurses and family/ paediatric advance practice nurses taking care of pregnant women with histories of abuse. These collaborative services provided the target clients with integrated physical and psychological interventions in preparing for child birth and post-delivery. Another study conducted by Hendricks and Hendricks (2001) illustrated an effective diabetes care programme involving collaboration of a certified pedorthist and a certified diabetes educator. As public health educators work in teams and carry out their jobs both intra-organizationally and inter-organizationally, effective communication and collaboration skills are important in contemporary healthcare provision (Lovelace et al., 2009). Certified candidates demonstrated with these competent skills help in launching the programmes successfully in the contemporary healthcare environment. As reported by Redd and Alexander (1997), supervisors tended to rate higher scores on certified nurses than non-certified nurses in the areas of collaboration.

4.4.2 Higher Level of Specialized Knowledge and Clinical Competence

The survey by Cary (2001) reported that 65% certified nurses felt more competent in their skills as a professional nurse after certification.

In assessing the nurses' knowledge on staging the pressure ulcers through a web-based examination, registered nurses certified in wound, continence, and/ or stoma care scored significantly higher than the non-certified registered nurses (Hart, Bergquist, Gajewski & Dunton, 2006). Another study assessed the pressure ulcer knowledge of a group of nurses using convenience sampling method reported similar results (Zulkowski, Ayello & Wexler, 2007). A standardized assessment test named as Pieper Pressure Ulcer Knowledge Tool was used. The content of prevention, staging and general wound knowledge was assessed. The respondents, 460 nurses were divided into three groups, those certified in wound care, certified in an area other than wound care, and non-certified. It was found that the certified nurses in wound care got significantly higher scores than the non-certified nurses. This showed that the certification scheme in wound care nurses is successful and that knowledge of nurse specialists can be differentiated.

Besides knowledge of wound care, another prospective study conducted on certified and non-certified oncology nurses showed that the pain knowledge was higher in certified nurses (Coleman et al., 2009). However, significant difference on nausea knowledge was not identified between certified and non-certified nurses. This negative result can be explained by the insufficient sample size of the study in that only 93 nurses were recruited in a desired sample size of 102 nurses.

Apart from the knowledge, other study found that the certified nurse specialists demonstrated higher accuracy in palpitating peripheral pulses and measuring ankle-brachial pressures than non-certified nurses (Kendall-Gallagher & Blegen, 2009). This finding showed that certification has its influence in clinical practice that certified nurses perform better than non-certified nurses.

Validating the specialized knowledge and indicating levels of clinical competence are major values of certification for nurse specialists practice. In addition to perception, the above evidences illustrate that certified nurses do have higher knowledge and are more competent in their practices.

4.5 Benefit from the Employers

Certification had a positive influence on job satisfaction, retention and patient care (American Association of Critical-Care Nurses & American Association of Critical-Care Nurses Certification Corporation, 2003). From the observations of Craven (2007), the patient satisfaction rate on nursing service rose after increasing the number of certified nurses by 60%. From the perspective of employers, such a high patient satisfaction put the hospital in a more competitive position in the healthcare market. In the managers’ view, report showed that 86% nurse managers preferred hiring certified nurses to non-certified nurses (Leak & Spruill, 2008).

Meanwhile, Craven's study (2007) also reported that the turnover rate of registered nurses decreased from 16.7% to 8.1%, and the vacancy rate of registered nurses decreased from 11% to 4.7% when the number of certified nurses increased by 60%. Their job position retention clearly indicates that certified nurses experienced job satisfaction themselves. This observation was further supported by another study that the certified critical nurses were less likely to have the intention of leaving their current position than the non-certified nurses (Fitzpatrick, Campo, Graham & Lavandero, 2010).

5 Potential of Certification in Clinical Care Improvement

Although significant improved clinical outcomes are difficult to find in actual clinical settings, certification has the potential to improve clinical care. Major factors of improving clinical care were identified in the survey of certified paediatric nurses. The factors included enhanced confidence in clinical skills, commitment to learning, professional credibility, interest and willingness to mentor colleagues, recognition by others, professional autonomy and job satisfaction (Wyatt & Harrison, 2010).

This potential was also demonstrated in certified nurses. 53% certified nurses in Cary's survey (2001) reported experiencing more confidence in their practice. Commitment to learning was shown in the study of Coleman et al.

(2009), in that the certified oncology nurses did more hours in continuing education activities, showing their commitment to learn was higher than the non-certified nurses.

Apart from the professional and clinical related implications, professional certification also has its value for healthcare consumers. Cary (2001) reported that the certified nurses in her survey experienced being seen as a credible provider. The value of certification discussed in this chapter—the higher knowledge, more competent practice, fewer adverse events and better clinical outcomes of certified nurses—was demonstrated in the credibility of the certified nurses. 77.2% of the certified paediatric nurses perceived a somewhat high impact of their care on patient or family satisfaction in the 2008 survey (Wyatt & Harrison, 2010). One respondent commented that "When families learn about my specialty certification, they have confidence in my abilities to provide the best care to their children." (Wyatt & Harrison, 2010, p.208).

Apart from benefits to professional practice, certification promotes recognition from peers, other health professionals and employers. The study by Redd and Alexander (1997) showed that supervisors appraised certified candidates as achieving better job performance in comparison to their non-certified counterparts. It reported that certified nurses scored higher performance ratings from their supervisors than non-certified nurses, in the total performance and in the aspects of planning/ evaluation and teaching/ collaboration. This recognition from supervisors is evidenced that certified nurses were enabled to demonstrate better clinical knowledge, skills and competence than non-certified counterparts. With high levels of clinical competence, this recognition from others was one of ten factors associated with improving clinical care (Wyatt & Harrison, 2010).

Although there was no significant difference in job satisfaction between certified and non-certified oncology nurses in the study by Coleman et al. (2009), the national survey for certified paediatric nurses found that 88% respondents experienced excellent to good job satisfaction (Wyatt & Harrison, 2010).

In different surveys of the perceived value of certification, "enhances professional autonomy" was reported in a high proportion (Byrne et al., 2004; Gaberson et al., 2003; Niebuhr & Biel, 2007). All the contributing factors of improving clinical care, namely, confidence in clinical skills, commitment to learning, professional credibility, interest, recognition by others, professional autonomy and job satisfaction, have been shown by the certified nurses or are the characteristics of certification (Wyatt & Harrison, 2010). It is quite convincing to claim that certification is more likely to improve clinical care in any healthcare setting because all the factors that improve clinical care are demonstrated in the certified candidates.

6 Certification in Infection Control

As the pioneer in nursing certification, the United States of America established its first programme in 1945 (American Association of Critical-Care

Nurses & American Association of Critical-Care Nurses Certification Corporation, 2003; Goldrick, 2005). Nonetheless, its certification for infection control and epidemiology only started in 1983. In the members' survey of Association for Professionals in Infection Control and Epidemiology in 1997, only 38% of respondents reported as being certified in infection control (Goldrick, 2007). Studies reviewing the relationship between certified infection control nurses and clinical outcomes are limited. Measuring the relationship between the competence of an individual nurse and patient outcome or safety is sometimes difficult in certain care providing areas because nursing practice is characterized as a group activity (Kendall-Gallagher & Blegen, 2009). The situation is more difficult in infection control nurses as they do not provide direct patient care service. Instead, they indirectly influence patient care practices through educating healthcare workers and implementing infection control programmes. Pirwitz and Manian (1997) conducted a survey of infection control professionals working in in-patient facilities. Fifteen outdated or unscientific infection control practices were listed on the questionnaire. The respondents were asked which practices on the list were parts of their infection control programme. If the practices were in use, the respondents were further asked if they were interested in changing the practices. Demographic data of the respondents, including their certification status in infection control were requested. The results showed that the certified respondents were less likely to use 11 of 15 outdated or unscientific infection control practices than the non-certified respondents. However, when the outdated or unscientific infection control practices were used, certified infection control professionals were more likely to have no intention of changing their practices, as opposed to non-certified infection control professionals. Possible reasons for this lack of intention to change, such as limited knowledge or undefined obstacles, were not further explored. In the absence of correlation studies between certification status and infection control professionals' competence, this survey hinted that certified infection control professionals rather than non-certified infection control professionals were competent in their practices.

In view of having positive influences of certification, this research enhances the professional development in the direction of certification in Hong Kong. Infection control nurses serve as the group to be examined. Before further planning for this research, I will review the established certification programmes in infection control in various parts of the globe.

6.1 United States of America

In the northern hemisphere, the United States of America is one of the leading countries in the field of infection control practice. Its certification in infection control was organized by Certification Board of Infection Control and Epidemiology (CBIC), an independent organization (Miller & Boyle, 2008). The organization has been accredited by the National Commission for Certifying Agencies since 1995 (Docken & Sanders, 1999).

6.1.1 Eligible Candidates for Certification

The certification examination of Certification Board of Infection Control and Epidemiology, Inc. (CBIC certification examination) is designed for practising infection control practitioners. Since 2009, infection control practitioners who meet the requirements on both education and practice are eligible to take the certification examination (Certification Board of Infection Control and Epidemiology, Inc. [CBIC], 2011). Candidates are required to be currently practising infection control, having related responsibilities either in the workplace or in an organization. Infection control practice is defined in the CBIC candidate handbook. Candidates who have not passed the certification or lapsed certificants fall in the category of initial certification. For the initial certification, one should have a minimum of either a baccalaureate degree or the current license or registration of a medical technologist, clinical laboratory scientist, physician or registered nurse. A person who only satisfies with the practice requirement may apply for a waiver of the educational requirements (CBIC, 2011).

6.1.2 Certification Examination

The objective of the certification is to endorse the concept of voluntary and periodic certification in order to encourage infection control practitioners to meet the standards of education and practice. The examination is developed based on the practice analysis survey on infection control (Goldrick, 2007). To ensure the examination content is in line with the evolvement of the practice, the examination content is revised based on the periodic practice analyses. The first practice analysis was conducted in 1982 with the first examination conducted in 1983. The latest practice analysis was completed in 2010 (CBIC, 2011). The examination is conducted in a computerized format in selected centres in the United States and Canada (Pirwitz, 1995). Other test sites may be arranged for an extra fee. The examination consists of 150 multiple choice questions (CBIC, 2011). However, only 135 questions are used to compute the scores. The questions that are too easy or too difficult will be rewritten or disregarded (Pirwitz, 1995). To ensure all the tests are at the same level of difficulty, some questions that are relatively more difficult are reused in subsequent tests.

6.1.3 Recertification

As required by the National Commission of Certifying Agencies, a certification programme must have a recertification process (Pirwitz, 1995). The CBIC certification is valid for five years after passing the examination. The recertification examination is in a web-based format called the Self Achievement Recertification Examination (SARE). The SARE also contains 150 multiple choice questions (CBIC, 2011). The questions focus on the most current advanced infection control practices. As other objectives for SARE are proposed based on the dynamic infection prevention and control strategies, the questions of SARE are more difficult because the CBIC believes that these recertifying candidates have at least five years more experience than the candidates who take the initial examination.

6.1.4 Title Granted for Certified Candidates

Candidates who passed the certification examination are entitled to use the designation “CIC®” after their names. The certification on infection prevention and control will expire five years after passing the examination, and candidates need to be successfully recertified in order to retain the “CIC®” title (CBIC, 2011).

6.1.5 International Development

As the custodian of a well-developed certification examination for infection control practitioners, the CBIC is expanding its credentialing boundaries beyond North America. Through the network of Applied Measurement Professionals, Inc., international test centres have been set up all round the world, including Asia (including Hong Kong), Europe and Africa (Memish, Soule & Cunningham, 2007).

6.2 Australia

In the southern hemisphere, Australia is the leading country in infection control practice. Its certification in infection control is called the “Infection Control Professional Credential” organized by the Australian Infection Control Association (AICA), which is a member of National Nursing Organization (Hunt & Hellsten, 2006). The credential is a self-regulatory process to acknowledge the relevant nurse specialists who have demonstrated the described competency (Australian Infection Control Association [AICA], 2007). In view of there being no specified qualification and training assessment for practising infection control in Australia (Raird, 2006), the AICA made a pro-active move to initiate this credentialing process in order to (AICA, 2007):

1) establish a national standard by identifying a group of experts who are the designated specialists or who possess advanced expertise;

2) set up qualifications for independent practice and career development; and

3) enhance the quality of care through informing customers and assisting employers about managing risks.

However, the development process of the credentialing package was not reported. The AICA credentialing process was started in December 2000 (Hunt & Hellsten, 2006). Because of poor response from members, the credentialing process was suspended for a few years for further revision. Through extensive consultation, the credentialing package was revised and re-launched in 2006. At present, only small numbers of AICA members have been credentialed. According to the credentialed list of infection control professionals published on the AICA website on 24 March 2011, 57 infection control professionals have been credentialed to date (AICA, 2007).

6.2.1 Credentialing Process

The credentialing process only caters for the members of AICA. It is an assessment method through self-reporting (AICA, 2009a). There are two components for submission. The first is educational component and the second is other component. Applicants may obtain 20 to 90 points in the educational criteria based on their highest educational qualification. For example, the lowest educational level, Bachelor of Nursing from a recognized tertiary facility will get 20 points. The highest educational level, PhD in Infection Control or related discipline will get 90 points. Another 100 points are allocated for other criteria in five sections as shown in Table 3-2.

Table 3- 2: Points allocation for Other Component of AICA credentialing for infection control professional

Other component	Points
Portfolio submission	25
Education project	25
Peer review submission (mandatory)	20
Personal statement/ critical review	20
Current curriculum vitae (mandatory)	10

For the portfolio submission (25 points), applicants may choose one topic on a specific outbreak situation, on a quality improvement activity or on an infection control policy/ procedure that was developed. In the education project (25 points), a detailed description of an educational programme/ project is needed. Peer review is a mandatory portion (20 points). Applicants are requested to identify a suitable review article and to write up a commentary on their professional management practices and interpersonal skills according to the guidelines. A personal statement/ critical review is needed to discuss a critical review and personal reflection of the applicant’s contribution to infection control (20 points). The conditions include publications, conference presentations/ attendance, membership of professional body, participation in any significant/ relevant education or research endeavours, major projects, awards/ grants received, continuing education or any other activities/ achievements. Lastly, the current curriculum vitae of the applicant are requested (10 points). Detailed guidelines for preparing the written documents have been clearly described in the application package for applicant's reference. As a whole, the credential will only be granted to the candidate who gains at least 100 points (AICA, 2009a). The submission is individually assessed by the members of Credentialing Committee of AICA. The AICA Executive makes the final decision on awarding a credential based on the recommendation of Credentialing Committee.

6.2.2 Re-Credentialing

One may apply for re-credentialing at the end of the third year of credentialing (AICA, 2009a). Credentialed infection control professionals whose credential has lapsed for more than six months from the expiry, are required to complete the whole credential process instead of the re-credentialing process. The re-credentialing process depends on a self-reporting submission. The content required is less extensive than for initial credentialing (AICA, 2009b).

6.2.3 Title Granted After Successful Credentialing

The names of those successfully credentialed infection control professionals (CICP) are added to the database of AICA. They are entitled to use the post-nominal title "CICP" for three years after credentialing. However, the CICP is not eligible for using the said title if he or she is no longer practising infection control even within the valid period of credentialing (AICA, 2009a).

6.3 Korea

Following the revision of its Medical Service Act in 2003, Korea launched a formal infection control nurse specialist graduate programme, which is a master's degree programme. The infection control nurses graduating from the programme are certified through the national qualifying examination, known as the Korean certification examination. Candidates who pass the examination are certified as infection control nurse specialists. The first examination was organized in 2006 and it is now an annual exercise. This examination is supervised by the Korean Accreditation Board of Nursing. The board prepared the job description of the nurse specialists and standard curricula through several workshops. The questions were developed from the expertise of infection control nurses, nursing professors and medical professors. The Board of Examination, consisting of infection control experts and nursing professors, is responsible for selecting questions for the examinations (Kim, Jeong & Park, 2010).

The Korean certification examination consists of two components: a written part and practice. The written part contains 150 multiple-choice questions. After passing the written examination, a practical examination conducted in a simulated clinical setting will follow. A pair of nursing professors and infection control nurses with more than 10 years experience in infection control act as the evaluator group. They identify the assessment protocol before the practical test and they assess the candidate together. The test comprises one hour of questions about infection control intervention and 10 minutes of skills demonstration, such as hand hygiene, donning of personal protective equipment, and so on (Kim et al., 2010).

At present, no title is available for the certified infection control nurse specialists, but the certificants need to complete 10 hours continuing education each year to maintain their certification (Kim et al., 2010).

Although the Korean infection control nurses are eligible to sit for the certification in infection control organized by the CBIC in the United States, most opt to complete the Korean certification examination (Kim et al., 2010). Based on the published information in 2006, only one infection control professional from South Korea was certified by CIC® of CBIC examination of the United States (Memish et al., 2007). The Korean examination is a little different from the ordinary certification programme. It likes an exit examination for infection control nurse specialists, which is a one-off exercise.

6.4 United Kingdom

The United Kingdom, despite being the pioneering country in infection control practice in the world, does not have any certification programme for infection control practitioners at present. Considering the benefits of validating the abilities of the practitioners, the Infection Prevention Society is aware of the needs to investigate the platform to provide credentialing on competencies achievement (Burnett et al., 2009). From the published data in 2006, only three infection control professionals from the United Kingdom was certified by CIC® (Memish et al., 2007).

Globally, certification programmes for regulating infection control practice are available in the United States, Australia and Korea. Only the programme of the United States is open to practitioners internationally. Participating in the certification programmes of other countries may not serve the purpose of validating the competency level of the practitioners in local setting because the practices may vary across different parts of the world (Chan, 2005). That's why the infection control specialist groups in Australia and Korea develop their local-context specific certification programme instead of participating in the certification programme in other countries.

7 Situation in Hong Kong

As noted above, in Hong Kong, the self-regulation system organized by the Nursing Council of Hong Kong only applies to nurse generalists, who are registered nurses and enrolled nurses. The certification system for recognizing and regulating the practice of nurse specialists does not exist.

7.1 Nurse Specialist Recognition Programme in Public Hospitals

As of this writing (May, 2011), Hong Kong does not have a formal regulatory system for nurse practice at specialist levels. With the growing complexity and specialization of healthcare, the Hospital Authority — the organizational body of public hospitals of Hong Kong — started the practice of nurse specialists, the so-called "post-basic specializations in nursing" in 1993. Initially, the recognized nurse specialists were required to have at least five years of clinical experience, as well as a certificate in the specialty and a nursing degree. In recent years, the title of Advanced Practice Nurse was used to recognize this group of specialists (Wong, 2009). According to the definition of the International Council of Nurses, an Advanced Practice Nurse is "a registered nurse who has acquired the expert knowledge base, complex decision-making skills and clinical competencies for expanded practice, the characteristics of which are shaped by the context and/ or country in which s/he is credentialed to practice. A master degree is recommended for entry level" (International Council of Nurses, 2005b, p.5).

The Hospital Authority launched a specialty nurse recognition scheme, a form of the Institutional Licensing Model, at the end of 2009. According to an internal document of the Hospital Authority (Hospital Authority, Co-ordinating Committee (Nursing), 2009), registered nurses working in the Hospital Authority who fulfil the specified educational requirements and post-registration experience in the specialty will be granted the title of specialty-nurse in that area. Infection control is one of the recognized specialties in the scheme.

7.2 Preparation for Regulating Specialist Practice in Nursing

Nurse specialists have been recognized in Hong Kong under the umbrella of Hospital Authority since 2003. A preparatory committee was set up in 2006 to establish the Hong Kong Academy of Nursing to regulate the practice and promote the professional development of advanced practice nurses in post-basic specialties (Hong Kong Academy of Nursing, 2011). The preparatory committee proposed to develop colleges of different nursing specialties under the Hong Kong Academy of Nursing.

7.3 Certification Activities in Infection Control Professionals in Hong Kong

Although there is no formal certification system for infection control professionals in Hong Kong, local infection control nurses (ICNs) participated from time to time in the CBIC certification examination of the United States to test their competency level in infection control. However, many nurses said that candidates with CIC® granted successfully from the system of the United States only felt that they were competent to work in the United States instead Hong Kong situation (Chan, 2005). According to the information published in 2006, eight infection control professionals (doctors and nurses) were certified by CIC® (Memish et al., 2007).

8 Demand for a Model for Developing the Certification Content

In the literature review in this chapter, I have assessed the values of certification. Apart from the perceived high values from both certified and non-certified nurses, studies demonstrated that certification was associated with higher patient safety, higher consumer satisfaction, increase in personal growth of certificants and other benefits from the employers, such as lower turnover rate of certified nurses.

Although the certification programme in infection control in the United States is open internationally to all, countries, such as Australia and Korea have their own certification programme because local infection control practitioners are fully aware of the importance of local-context specificity. It is acknowledged that some questions in the CBIC certification examination are not fit for the infection control professionals in other countries because of the unique characteristics of different geographic areas, such as cultural norms, economic realities and clinical practices (Memish et al., 2007).

Certification is not solely a professional issue. In the United States, since the implementation of nursing specialty certification in 1945, public awareness of nursing certification increased over time (American Association of Critical-Care Nurses & American Association of Critical-Care Nurses Certification Corporation, 2003). In a national survey conducted by Harris Interactive in 2002, among 1,039 American participants, 8 out of 10 respondents knew that nurses could be certified (American Association of Critical-Care Nurses & American Association of Critical-Care Nurses Certification Corporation, 2003). The awareness level on nursing specialty certification was higher than other disciplines, such as the certification of teachers and of physicians. This survey also showed that 9 out of 10 respondents believed that it was very important for nurses to update their knowledge and skills regularly if they were taking care of critically ill patients. Most of the respondents showed that they were more likely to choose a hospital with a higher ratio of certified nurses.

The situation is similar in Hong Kong. To ensure the quality of care, more and more private and public hospitals in Hong Kong join hospital accreditation scheme. Certification of healthcare professionals, which regulates their professional practice, is an important part and is a desirable quality control process for nurse specialists in a healthcare system. Certification programme must be a valid tool. Valid means that the content for the certification programme can reflect the practice of the local region or own country (Memish et al., 2007). Foreign certification programmes developed by other countries do not serve this purpose as healthcare practices are context-specific. Locally developed certification programmes are desirable. Also, in an ever changing healthcare environment, certification programme development must be a dynamic process, that is the content for the certification programme must be regularly revised to fit local changing practice. The establishment of the Hong Kong Academy of Nursing aims at paving the way for nursing specialization and a process model can facilitate the development of a certification content blueprint, thus guiding the development of certification programme.

CHAPTER 4

INFECTION CONTROL IN HONG KONG

1 Introduction

After reviewing the literature on infection control and certification, this chapter introduces the situation of local infection control, including the service, training of infection control nurses and the related credentialing activities. At the end, I conclude the needs of the process model for developing the certification content as proposed for this research.

2 Need for Certification in Nursing Profession

Healthcare is growing more complex nowadays because of advanced technology in treatment and increasing survival at the extremes of life, namely newborns and the elderly. Nurses taking care of people at these extremes need advanced knowledge and skills. Other than direct patient care, some nurses have new responsibilities in healthcare practices, for example, infection control.

Infection control entails taking care of hospital hygiene, monitoring the practices of other healthcare workers, the infection outcomes and making improvements. In short, the development of specialties in nursing (or post-basic specialization in nursing) is a trend.

In the nursing profession, after graduating from the nursing schools or universities, trained nurses start their practice (or career) as nurse generalists. They are also called licensed nurses, registered nurses, qualified nurses, and so on. Their practices are regulated by licensure, which is one kind of credentialing activity (International Council of Nurses, 1992). It means that by law, these nurses, who meet the established standards, are granted exclusive powers or privileges, and are allowed to engage in specific occupations or professions (International Council of Nurses, 2005b). The main purpose of the licensure system is to ensure that nurses provide competent care to the public (International Council of Nurses, 1992). In Hong Kong, the regulating process for nurse generalists establishes the minimal standard, and makes it mandatory. It is a licensing procedure managed by the nursing profession under the law through accreditation of training programmes. Candidates who complete the accredited training programme are able to apply for a license to be a nurse generalist in Hong Kong.

All the regulating processes for nurse generalists and specialists are called “credentialing”. As defined by the International Council of Nurses, “credentialing” refers to all processes used to determine that an individual, programme, institution or product have met established standards set by an agent (governmental or nongovernmental) and is recognised as qualified to carry out this task. Licensure, registration, accreditation, approval, certification, recognition or endorsement may be used to describe different credentialing processes (International Council of Nurses, 2005b, p.12). The International Council of Nurses further provides that a standard for a credentialing process is either minimal and mandatory or above the minimum and voluntary (International Council of Nurses, 2005b).

Nursing practice is expanding in its scope into various specialties. Before going to work in a specific field as nurse specialists, nurse generalists must be trained; they must acquire the knowledge, skills and practices specific to that field. In nursing practice, this is called post-basic specialties training. As defined by the International Council of Nurses (2005), a nurse specialist is prepared beyond the level of a nurse generalist, and authorized to practise as a specialist with expertise in a specified field of nursing. The essence is that the purpose of post-basic specialty training is to make a nurse generalist a competent specialist. To guarantee the nurse specialists in the field have the specified competency and practices, a regulating system is needed and should be monitored by the profession itself. It is also important to have a system to inform the public and the employers who the competent nurse specialists in the field are. A certification programme, which includes individual competency assessment and specific title awarding, serves the purpose of identifying these nurse specialists. Unfortunately, at the moment, we do not have such regulatory system in Hong Kong.

With the growing trend toward post-basic specializations in nursing, the concern for regulating specialist practices is increasing (International Council of Nurses, 1992; 2005a; 2009). While the practice of nurse generalist is governed by licensure, individual nurse specialist practices are commonly regulated by specialist certification programmes, like the system of the United States. According to the International Council of Nurses, “certification” is a term commonly used to describe the process of regulating a practice of nurse specialists. It is a voluntary time-limited process managed by a non-governmental organization within a profession or specialty. It recognizes the competence of an individual who has met pre-established eligibility requirements and standards (International Council of Nurses, 2005b, p.8). The time-limited design ensures that the knowledge and practices of the certified nurse specialists are up-to-date and evolved over time.

Certification for a profession is a process that applies to an individual instead of a training programme (The term “accreditation is used when regulating the training programme). Through a certification programme, a certificate, like a product kitemark indicating that it has met certain standards of safety and quality, is granted to a nurse specialist to acknowledge his/ her competency and to inform the public he/ she is qualified to work in the specified field. This certification process maintains the quality of nurse specialists’ practice. It is also an important component of post-basic specialization in nursing (International Council of Nurses, 2001).

2.1 Post-Basic Nursing Specialization in Hong Kong

In view of the growing complexity and specialization of health care, the Hospital Authority, the largest public healthcare provider in Hong Kong, has been trying to establish its own specialists in nursing practice. The Hospital Authority commenced post-basic specialization in nursing in 1993 (Wong, 2001). Initially, these nurse specialists were required to have at least five years of clinical experience in a specified specialty, a certificate of the recognized training programme for that specialty and a bachelor degree in general nursing. There was no specification about the standard of the specialty training programme. Most of the specialty training programmes were provided by the Hospital Authority itself, but some were out-sourced, including those for infection control. Under such arrangements, the “specialty training” for nurse specialists in the Hospital Authority was not standardized. Although this group of “nurse specialists” did have a higher educational background and a specialty training that was an advance on the nurse generalists, the granting of specialist title was still uncertain regarding their knowledge and practice level. In recent years, the scheme changed to a higher academic qualification, a master degree, and the title of Advanced Practice Nurse has been used to identify this group of specialists (Wong, 2009). However, there are no universal standards for a master’s degree. The concern on this point is that the standards of master’s degree programmes vary between different universities, both local and overseas. The requirement of specialty training is still uncertain. As a result, some Advanced Practice Nurses were promoted only after one-year of on-the-job experience in the specialty after fulfilling the educational requirement. Again, having such a title does not mean they have acquired the relevant specialist knowledge and skills. More importantly, there is nothing indicating that they are competent to practise in the field. Granting a title is some sorts of career development within the Hospital Authority. According to the definition of International Council of Nurses (2005, p.5), an Advanced Practice Nurse is “a registered nurse who has acquired the expert knowledge base, complex decision-making skills and clinical competencies for expanded practice”. Both the initial nurse specialist and Advance Practice Nurse promotion schemes are merely a kind of recognition by an employer and so-called institutional licensing systems. Institutional licensing systems are initiated by the institution without government regulation (International Council of Nurses, 2001). The system applies to institutional workers only, not to the whole profession. This form of institutional licensing system has been further developed by the Hospital Authority, and a specialty nurse recognition scheme was launched in late 2009. According to an internal document of the Hospital Authority (Hospital Authority, Co-ordinating Committee (Nursing), 2009), registered nurses working in the Hospital Authority who fulfil the specified educational requirement and post-registration experience in the specialty will be granted the title of a specialty nurse in that area. The educational requirement can be a master’s degree in a nursing specialty or recognized specialty training. It is interesting that if a candidate holds a master’s degree in general nursing instead of the specialty, he or she may register in any specialty based on their post-registration specialty experience. Apparently, the master’s degree candidate may not have any knowledge-based education in that specialty. Unlike the previous “nurse specialist” scheme or Advanced Practice Nurse promotion scheme, granting the title of specialty nurse is a mark of completing the required specialty training/ master’s degree in nursing and the required post-registration specialty experience. It has never been a kitemark ensuring their competency in that field. It is not surprising that this Specialty Nurse Recognition Scheme does not convince the specialists in the field to recognize these specialty nurses since the scheme does not identify the competent specialty nurses who are equipped with the necessary knowledge and practice, especially those holding only a master’s degree in nursing without specialty knowledge or training.

So far, all three Hospital Authority schemes are only recognized by the employer who runs the schemes itself, and by the nurses working in the Hospital Authority. Furthermore, these institutional licensing systems fail to provide a checking system to ensure that individual specialists achieve the standard level of competency. The certification system is commonly used to regulate nurse specialist practices in other countries, such as the United States, Australia and Korea (Hunt & Hellsten, 2006; Kim, Jeong & Park, 2010; Certification Board of Infection Control and Epidemiology, Inc., 2011). The certification systems assess the competencies of individual nurses and award titles. Hong Kong nurse specialists need certification programmes for regulatory purposes.

2.2 Development of Hong Kong Academy of Nursing (HKAN)

As the trend of post-basic specialization in nursing is growing worldwide, nurse specialists have been recognized in Hong Kong under the umbrella of the Hospital Authority for more than a decade, from the nurse specialist scheme created in 1993, then later modified to the Advance Practice Nurse scheme, and now developed another Specialty Nurse Recognition Scheme. Yet, all these schemes are institutional licensures, not applying to the whole profession. Hong Kong still lacks a self-regulation system for nurse specialist practice. A preparatory committee was established in 2006 to prepare the Hong Kong Academy of Nursing for regulating the practice and promoting the professional development of advanced practising nurses in post-basic specialties (Hong Kong Academy of Nursing, 2011). The preparatory committee proposed to develop colleges of different nursing specialties under the Hong Kong Academy of Nursing. As of March 2010, 13 colleges have been initially supported for establishment (Hong Kong Academy of Nursing Preparatory Committee, 2010). They are:

1) community and public health nursing;
2) medical nursing;
3) surgical nursing;
4) cardiac nursing;
5) critical care nursing;
6) emergency nursing;
7) perioperative nursing;

8) mental health nursing;

9) paediatric and adolescent nursing;

10) gerontological nursing;

11) women care nursing;

12) education and research in nursing; and

13) nursing and health care management.

The information of the establishment is preliminary at the time of this writing (May 2011). Due to the financial implications, some specialties are grouped so as to be managed by one college. Infection control has been grouped under Hong Kong College of Medical Nursing as its specialty population is small.

With the establishing of Hong Kong Academy of Nursing, the developing self-regulating certification for nursing specialty is the way forward.

3 Significance of Infection Control Specialty

Among the specialties in hospital, infection control has more than 50 years' history since its launch in the United Kingdom. With its long history, infection control has become an important and significant specialty in healthcare, in particular, in nursing practice.

Hong Kong started an infection control service in the 1980s (Seto, 1989). Its establishment, as in other pioneer countries, was because of infection outbreaks (Gardner, Stamp, Bowgen & Moor, 1962; Nguyêñ et al., 2000). At that time, the outbreak of Methicillin-resistant *Staphylococcus aureus* occurred in the nursery of a public hospital (Seto, 1989). After the crisis passed, infection control services in hospitals were supported by a limited budget (Chan, 2005). The service came into prominence again during the outbreak of severe acute respiratory syndrome in 2003 (Brewer, 2009; Cheng et al., 2010; World Health Organization, 2008). The influenza pandemic in the year of 2009 again brought infection control service into the limelight in the hospitals of Hong Kong.

The Study on the Efficacy of Nosocomial Infection Control (SENIC) conducted in the mid-1970s by Centers for Disease Control and Prevention of the United States informed us that hospital-acquired infections could be reduced by more than 30% if infection control activities/ programmes are managed in hospitals effectively (Haley, Culver, White, Morgan, Emori, Munn & Hooton, 1985). Such activities/ programmes were able to save patients' lives, reduce the length of hospitalization due to complications by infections, and save medical costs.

Learning the experience from overseas countries, similar results of infection control service were found in Hong Kong. French, Wong, Cheng and Donnan (1989) reported that after launching an infection control programme in a teaching hospital in Hong Kong, the prevalence of hospital-acquired infection decreased from 9.9% to 6.0% in three years. Another study conducted in the same hospital demonstrated that the overall hospital-acquired infection rate fell from 7.3% to 4.0% in 15 years (Lee, Chiu, Chow, Lam & Lai, 2007). The factors contributing to this decrease included the additional infection control nurses allocated after the epidemic of severe acute respiratory syndrome. The infection control nurse-to-bed ratio increased from 1:700 to 1:250. At the same time, different infection control programmes, for examples “alert organism” reporting, biannual hand hygiene audit, regular education/ training in infection control to healthcare workers and targeted surveillance on various hospital-acquired infections, were reviewed or implemented. Increased awareness of infection control by healthcare workers were evidenced by higher hand hygiene compliance. The hospital-acquired infection rate in intensive care units reduced substantially from 35.5% to 26.7% over 15 years’ time, although it is still the highest among all specialties.

The hospital also reported a reduction of catheter-associated urinary tract infection from 2.9% to 2.2% after implementing an infection control programme involving the infection control link nurses (French et al, 1989).

Besides noting the longer hospital stay for infected patients, French and Cheng (1991) also reviewed the treatment cost for patients with hospital-acquired infection and found that the average antibiotic expenditure was US$190 (HK$1,330). When projecting this figure to the annual statistics, an extra of US$0.3 (HK$2.3) million would be needed annually. All these extra expenses — hospital stays and treatment costs — are healthcare costs. They could be saved by preventing these infections. Infection control programmes launched by the infection control team can reduce hospital-acquired infections, as demonstrated by different local studies (French & Cheng, 1991; French et al, 1989; Lee et al, 2007). The presence of infection control specialty in hospitals therefore saves money, saves lives and reduces suffering of patients. Hence, the infection control service in hospital is valuable, as it ministers to both patient and staff safety issues in the hospital environment. It has become an important specialty in healthcare.

4 Infection Control Service in Hong Kong

Hong Kong started infection control in the 1980s (Seto, 1989) with nurses being the main service providers. It was developed only after an outbreak of Methicillin-resistant *Staphylococcus aureas* in the nursery of one general hospital in 1985. With the support of the Medical and Health Department (the former government body responsible for same functions of both Department of Health and Hospital Authority nowadays) and cooperation of universities, infection control service was implemented in many public hospitals (Seto, 1989; Yung & Seto, 1989). However, resources for infection control service were limited (Chan, 2005).

Infection control became increasingly important after the epidemic of severe acute respiratory syndrome in 2003. More resources were allocated for further development. The Hospital Authority planned to increase the number of infection control nurses in its hospitals. More and more infection control nurses were deployed to the hospital infection control teams in order to meet the recommendation of the Study on the Efficacy of Nosocomial Infection Control (SENIC), a study from the United States. The recommendation said that there should be one full-time infection control nurse to look after 250 patient-beds (Haley et al., 1985; Goldrick, 2005). Hong Kong government set up Centre for

Health Protection, which is the highest level for controlling infectious diseases with a dedicated branch being responsible for infection control. The branch serves the clients of the healthcare continuum from hospitals to community (Department of Health, 2006). It provides infection control advice to promulgate the best practices, and it evaluates infection control measures. After performing an infection control capacity survey in 2004, the Centre for Health Protection concluded that the SENIC ratio was desirable, and recommended the same infection control nurse-manpower ratio, one infection control nurse to 250 patient-beds for Hong Kong (Centre for Health Protection, Scientific Committee on Infection Control, 2005). Although some private hospitals only had part-time infection control nurses, after the manpower recommendation by the Centre for Health Protection, most of them have added full-time posts of infection control nurses to strengthen the infection control service in their hospitals. The Centre's Scientific Committee of Infection Control also added key areas of hospital infection control service in Hong Kong hospitals (Centre for Health Protection, Scientific Committee on Infection Control [CHP, SCIC], 2005). The essential services include surveillance, active prevention of infectious diseases outbreaks, education and training of healthcare workers, involvement in employee health, involvement in antimicrobial stewardship programme, and other activities, such as disinfection, sterilization, managing hospital waste and product evaluation. These recommendations mainly provided guidance on the role and function of the service of hospital infection control teams as a whole, but the role and responsibilities of individual infection control nurses were not elaborated. Although the Centre for Health

Protection recommended that training be required for infection control nurses, the training standards and qualification recognition system for infection control nurses to ensure the their competency were not mentioned.

Before the recommendations of the Centre for Health Protection, without the service guide for hospital infection control, hospital infection control teams of public hospitals of Hong Kong developed individual infection control services based on their service needs. After the epidemic of severe acute respiratory syndrome in 2003, infection control specialty became important. The Chief Infection Control Office was set up in 2008 at the corporate level in the Hospital Authority to oversee infection control services in their hospitals. Some surveillance methods on infections are standardized, and hospitals are required to report the indicators periodically. Some other corporate level projects have been initiated, including hand hygiene programme and a prevalence survey on hospital infections. Information technology is available to analyse large amounts of data. These special duties are not performed by nurse generalists but a group of specially trained nurses. Recognizing the infection control nurses as specialists in nursing practices in Hong Kong is also recommended internationally.

5 Infection Control Nurses in Hong Kong

Infection control was a new line of service in nursing when it started in the United Kingdom more than 50 years ago (Gardner et al., 1962). Instead of patients, their direct clients are the healthcare workers. Infection control nurses set up system(s) to control infection spread in hospitals. They disseminate infection control concepts to frontline colleagues who deliver patient care. Patients then become the indirect clients to infection control nurses. Certification Board of Infection Control and Epidemiology Inc. (2009) defines infection control practice to include a wide range of activities. They are:

- analyzing and interpreting collected infection control data, surveillance and investigation of the suspected infection outbreaks;
- planning, implementing and evaluating infection control and prevention programmes;
- educating individuals on infection risk, prevention and control;
- developing and revising infection control policies and procedures;
- managing infection prevention and control activities; and
- providing consultation on infection risk assessment, prevention and control strategies.

The term "ICN" should refer to the nurse who monitor infection data and patient care practices and make improvements in a healthcare institution setting (Ayliffe, Fraise, Geddes & Mitchell, 2000). Nowadays, the term "ICN" is used liberally in Hong Kong for another distinctly different group of nurses, the nurses working in the Infection Control Branch of the Centre for Health Protection, Department of Health, Hong Kong. They provide infection control advice to clients all over—both in hospitals and in the community to foster better understanding of infection control. Their duties are under the stream of infectious disease prevention in public health management; they are not the same as the infection control activities done by the infection control nurses in hospitals. Also, most in this group of nurses do not have any clinical experience in hospital infection control. Strictly speaking, they are not infection control nurses and they actually belong to public health nurses.

Due to the job characteristics and ability required, in the United Kingdom, it is recommended that an infection control nurse be a Clinical Nurse Specialist or Senior Nurse Manager (Ayliffe et al., 2000). This has been true since the early establishment of infection control nurse in 1959 in Torbay Hospital of the United Kingdom. At that time, an Infection Control Sister was appointed (Gardner et al., 1962). The nurse position of "Sister" in the United Kingdom is similar to the position of Nursing Officer or Advanced Practice Nurse (i.e., has an additional level of competency compared to a registered nurse) in Hong Kong. The infection control nurses in Australia are usually employed as clinical nurse consultants when they have achieved clinical and managerial expertise in the specialty (Winchcombe, 2000). Even if not achieving the consultation level, they are usually appointed as clinical nurse specialists because they are the resource persons for infection control advice. As in the United Kingdom, in the early days of 1980s, infection control nurses in Australia are also Infection Control Sisters (Victorian Specialty Interest Group Members, 1982). A senior position for infection control nurse has also been suggested at the international level (Hambræus, 1995). A senior position for infection control nurses in Hong Kong is also recommended by the profession. Unfortunately, the proportion of this position in the field has been only increased after severe acute respiratory syndrome outbreak in 2003.

The Royal College of Nurses of the United Kingdom has suggested that specialist practice involves a clinical and consultative role, teaching, management, research and application of research (Law, 1993). The College also supports that the practice of infection control nurses belonged to specialist practice. In the United States, nurses and related healthcare professionals, for examples, respiratory therapists, laboratory technicians, assume infection control roles without necessary being prepared at the master's level. However, certification assures that professionals in this position have demonstrated competencies in infection control.

Infection control is important, as has been demonstrated through the experience of the severe acute respiratory syndrome and the influenza pandemic in 2009. It was generally acknowledged that the Hong Kong infection control nurses responded in an outstanding way during these crisis situations. The specialty expanded rapidly after the outbreak of severe acute respiratory syndrome with the arrival of fresh infection control nurses. Not looking after patients directly, the work of infection control nurses in hospital is supporting daily patient care and ensuring safe practices by special duties related to preventing infection spread in the hospitals (Gardner et al., 1962). Their work is indispensable. Their practice is so distinct that it cannot be accomplished by nurse generalists. It is no doubt that infection control nurses are specialists in the nursing field (Law, 1993; Winchombe, 2000). As nurses are the major workforce in infection control, and as more and more nurses are joining this field, regulating their specialist practice is crucial as well as a professional obligation.

6 Training Infection Control Nurses in Hong Kong

Infection control is a specialty of nursing practice. Before infection control nurses go to work, they must have obtained relevant training. This was emphasized by infection control experts in Hong Kong once infection control nurses were firstly appointed in 1985 (Yung & Seto, 1989). The training programme for infection control nurses has been conducted by local experts and collaborating overseas faculties since 1985. At that time, the programme was coordinated by the Department of Microbiology, University of Hong Kong. The curriculum was developed with a reference to training programmes in the United States and the United Kingdom. This training programme enrolled participants from neighbouring regions, such as Macau, Mainland China, Thailand and Vietnam, as well as Hong Kong. Today, while the training course for infection control nurses is led by the same group of infection control experts, the course is organised annually and co-ordinated by the Squina International Centre for Infection Control, the Hong Kong Polytechnic University of Hong Kong, and co-organised by some other infection control professional groups. The course comprises approximately 50-hours of lectures, but no clinical practicum (PL Or, personal communication, 20 October 2010). In contrast in the United States, the training for Advanced Practice Nurses who can become infection control nurses is a master's degree with 400-500 hours each for theoretical and clinical training (Wong, 2009). Other master's degree programmes for preparing infection control nurses in the role of clinical nurse specialists are also available (Gail, Field, Simpson & Bond, 2004). In the United Kingdom, infection control nurses are required to complete specialist training courses or the equivalent at diploma or university degree level (Ayliffe et al, 2000). Korea also offers a master’s degree programme for infection control nurses (Kim, Jeong & Park, 2010). Compared with overseas countries, local infection control nurses receive less training hours and lack of clinical practicum. In recent years, a university in Hong Kong has been offering a master’s degree level training programme for infection control practitioners (The Hong Kong Polytechnic University, 2009). However, this is not a mandatory training requirement for infection control nurses in the field. All in all, training can help to maintain the quality of infection control nurses when they enter the field, but initial training does not ensure they will maintain competent practice over time. To ensure patient safety and to guarantee effective, continuous infection control activities in healthcare facilities, a means of certifying infection control nurses is needed.

Nurses calling themselves infection control nurses are not necessarily competent. The “specialists” recognized by different schemes in the Hospital Authority, such as the nurse specialist scheme introduced in 1993, and the Advanced Practice Nurse schemes introduced in 2003 or Specialty Nurse Recognition Scheme introduced in 2009, does not mean an accepted specialists recognition in the profession across the public and private sectors. The recognition schemes under the umbrella of Hospital Authority are only a path toward career development, not professional development. These nurse specialist and Advanced Practice Nurses schemes are considered paths toward promotion. The Specialty Nurse Recognition Scheme may help the selection board to identify experienced and trained personnel in the field during their promotion; however, these sorts of promotion/ recognition schemes are not to ensure the specialists are competent.

7 Credentialing Activities in Infection Control in Hong Kong

Although there is no credentialing system in relation to infection control in Hong Kong, local infection control nurses, from time to time, voluntarily participate in the certification examination organized by the Certification Board of Infection Control and Epidemiology, Inc. (CBIC) of the United States of America to test their competency level (Memish, Soule & Cunningham, 2007). At present, only the CBIC certification examination for infection control practitioners is available internationally. In 2004, a group of local infection control professionals consisting of infection control nurses, infection control officers and microbiologists, collaborated with CBIC, in organizing a certification examination in Hong Kong. In 2005, this certification examination was introduced to Hong Kong through the Infection Control Branch of the Centre for Health Protection, Department of Health. This arrangement induced much controversy among local infection control nurses. They queried the appropriateness of the CBIC certification examination for local practitioners (Chan, 2005). The participants commented that the knowledge tested in the multiple choice certification examination was not necessarily applicable in Hong Kong's practice, due to differences in culture, education, disease epidemiology and resources. All these factors affect daily practices in infection control and the level of emphasis in the practice.

The management of tuberculosis is a typical example showing how post-exposure management for patients and staff differs between Hong Kong and the United States of America. Tuberculosis is prevalent in Hong Kong but not in the United States of America. In the United States, a stringent contact tracing approach for a newly diagnosed tuberculosis patient is used. In Hong Kong, the contact tracing process in this situation is limited or deemed unnecessary. The vaccine preventing tuberculosis has been included in the childhood immunization programme for many years in Hong Kong. Positive reaction to the skin test may be due to the previous vaccine or the infection with tuberculosis bacteria. Rigorous screening tests therefore provide confusing interpretation. The screening strategy can be adopted in the United States because the vaccine for preventing tuberculosis is not widely used (Centers for Disease Control and Prevention, 2011).

A small phenomenological study was conducted by Chan and Wong (2009) through interviewing local infection control nurses who participated in the CBIC certification examination. The study interviewed 10 infection control nurses through snowball sampling technique. Sixty percent reported of passing the examination while 40% failed. Most of them commented that passing the CBIC certification examination does not mean a person is competent in infection control nurses practices. They observed that a candidate could pass, using examination-passing tactics without actually knowing the subject thoroughly. They also observed that some candidates without any infection control experience could pass the examination by only studying the examination content. These experiences indicate that when a candidate reads through the examination content thoroughly, he or she can pass the certification examination. All the materials, including knowledge, skills and practices, are based on the United States of America. The local practices in infection control, which differ from those in the United States of America, are not assessed. This challenges the usefulness of the CBIC certification examination for Hong Kong infection control nurses. The subjects also commented that important infectious diseases in Hong Kong were missed in the examination content. This may be due to the different epidemiology of the infectious disease between countries. The interviewees concluded that there were differences in daily practice between countries although most of the principles are similar. In the followings, they gave some examples. Healthcare structure makes the reporting line and process different; both of these are local and specific. Thinking and management approaches based on education background and culture that influencing the work sequence. Setting and resources are interlinking that influencing the precautions system adoption. There are many single rooms in hospital wards in the United States of America, so they can put all sorts of infectious patients into the rooms. Hong Kong is different in that single rooms are limited so priority of patient placement is necessary. Entities and patterns of infectious diseases are different so that focuses vary between countries. Educational background of the infection control nurses in different countries changes the practice emphasis. For instance, nurses in the United States of America learn details in education methodologies, but Hong Kong nurses receive hardly any of this subject in the basic training. Therefore, the knowledge of education is different between infection control nurses of Hong Kong and the United States of America. It is true that knowledge may be shared across the countries, but it is not necessarily true for the practice. With all these differences in infection control practices, it is important and essential that a local-context specific certification programme for infection control nurses to regulate the local practice is needed

The interviewees found that those successful candidates with the awards under the CBIC certification examination informed that they were competent to work in the system of the United States only, not of Hong Kong. It is important to check that if the practitioners or specialists practise competently in local field after specialty training. Specialty training/ certification examination organized by other countries always lack the part of local-context specific practice of individual countries; this undermines their usefulness.

Furthermore, the knowledge tested in CBIC certification examination is based on practice analysis results. To accommodate changes in the practice of infection control, practice analysis was conducted periodically. For extending the certification examination to Canada, both infection control practitioners from the United States of America and Canada have been included in the practice analysis since 1996. In order to further expand the certification examination to other places over the world, some international infection control practitioners were invited in the following practice analyses (Curchoe, Fabrey & LeBlanc, 2008, Feltovich & Fabrey, 2010). The response rates for the surveys conducted in 2005 and 2010 were only 21% and 27.5%, respectively. With the diversified sources of practice serving as the content base of the certification examination and with the poor response rates, the relevance of the non-local organized examination to individual local practices needs to be reconsidered.

8 Need for a Local-Context Specific Certification Programme for Infection Control Nurses in Hong Kong

Even if the infection control practice of the United States is a major influence all over the world including Hong Kong, direct practice adoption is not ideal. Learning from the practices of the United Kingdom and the United States, Hong Kong has developed its own infection control practice based on our client needs, culture, resources, etc. The certification examination of the United States (CBIC certification examination) was developed mainly based on their practice analyses. The survey practitioners are mainly in the United States of America and Canada. Infection control practice in Hong Kong is not covered. This overseas certification examination is not practical to test the competency of local infection control nurses. As suggested by McGahie and colleagues, competencies required for the practitioners, which is to be measured in the certification programme, is influenced by local management policies, social and economic situations, health needs, resources availability and structure of healthcare system (McGaghie, Miller, Sajid & Telder, 1978). That is the reasons for researchers commented that some questions in CBIC certification examination were not suitable for other countries outside United States (Memish et al., 2007).

A certification tells the world, employers and clients; it is the passport to promotion, it reassures clients. As a means for acquiring post-basic specialization in nursing, certification of the competent nurse specialist is a direct and transparent option. Credentialing processes may apply to individual practitioners, training programmes, training institutions or training outcomes (products). In a non-governmental regulating system, accreditation of the training schools or training programme is difficult, and the training outcomes of the same training programme may vary due to individual differences. The greatest concern of the employers or service users is whether the individual specialist is competent. It is sufficient that a valid certification process tells who competent specialists are.

Certification in the nursing profession is new in Hong Kong. There is no experience in establishing a certification programme in local nursing. Nevertheless, the most important point is that we need a certification programme to certify our local practitioners. After the epidemic of severe acute respiratory syndrome in 2003 and the recent influenza pandemic, infection control has been recognized as an important specialty in healthcare. For regulatory purpose, a certification programme specifically for infection control nurses is desirable. This kind of certification programme would provide assessments in various forms, and would grant a formal title of infection control nurse, as those in the United States and Australia do.

The relevancy of a certification programme for a specified group of specialists depends on whether the programme content is relevant to the practice. To develop a certification programme for a profession, the practice is always the starting point and is the elementary substance of the programme content. Core competency is comprised of the abilities required for professional practice. Therefore, core competency is the key component during the programme development (Axley, 2008). It transforms the practice to the certification programme.

9 Need for a Process Model for Developing Certification Content

In the modern healthcare environment, professional practices are dynamic; they evolve. To be an up-to-date certification programme, its content must be revised regularly. Practice analysis survey is one method to identify or determine the existence of a professional practice to determine the certification content. Taking infection control specialty as an example, practice analysis surveys have been conducted by the CBIC periodically since 1982 (Goldrick, 2005; Curchoe, Fabrey & LeBlanc, 2008). The survey has been conducted every four to five years, and the latest one was done in 2009 (Feltovich & Fabrey, 2010). The scope of practice has changed a lot. This change of practice means infection control specialists need regularly to update their knowledge and practice to be competent. When the practice changes, core competency changes. Then, the change of the content of certification programme is needed. A content blueprint is a guide to develop the certification programme. It contains a list of core competency items and their content weights. So, when the content of the certification programme changes, renewal the content blueprint is needed. Revision of certification programme content is a repeating process once a certification programme has been established (Raudonis & Anderson, 2002). A process model for developing the certification content that delineates the procedures and methods of deriving the core competency for the specialty can facilitate updating the certification programme. Further to establish a certification content blueprint for local infection control nurses in this research; I will explore the methods used for the content blueprint development to form a model. This process model provides a systematic way to identify the core competency items and its content weights of a specified group of practitioners. With this process model in place, developing a new certification programme for other nurse specialists or revising the established certification programme becomes standardized and efficient. This model is a tool to complete the regulatory system of nurse specialists in Hong Kong. It will yield the core element to post-basic specialization in nursing practice.

10 Summary

Although specialist training for infection control nurses of Hong Kong is offered, a regulating system to ensure their competency in the dynamic healthcare environment is warranted. As noted at the beginning of this chapter, there is no certification system in the field of nursing in Hong Kong. Participating in the certification programmes in infection control of other countries is not the solution as the practices in different areas are varied. The need for setting up such a system for nurse specialists to ensure patient safety and foster the professional development is needed. The certification programme that reflects the up-to-date and local-context specific practice is necessary to maintain a valid regulatory system. A time-limited certification programme will assess the competency of the practitioners periodically.

Once the certification system has been launched, its programme has to be revised periodically. In order to keep the certification programmes up-to-date, a simple and efficient process for development of certification programme is urgently needed. A content blueprint guides the development of a certification programme. A process model for developing the certification content blueprint facilities the periodic certification programme development in an efficient way when the practice changes. The model also integrates the interlinking process between specialist training, refresher and certification. Furthermore, beyond this model, it provides building blocks to develop training programmes, continuing professional educational programmes for the same group of specialists.

Having reviewed the local background of this research in this chapter, the notion of competency and its related issues, which is the foundation concept of this research, will be discussed in the next chapter.

CHAPTER 5

COMPETENCY AND RELATED ISSUES

1 Introduction

This research aims to develop a process model for the content of certification for infection control nurses in Hong Kong. The content of the proposed certification is the core competency of the infection control nurses. Competency is the foundation of test development for clinical professionals. Therefore, the first step is to identify what the core competency for infection control nurses in Hong Kong actually is. The process of competency identification creates a common language between educators and practitioners and also ensures the validity of the subsequently developed test (Leach, 2008).

"Competency" is the focus of this chapter. Figure 5-1 depicts the overview of competency and its related issues that form the structure of this chapter.

Competency is derived from practice, based on its fundamental concept and approaches of definition. The conceptual process of identifying competency influences the methods used. Competency for the profession is what practitioners are expected to show in their current and future roles (Mansfield & Mitchell, 1996). This competency is the standard for the profession. The identified competency is used for setting the content standards for education and assessment, but validation of these standards as well as the reliability are major concerns. The standards used are different for different purposes. The standard for the profession is competency, content standard for education is the curriculum and the content standard for assessment is what the practitioner is required to achieve. With the exception of the education component, each of the issues listed above will be explored in this chapter.

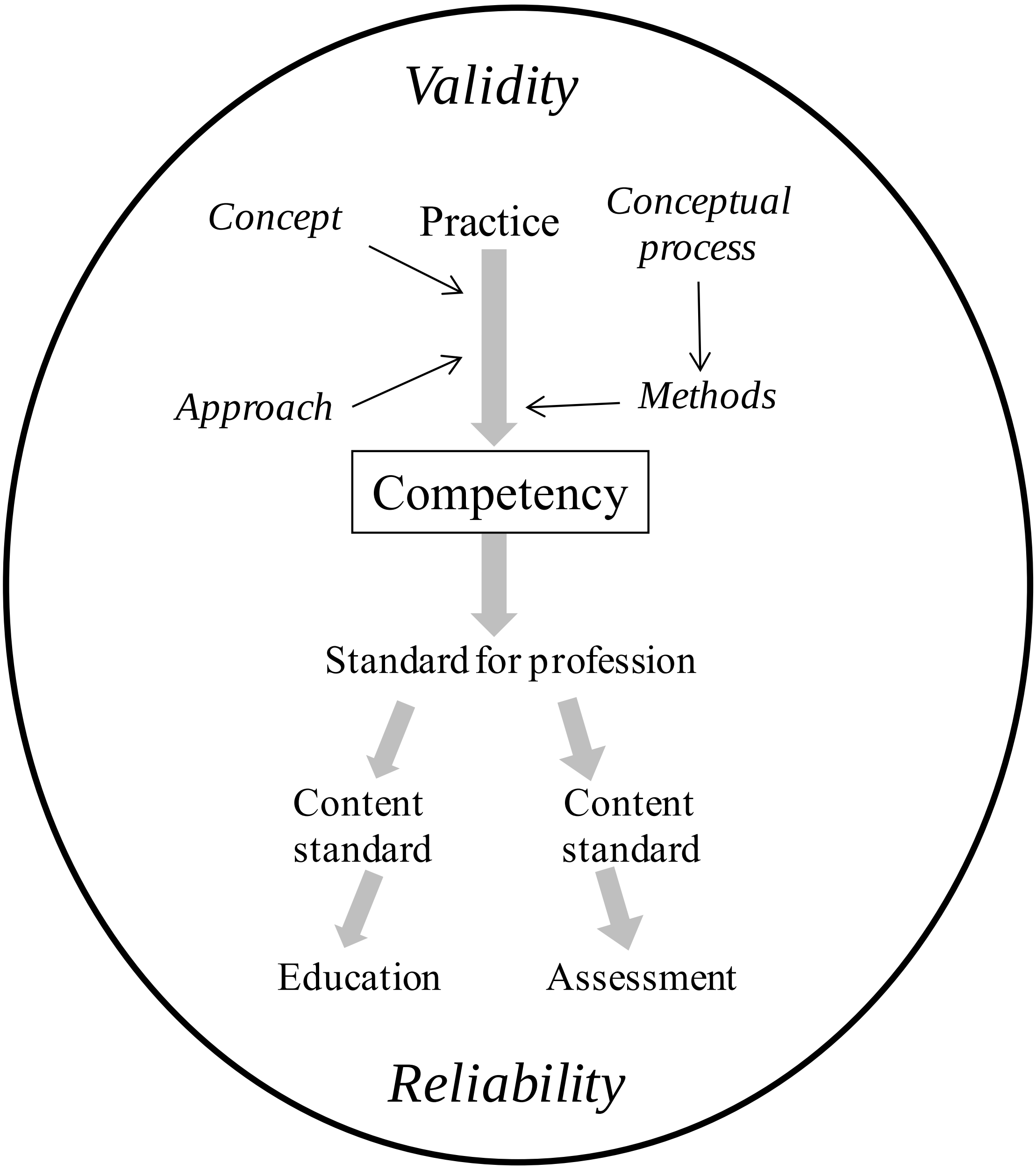

Figure 5- 1: Overview of competency and related issues

2 The Concept of Competency

The term "competency" originated in the field of human resources. It is defined as "a set of behavior patterns that the incumbent needs to bring to a position in order to perform its tasks and functions with competence" (Woodruffe, 1993, p.29). Competency is the behavior that enables people to perform the job effectively, and thus to be defined as competent (Woodruffe, 1993). However, competency is different from "performance", as it is only something underlying performance (Noddings, 1984). As argued by Axley, "competency is more than the mere attainment of skills as it also involves other qualities, such as attitudes, motives, personal insightfulness, interpretive ability, receptivity, maturity, and self assessment" (Axley, 2008, p.218).

Based on the literature review, the concept of nursing competency includes the following attributes (synonyms) (Axley, 2008):

1) Knowledge (information, teaching, training)
2) Actions (ability, patterns, processes, skill)
3) Professional standards (criteria, requirements, qualification)
4) Internal regulation (accountability, attitude, autonomy, motivation, self-regulated)
5) Dynamism (changing, consistent improvement, ongoing)

2.1 "Competency" and "Competence"

The terms "competency" and "competence" are often used interchangeably in the literature and the distinction between the two is unclear (Manley & Garbett, 2000). While competence is considered as a person's ability to perform, competencies mean the person's total capability, which comprises the characteristics and qualities that enables a person to do an effective or superior job (Manley & Garbett, 2000; William & Berry, 1999).

Competencies are often confused with the job itself. The relationship between the two is that the job consists of a set of deliverables, outputs or roles that requires a number of individual competencies (Woodruffe, 1993).

David McClelland, a Harvard psychology professor, is considered the founding father on the work of "competency" (Adams, 1995; Calhoun, Davidson, Sinioris, Vincent & Grifffith, 2002; Manley & Garbett, 2000). He led the competency movement in the United States when promoting his ideas through the McBer Consultancy. The concept of "competency" was used to replace a narrower concept, "skill". Boyatzis was another significant researcher who linked competency to effective performance and achievement. He defined competency as a motive (self-image), trait (social-role), skill or knowledge that a person uses, which together creates the underlying characteristics of performance (Boyatzis, 1982).

"Competence" is regarded differently in the United Kingdom. Instead of focusing on the personal qualities for competency, as directed by the UK National Vocational Qualification, competence concentrates on the job, referring to the minimum standard or performance in the workplace (Manley & Garbett, 2000). As such, it has replaced the original term "knowledge" in the field of education (Bradshaw, 1998). Being used in a job-oriented sense, it is considered as the basis for occupational standards and performance criteria and is associated with certification licensing and safeguarding the public (Manley & Garbett, 2000).

Although this research is related to professional certification, the core competency of infection control nurses identified is not the sole purpose of this thesis. For professionals, the expected behavior goes beyond fulfilling the functions of the job. They should be capable of safe practice in an effective or superior manner. Competency, instead of competence, has been used by the regulating body for nurses and the largest public healthcare service provider in Hong Kong, the Hospital Authority (Hospital Authority, 1997; The Nursing Council of Hong Kong, 1997). The Hospital Authority views the nursing core competency as not solely for managing the staff and monitoring the quality healthcare delivery, but also individual staff development and the direction of the nursing profession are also considered (Hospital Authority, 1997). For these reasons, the term "competency" is used in this research to encompass the broader sense of the concept.

2.2 Competency and Standard

A standard is the basis for comparison or measurement. It is a reference point against which things can be evaluated and to which they should conform (Dorland's Medical Dictionary for Health Consumers, 2007). As described by Gonczi (1994), competency in Australia and UK belongs to a standard; hence, it is named as competency standard. Mansfield (1989) elaborated that standards describe competence (i.e., competency is used in this research) and as a consequence, it is linked to performance, because competency is not directly observable, but may be demonstrated in an action or behaviour.

More importantly, contents of learning and assessment can be derived directly from standards. Competencies provide standards of practice that are recognized and accepted by the profession, the public and employers. They provide a framework for developing skills for the professionals and form a foundation for valid assessment (King 2005). This research is going to elucidate a competency standard for infection control nurses that can be utilized for professional development, such as education, training and competency assessment.

The competency standard consists of units of competency, which describe a group of work functions. Each unit of competency is divided into smaller elements of competency that describe their associated performance criteria or desired behaviour. In other words, performance criteria are "described" standards contributing the holism of the nature of competency (Gonczi, 1994). The work on core competency in this research adopts a similar structure, in that the desired behaviours are delineated from the selected conceptual framework.

2.3 Benefits of Competency

Competency is the core component of professional development. It reflects or documents the professionals' work within a broader framework. This enhances monitoring within the profession. It informs the public or consumers about what a qualified professional is competent to do, so that a reasonable expectation can be developed. This allows the engagement of non-professionals in related professional issues or services. The professional competency sets clearer goals for developing professional education and training and will strengthen assessment procedures, if they exist, for the registration of professional qualifications. It also provides the basis for people to join the profession, or advance from generalist to specialist (Gonczi, 1994). That is why defining professional competency is only the first step. The subsequent work, including competency assessment, is the ultimate goal of defining competency (Axley, 2008).

With these benefits in mind, the core competencies for nurse generalists (registered nurses and enrolled nurses) have been documented by The Nursing Council of Hong Kong, the nurses' regulating body in Hong Kong (The Nursing Council of Hong Kong, 2004; 2010). Although there is a move towards post-registration specialization of nurses, core competencies for nurse specialists in different specialties have not yet been established. Core competencies for nurse specialists are needed to serve as the reference standards for their further professional development.

3 Approaches to Defining Competency

Three main approaches are used to conceptualize the nature of competency, namely task-based/ specific tasks/ behaviourist approach, attribute/ generic skills approach and integrated/ task attribute/ holistic approach (Gonczi, 1994; Hager, 1993).

3.1 Task-based/ Specific Tasks/ Behaviourist Approach

The task-based or behaviourist nature of competency is the most commonly used concept (Gonczi, 1994). This concept describes competency as a number of separated behaviours related to the tasks. The performance of the task becomes the competency. An example of task-based approach competency is "conduct surveillance using standardised definitions". There is no agreement on the composition of satisfactory performance, but the possession of competency in this approach can be evidenced by direct observation of performance.

This approach has been utilized in many industries in Australia and UK, when these countries first developed the competency standard (Gonczi, 1994). The simplicity and clarity of this approach are the reasons for its popularity, but problems arise when this approach is applied to professions with complex work and a lengthy specific competencies list results (Hager, 1993). This approach adopts an individualistic view that ignores group work. It is also focused on the tasks and skills, running the risk that underlying attributes will be ignored (Gonczi, 1994). For instance, in the task-based competency statement "recognize an outbreak through surveillance information and reporting channels", the skills of risk assessment and knowledge of infection and epidemiology are needed to contribute to such behavior. The required knowledge and skills for the desired behavior can be ignored as it is difficult to observe such behavior accurately. In terms of measurement, this approach can only measure minimum competency, thereby discouraging excellence (Hager, 1993).

3.2 Attribute/ Generic Skills Approach

The attribute/ generic skills approach focuses on the general attributes of the practitioner as predictors of future performance (Gonczi, 1994; Hager, 1993) and the context is ignored. With this approach to competency, curriculum development is not specific to any group of professionals. It has been criticized on the grounds that expertise is domain specific and the application of generic attributes across different areas is not possible. That means, the application of generic attributes, such as critical thinking skills, is different between professions. Although generic competency is important for success, however, it lacks specificity for professional practice (Hager, 1993).

3.3 Integrated/ Task Attribute/ Holistic Approach

While the behaviourist approach explicitly informs the notion of competency as performance, Noddings (1984) proposed an alternative argument that if competency is a group of behaviours that can be observed, every competent person will be observed as carrying out the same series of behaviours. This is obviously not the case in the field.

Therefore, an integrated approach has been proposed which combines the above two approaches. It brings the individual abilities and tasks together and incorporates the components of professional judgement in different situations (Gonczi, 1994). After listing professional tasks, which are termed intentional actions, competency can be easily conceptualized in terms of knowledge, skills, abilities, and attitudes (Hager, 1993). Hager (1993) also reported that, based on his research experience, with the integrated approach, it is possible to set up professional competency standards according to professional practice. It seems to overcome the shortcomings of the previous two approaches. However, the assessment of competency is not simple as competency may need to be demonstrated over time.

In view of missing the context, the attribute/ generic skills approach does not appear to be appropriate for a complex profession, like nursing. The behaviorist approach seems to be too simple or narrow to prepare the competency standard for nurses, whose practices are complex. The integrated approach starts with the "intentional actions" in the action categories. Using the term "action description" represents the intended activity rather than the observable movement for "behavior description". Apart from the underlying meaning, the structure between the two is the same. To describe the tasks, the description starts with a verb to describe the action, and is called a task-oriented descriptor (Campbell, 1989; Raymond, 2001). Larson and colleagues (1988) also proposed the integrated approach when developing a certification examination. Once the desired behaviors have been defined, the test developers further identified the related knowledge, skills and attitudes to develop the test (Larson et al. 1988).

4 Methods of Identifying Competency

Identifying professional competency is the cornerstone of establishing the competency-based training and competency-based assessment (McGaphie, Miller, Sajid & Telder, 1978). The desired attributes of a nursing professional are decided with many considerations, such as expert opinion, the practice setting, patient types, healthcare problems, nature of the discipline or specialty and the socio-economic development of the community. These influential factors vary across different countries. Hence, clinical professional competency is local-context specific. In the following discussion, a few common methods for identifying competency are elaborated upon.

4.1 Observation

Although competency is a construct which is not observable, it may be concluded from successful performance (Hager, 1993). Adopting direct observation to identify professional competency is commonly used (Defloor et al., 2006; Patterson et al., 2000; Patterson et al., 2000; Raymond, 2001). The observation can be carried out directly by an observer or indirectly by a camera or video recorder (Campbell, 1989). This method can be used for the jobs or practices with observable psychomotor tasks. However, the presence of an observer—either human or machine—may induce stress upon the operator. Also, observation of all the tasks, including infrequent ones, and observing tasks related to personal judgement or mental application is often not possible (Campbell, 1989; Raymond, 2001). The method requires a trained and knowledgeable observer who should have some familiarity with the field or specialty and the observations should be verified by other competent observers and other sources (Campbell, 1989; Markowitz, 1981; McGaphie et al., 1978).

4.2 Interview

Interview of job incumbents and their supervisors is another method for identifying competency. It can be performed in-person or by telephone (Campbell, 1989). Compared with an in-person interview, a telephone interview is more convenient and less expensive. The method is suitable for the tasks involving personal judgement or method application, and it is appropriate for illiterates or persons with language difficulties. However, conducting an interview is time-consuming. The participants may not be able to recall all the job tasks, especially those infrequently performed. Also, individuals may give conflicting information, which is difficult to handle (Campbell, 1989; Markowitz, 1981).

4.3 Critical Incident Technique

The critical incident technique describes the behaviours that are expected to have a significant or critical impact on the outcome (Raymond, 2001). This technique was applied in medicine very early on for defining the competency of a physician after internship (McGaphie et al., 1978). It starts by collecting verbal anecdotes of superior or poor performance from practitioners, supervisors or those familiar with the practice using questionnaire, interview or focus groups (McGaphie et al., 1978; Raymond, 2001). Each anecdote describes the occurrence of an incident, the setting where it took place, the outcome and why this was judged to be effective or ineffective. Once the study is completed, test plans, performance evaluation forms and training materials can be developed. An advantage of critical incident technique is that the findings are specific to very important outcomes and they can be decomposed to a task inventory for further investigation. However, the use of descriptors is flexible for the subject matter experts and, as a result, different terms may be used for the same practice, which may be confusing. In addition, only behaviours that are believed to be critical will be identified. Identifying competencies comprehensively for a profession is not feasible (Raymond, 2001).

4.4 Group Consensus

The group consensus technique is commonly employed for identifying competency. Combining the opinions of experts is an intellectual rather than an empirical exercise. This exercise is less subject to criticisms (McGaphie et al., 1978). Predetermined alternatives are provided prior to the input by the experts (De Villiers MR, De Villiers PJT & Kent, 2005). This initial information may be sought from the same group of participants (Sumsion, 1998). In this situation, open-end questions are used to explore the possible answers (Whitehead, 2008). Literature review is also a common approach used (Leach, 2008).

4.4.1 Delphi Method

The Delphi method is one of the common formal consensus processes. The name "Delphi" refers to oracle of Delphi, considered as Apollo's most truthful and trustworthy "expert" informant (DeVilliers et al., 2005; Jones & Hunter, 1995; Whitehead, 2008). The Delphi method was first used in a military defense project in the USA at the end of the 1940s (Fink, Kosecoff, Chassin & Brook, 1984; Landeta, 2006). In the 1960s, the field of application of the Delphi method was extensively broadened. Apart from being used for military and economic purposes, it covers areas of technological forecasting and evaluation of complex social problems. It has further become a social research technique to obtain the opinion of a group of experts, such as in clinical practice development (Jones & Hunter, 1995). It is a method of structuring communication between groups of people who can provide valuable contributions to resolve a complex problem (Landeta, 2006).

There are three types of Delphi approach, namely conventional, real-time or modified, and policy (DeVilliers et al., 2005). The conventional Delphi consists of rounds of responses from a group of experts. Subsequent questionnaires are refined based on the results from the ones returned. The real-time or modified Delphi is a shorter form and is commonly used in meetings for summarizing the members' responses immediately. The policy Delphi is used by decision makers to collect the opinions from opposing views of an informed group. It is a collection of ideas rather than a mechanism for reaching a decision (Rayens & Hahn, 2000; Turoff, 2002).

4.4.1.1 Four Characteristics of Delphi

There are four characteristics of the Delphi method (Jones & Hunter, 1995; Landeta, 2006). It is a repetitive process, and the experts are anonymous. It is a method with controlled feedback, and the results can be interpreted quantitatively.

As a repetitive process, Delphi allows experts to re-consider their answers based on the input from other experts. Anonymity has to be maintained (DeVilliers et al., 2005) and the experts are not required to meet with each other (Bonner & Stewart, 2001; Halcomb, Davidson & Hardaker, 2008; Hasson et al., 2000; Landeta, 2006; 彭 et al., 2000). A coordinator, usually the researcher, collects the answers from the experts, puts all the answers together, and provides feedback to the experts for another round of survey. Strictly speaking, the anonymity of the Delphi survey only applies to the experts (participants), but not the researcher. This "quasi-anonymity" enhances the response rate of the participants. It also reduces the problem arising from direct interaction in the process of traditional group facilitating methods (Landeta, 2006; Sumsion, 1998). The undesirable psychological effects on the survey participants including inhibition, dominant personalities, and so on are minimized. The anonymity of their answers facilitates participants' free expression of their ideas and comments without pressure from other participants (Bonner & Stewart, 2001; William & Webb, 1994).

The feedback to experts in subsequent rounds of questionnaire survey is controlled in the Delphi approach. After receiving answers from experts, the coordinator will eliminate any irrelevant information before putting the remaining information together, and sending the feedback to experts for further circulation and review (Bonner & Stewart, 2001; Hasson et al. 2000; Landeta, 2006).

The use of several rounds of survey is a streamlined way of working on the topic rather than a final decision-making process. The experts' answers will be processed quantitatively and statistically. The survey will come to an end when consensus is achieved. A wide range of consensus level, from 55% to 100%, has been employed in different studies (Table 5-1). The higher the agreement level, the more convincing the results are when a decision is made.

Table 5- 1: Proposed agreement levels in different studies

Proposed agreement level	References
55%	Payne, Fineman & Wall, 1976
60%	Fitch et al., 1996
70%	Sumsion, 1998
75%	Williamson, 2007
80%	Staggers, Gassert & Curran, 2002; William & Berry, 1999
90%	Fitch et al., 1996
100%	Williams & Webb, 1994

4.4.1.2 Disadvantages of the Delphi Method

The Delphi method has been widely used in the field of social research. It is a good tool to collect and collate views from experts, particularly when there are a small number of informers, to address social problems. However, it has its weaknesses and deficiencies (Landeta, 2006).

The participants in the Delphi survey are the subject matter experts, simply called Delphi experts. They are knowledgeable about a specific topic, and their views forms the sources of information of that particular topic. One of the criticisms of the Delphi survey is that the selection of experts is not rigorous enough (Landeta, 2006; William & Berry, 1999). Researchers opined that the Delphi experts should be representative of their profession. The defined experts should possess the relevant knowledge and experience (Goodman, 1987; William & Berry, 1999). Clinical experts, who are in the important positions and have significant contributions to the field, would be considered in this study. These significant people are mainly found to be working in public hospitals in Hong Kong because the public sector always tends to put more efforts on infection control than the private organization does. Some researchers, furthermore, proposed a stringent criterion that selecting Delphi experts should be based on their individual or collective publications (Whitehead, 2008). Strictly applying this rule is difficult for clinical experts. However, it is still a preferred criterion for selecting Delphi experts in this study. Choice for Delphi experts with such academic publications in the field of infection control of Hong Kong is limited because their duty-time is required to focus on clinical matters, such as managing hospital infection control issues, taking care of cross-infections among patients among patients and staff, etc. With the assigned busy clinical duties, they unlikely afford to writing up what they have investigated in their work for the purposes of publication.

In Delphi survey, expert participants are generally required to take several rounds of survey because they arrive at a consensus. Drop-out in the subsequent rounds is another common criticism, in particular, when the whole survey is found to be lengthy, endless and time-consuming (Sumsion, 1998). In order to avoid this drawback, obtaining participants' consents during invitation is useful. Before starting any Delphi rounds, sincere and clear explanation of details as to procedures and informing expected time of commitment to all expert participants is paramount. The intervals between rounds are maintained as short as possible to keep the experts finding the process is in progress and are willing to accomplish their contribution.

The validity of the Delphi method is another concern. Hasson and colleagues claimed that repeated survey rounds improve the concurrent validity (Hasson et al., 2000). However, others criticize that the Delphi survey yields a forced consensus because they found that participants do not have any in-depth discussion and cannot voice their opinion freely (Goodman, 1987; Hasson et al., 2000). In this study, next to each item of the Delphi survey questionnaire, a column of space is specifically provided for participants writing their views and comments freely. The investigator acts as the study coordinator to compile all their individual feedback and comments and return the compilation to all participants in the next round of survey. This creates an interactive environment between participants, which is in an indirect form of in-depth discussion under the Delphi anonymous characteristic.

4.4.2 Nominal Group Technique

The nominal group technique is another common formal group consensus method. It is a structured meeting, which has been used since the 1960s on the problems of social service, education, government organizations and industry (Jones & Hunt, 1995). It has also been used to develop consumer and professional roles (Fink et al., 1984). The meeting starts with the participants contributing one idea about the question individually and submitting it to the facilitator (Jones & Hung, 1995). All the ideas are posted up on the chart with similar ideas grouped together. There is a group discussion about the ideas and participants may clarify their idea, as appropriate. After discussion, the participants rate the ideas privately. The ranking is then summarised. Participants are allowed to re-rank the items/ ideas. The final results are fed back to the participants. With regard to reliability, although Horn and Williamson (1977) reported that the nominal group technique was highly reliable for most of the study topics based on statistical techniques, conflicting results have been found in different reports in the literature (Fink et al., 1984).

4.4.3 Consensus Development Conference

The consensus development conference is used to facilitate a face-to-face interactive debate on the scientific issues (Halcomb, Davidson & Hardaker, 2008). The synthesis of ideas from experts is the ultimate goal. An example of consensus development conference is the work of the National Institute of Health on developing clinical guidelines. The institute periodically reviewed the literature on selected health-related topics and then convened public sessions for panel members. During the sessions, members of the public were invited to submit ideas. However, the costs incurred by running a consensus development conference are high. Purposive sampling of participants who are thought to be the stakeholders of the issues under discussion, such as researchers, policymakers and clinicians in the field, are more likely to debate the issues critically (Fink, Kosecoff, Chassin & Brook, 1984). The involvement of consumers is more popular when finances permit. The expert in the consensus development conference has the role of presenting a number of views on the issue and being open for questioning by the facilitator to clarify his/ her proposals and ideas. However, the status of "expert" in the consensus development conference is always challenged and a more appropriate term, the "informed advocate" has been proposed. In the consensus development conference, debates are usually concluded by majority vote. The literature reviewing the validity, reliability and rigour of consensus conference method is limited, but the proposed criteria by Hasson and colleagues (2000) for the qualitative consensus method may be applied to the consensus development conference.

4.4.4 RAND/ UCLA Appropriateness Method

The RAND/ UCLA appropriateness method combines the features of the nominal group technique and the Delphi method. It was developed in the mid-1980s to reach consensus on interventions. The method starts with a literature review and then a list of indications for an intervention is drafted (Hutchings & Raine, 2006). An expert panel usually consisting of nine multidisciplinary members, is requested to rate the level of appropriateness for the interventions for each indication through a survey (Black, Murphy, Lamping, McKee, Sanderson, Askham & Marteau, 1999). A nine-point rating scale questionnaire is used. After convening a facilitated meeting to discuss the areas of disagreement, the experts may revise their previous ratings (Hutchings & Raine, 2006).

Each group consensus method has its strength and weakness. The most distinct characteristic among all is the anonymity of experts in the Delphi method, and this can be an advantage, depending on the composition of the expert groups. Social culture is another important consideration, such as the acceptance and confidence in open discussion, and the equality of social ranks of different members in the group.

4.5 Questionnaire Survey

Using a questionnaire survey to identify professional competency is efficient as a large number of participants can be involved within a short period of time (Raymond, 2001). The survey questionnaire involves the descriptions of professional competency, called descriptors of competency and the rating scale.

4.5.1 Descriptors of Competency

Different approaches to identify competency result in different competency descriptors. The task-based approach uses task-oriented descriptors, while the generic skills approach uses person-oriented descriptors. The integrated approach starts with the task-oriented descriptors and then links them to the person-oriented descriptors. The characteristics of the descriptors are elaborated upon below.

The task-oriented descriptor is concrete and observable (Morgeson & Campion, 1997). The descriptor or statement starts with an action verb to describe the desired behavior of the professional (Raymond, 2011). For example, “conduct surveillance using standardized definitions” is a task-oriented descriptor. Person-oriented descriptors list the knowledge, skills, ability and attitudes, and are abstract and can have ambiguous interpretations. “Communication skills”, for instance, is a kind of person-oriented descriptor, and may require several questions to clarify the definitions. The language may only be familiar to educators, psychologists, or some specific experts (Raymond, 2001). The advantage of the person-oriented descriptor is directly linked to the test plan (D’Costa, 1986). In the meta-analysis of job analysis reliability, researchers found that the inter-rater reliability was higher when using task-oriented descriptors compared with person-oriented descriptor in job analysis surveys (Dierdorff & Wilson, 2003). In the competency identifying process, the competency descriptors influence the reliability of the instrument thus affecting the content validity of the final results. Identifying competency for clinical professionals involves the input of clinicians and field practitioners, and it is crucial to provide them with concrete and understandable statements for review. Task-oriented descriptors are the appropriate choice for them. Adopting the integrated approach for defining competency, the related person-oriented descriptors can be worked out by other qualified experts, the educators, to further design the test plan and the test.

4.5.2 Rating Scale of the Questionnaire

In the survey questionnaire used for identifying competency for specific professionals, participants are asked to rate the listed descriptors (professional competency) according to the rating scale. The ultimate goal of the survey results is to find out the level of importance of individual competency items. Measuring the importance of the task is also critical to assign the weight to each item when developing the content blueprint of certification examination. A Likert rating scale is a common choice to measure the attitude or opinion of the participants. To decide the rating scale(s) for the questionnaire, a several aspects must be considered.

4.5.2.1 Choice of Scale

Different rating scales have been used in task analysis and variability between the scales include frequency, time spent, responsibility/ job requirement, need at entry/ extent at licensure, type of involvement, overall importance/ significance, criticality/ consequence, risk, necessity among others (Raymond, 2001).

A frequency scale is commonly used because of its objectivity (Dierdorff & Wilson, 2003). In the study by Willens and colleagues (Willens, DePascale &

Penny, 2010) to delineate the role of pain management nursing, frequency of performing the tasks were ranked within the range of *rarely*, *sometimes*, *often* and *repeatedly*. McMillan and colleagues also asked the participant to rate the frequency of the task when revising the blueprint for the oncology certified nurse examination. Participants were requested to rate the task from *never*, *seldom*, *monthly*, *weekly*, *daily* and *more than once a day* (McMillan, Heusinkveld, Chai, Miller-Murphy & Huang, 2002). Another format of frequency scale was proposed by Spray and Huang (2000) for rating the tasks using a 5-point system, from “I never perform this activity” to “I perform this activity daily”. However, performing tasks infrequently does not mean they are less important. For example, in normal circumstances, outbreak control is not a frequently performed task. However, in an outbreak, outbreak control is extremely important and infection control nurses should be familiar with the necessary procedures even if it seldom happens. Scales of frequency and time spent focus on the tasks that are actually performed. It cannot reflect the overall importance of all the tasks.

The ‘Importance scale’ involves elicit judgement of the tasks on the part of the raters. It is the most common scale used by researchers (Hallas, Butz & Gitterman, 2004; McGaphie et al., 1978; McMillan et al., 2002; Patterson, 2008). The scale addresses the skills crucial to public safety and so rarely performed activities are also evaluated (Raymond, 2001). In the meta-analysis by Dierdorff and Wilson (2003), the researchers found that when task-oriented descriptors are used, the importance scale showed the highest inter-rater reliability compared with scales of frequency, difficulty and time spent.

Similar to ‘importance scale’, The Certification Board of Infection Control and Epidemiology (CBIC) in the United States of America used a ‘significance scale’ in the recent surveys of infection control practice (Curchoe et al., 2008; Feltovich & Fabrey, 2010).

Scales of criticality are classified as similar to importance and significance scales (Raymond, 2001). However, there is little agreement on how to measure criticality, and Morgeson and Campion (1997) point out that criticality is a complex and multidimensional construct, which is difficult to measure using a simple scale.

After examining the commonly used rating scales, it is noted that there is a danger to using a ‘frequency scale’ as this can easily omit infrequent, yet important tasks. Criticality scales are abstract, and difficult to quantify and the reliability of such scales will be questioned. Therefore, the use of the importance scale and significance scale are considered to be both more useful, and more reliable.

4.5.2.2 Categories of the Scale

Regardless of the kind of scale used, it should provide all possible choices for the participant to rate. For the CBIC significance scale, the four points ranging from *extremely significant* to *minimally significant to the current practice* was adopted (Feltovich & Fabrey, 2010). This scale only provided the options for positive answers without any negative choices of significance while the category "not necessary for the job" had been removed from the previous practice analysis survey (Curchoe et al., 2008; Goldrick et al. 2002). This forced the survey participants to adopt the items as significant although the level could be varied. Even when the scale included both positive and negative categories, it was not without problems as controversy regarding inclusion of a neutral category in the scale still arose (Adelson & McCoach, 2010). The response rate may be lower when the neutral category is omitted from the scale (Guy & Norvell, 1977). This may be due to there being no option for the participants to rate when they do not have any idea on either side of the scale. Studies also showed that increased number of categories in the scale may lead to measurement error when the participant could not differentiate the rating between adjacent categories (Adelson & McCoach, 2010). To conclude, a reliable scale with positive, neutral and negative categories may be adopted to minimise the concerns discussed above. In this research, measuring the different levels on positive and negative sides is crucial. A 3-point Likert scale is not ideal while a 7-point scale may be too complicated for the raters. A 5-point scale provides equal opportunity on rating both side and it is commonly used in Likert scale surveys (Whitehead, 2008).

4.5.2.3 Number of Scale

Some researchers used a single rating scale (Arbet, Lathrop & Hooker, 2009) to measure the importance of the practice or task while others used multiple scales (McMillan et al., 2002; Willens, DePascale & Penny, 2010). Raymond (2001) reported that two scales increased the measurement precision of the attributes but there was only little positive effect when adding the third scale. Like other competency identification studies, the list of tasks or practices should be a long one. The problem of information overload in the job analysis process may result in data inaccuracy, thus reducing the reliability, due to incomplete responses, reduced dimensionality and reduced ability to discriminate between tasks (Morgeson & Campion, 1997). Using two rating scales in the survey may increase the reliability of the results but this will double the workload of the participants and may lower the response rate of the survey, in addition to creating information overload. A single reliable rating scale has been deemed sufficient for our opinion survey.

4.5.3 Effect of Raters' Background

When launching a practice analysis survey, field practitioners are invited to provide input on the importance or other rating criteria on the listed tasks or practices. A practice analysis survey on infection control practices in the United States was conducted by Curchoe and colleagues to evaluate the role of infection control practitioners (Curchoe, Fabrey & LeBlanc, 2008). The mean rating on the significance of items was examined based on the groups of participants from different backgrounds. The items was included when 84.25% of total participants rated items as significant and the overall mean significance rating reached 2.5 or above. The mean significance ratings were further tested in different groups of participants. It was found that the mean ratings provided by participants with two to six years of experience were comparable with the overall mean ratings. The mean ratings provided by infection control practitioners from institutes of different work settings, with different bed capacities and different certification status were also comparable with the overall mean ratings. However, when examining the answers from different groups about the time spent per week in infection control activities (part-time versus full-time), it was found that there were fluctuating mean ratings across the groups. This showed that the background of raters did not affect the mean ratings of the inclusion criteria in general. The work time spent on infection control activities resulted in different mean ratings in the survey.

4.5.4 Data Analysis

The survey measures the opinion of participants, which is a psychological measurement. The rating scale in psychological measurement belongs to the probabilistic model, rather than the deterministic model as the cognitive process is a likelihood condition instead of being accurately predicated like a physical or chemical situation (Osterlind, 2010). To express the perceptive level of research participants, an ordinal scale is commonly used. Variables in an ordinal scale reflect the ranking of the measures. The distance between the rankings may not be equal and may be non-linear, and managing these data as linear data is not appropriate (Osterlind, 2010).

4.5.4.1 Assumption of Classical Test Theory

The usual item analysis method on survey data, such as measuring the means, falls under the assumption of classical test theory. The scores on attributes along the construct are in a linear relationship if they are found to be consistently positively related (Osterline, 2010). Therefore, the scores of attributes generated from various methods can be summed or even combined. With this characteristic, measures are called composite tests, composite measures or composite scores. The scale of an opinion survey, like the one in this study, is a non-linear, ordinal scale. Strictly speaking, it should not be handled with classical test theory methods to sum or combine scores, though this is commonly done by researchers (Arbet et al., 2009; Blancero, Boroski & Dyer, 1996; Clark, Berry, McSteen & Fabrey, 2009; Docken, 1999; Doyle, Hula, McNeil, Mikolic & Matthews, 2005; Duffield, 1993; Feltovich & Fabrey, 2010; Fitch et al., 1996; Hallas et al., 2004; Kane, Kingsbury, Colton & Estes, 1989; Lin, Hsu, Li, Mathers & Huang, 2010; Turner, Kolenc & Docken, 1999; Willens, DePascale & Penny, 2010).

4.5.4.2 Rasch Measurement

The Rasch model was developed by the Danish mathematician Georg Rasch in the 1960s and can be used for handling ordinal survey data. It is a one-parameter item response theory model (Bond & Fox, 2007), and is often abbreviated to 1PL, which stands for parameter estimates of a logistic function (Osterlind, 2010). Rasch's work was widely promoted in the United States by psychoanalyst Benjamin Wright. Being a 1PL, Rasch model concentrates only on one parameter, which is item location--for example, item difficulty in a test. The Rasch model tackles two aspects of measurement, namely, item-focused and instrument-focused (Wilson, 2005). Instead of modeling the responses as classical test theory, it attempts to model the probability of responses. It proposes that the probability of an item response is a function of the respondent location (e.g. student ability, attitude towards something) and item location (e.g. item difficulty, item scale value) (Rasch, 1980). An item-person map or Wright Map is an important presentation to demonstrate the said relationship. The map is split into two halves, right and left, by a continuum of scale. The respondent and item locations are placed on each side respectively according to the scale. With this presentation, it is easy to compare the respondent locations and item locations (Wilson, 2005). Being an objective measurement, the results of the Rasch measurement is reproducible with the acceptable range of error (Institute for Objective Measurement, 2000).

The Rasch measurement is predominantly used in the field of education. It is utilized in setting and evaluating the assessments and passing standards of tests, including high-stake tests (Bond, 2003; Griffin, Cuc, Gillis & Thanh, 2006; O'Neill, Marks & Reynolds, 2005; Rasch, 1980). Other authors have used Rasch to analyse test items (Chang et al., 2010). The objective standard setting was most convincing in a study by Stone (Bond, 2003) where the passing standards of more than a dozen certification examinations over three years were compared and the investigators found that the objective setting standards were stable while the passing rates based on a traditional method fluctuated.

The objective standard setting by the Rasch measurement showed explicit quantification of qualitative evaluation. Engelhard and Stone (1998) also used the Rasch measurement to evaluate the quality of ratings of the standard-setting judges.

Gillis and Griffin (2004; 2005) proposed using rubrics to recognize different levels of performance in educational assessment. Such a learning or assessment framework has been employed by the Department of Education Victoria in Australia for school leaders (Department of Education Victoria, 2007). Nicholson and colleagues (2009) also utilized the Rasch measurement to determine the level of performance when assessing the clinical performance of nurses in operating theatres. The reliability of the scoring rubrics in this study was concluded to be high (Nicholson, Gillis & Dunning, 2009).

In social science research, the Rasch measurement is often used in the psychometric analysis of the developed scales to ensure or validate the scores in the scales, which are psychological measurements, are reliable and valid (Andrich, 2004; Clemson, Bundy, Cumming, Kay & Luckett, 2008; KJ Conrad, KM Conrad, Dennis, Riley & Funk, 2009; Doyle et al, 2005; Eklund, Erlandsson, Persson & Hagell, 2009; Hula, Doyle & McNeil, 2006; VanHartingsveld, Lucas, Kwakkel & Lindeboom, 2006; Vidotto, Ferrario, Bond & Zotti, 2010).

In addition to being used for performance standard setting based on dichotomous data, the Rasch measurement is an appropriate measurement model to analyze the data of opinion surveys to decide on the response levels. This measurement can handle polytomous data, such as a Likert scale. The analysis converts ordinal data to a logit (logarithm of odds unit) scale, which is an interval scale (Conrad & Smith, 2004). The interval scale, which is in a linear function, is easy to interpret and handle and can be used for parametric statistical analyses (Wright, 2002). A sample size as small as 30 are acceptable, providing the responses are suitably spread across the options on the scale (Bond & Fox 2007). This objective measurement also provides indicators to check if the data is sufficiently adhering to the model expectation and facilitates the decision of inclusion and exclusion of data, i.e. participants and competency items.

Measuring the construct validity of a scale is the key role of the Rasch measurement. Compare to factor analysis, Rasch experts commented that “factor analysis is confused by ordinal variables and highly correlated factors” (Schumacker & Linacre, 1996, p.470). Studies showed that both the misfitting items and outliers of the Rasch model were reported as minor factors by the principal component analysis in factor analysis, and investigators concluded that the Rasch measurement should be recommended when one factor or highly correlated factors are dominant. Factor analysis is suitable only when the uncorrelated factors are dominant. However, factor analysis only identifies the underlying variables. It cannot locate them. In contrast, the Rasch measurement can locate both the persons and items (Schumacker & Linacre, 1996).

5 Content Standards Setting

When discussing standard setting, it is important to differentiate between content standards and performance standards. Content standards form the curriculum that the examinees are expected to know and be able to do, while performance standards are the required performance of examinees related to the content standards (Hambleton, 2001; Tannenbaum & Wesley, 1993). The standard setting in this research belongs to setting the content standard as it defines the content for a certification programme, which is a type of competency assessment.

Harden (2001) describes the curriculum map, which demonstrates the links between different components in a curriculum. Different components include learning opportunities, which may be a lecture or a practical learning session, learning outcomes, content and assessment. All the four components are interlinked, which means, the content contributes to the learning opportunity and also to the assessment. According to this concept, the content of educational curriculum also serves as the content of the related assessment.

Performance standards can be classified based on the judgement of a panel (Hambleton, 2001). The judgement may be based on the review of assessment material and scoring rubrics (e.g. Angoff method), covering the work of the examinee (e.g. paper selection, whole booklet classification, analytical judgement, whole body of work methods); the score profiles (e.g. dominant profile method, policy-capturing method); and the candidates (e.g.

contrasting-groups method). These methods can only be used when the performance of candidates is available. Therefore, it is not appropriate to apply it to setting *a priori* standards for the assessment.

The first step in constructing an assessment is defining the construct of measurement (Walsh & Betz, 2001). The construct to be measured in a competency assessment of course, is the competency itself (Shrock & Coscarelli, 2010). This exercise improves the fairness for candidates and examiners. However, the fundamental question of "what the competency is" influences the assessment methods (Searle, 2000). Therefore, setting content standards for the assessment, returns to the issue of identifying professional competency. However, the issue is not identifying a comprehensive competency for the profession, but only the competency boundary for the assessment. I will discuss the common methods in the following sections.

5.1 Critical Incident Technique

The critical incident technique is one of the methods to identify competency. By offering detailed descriptions of the incidents, it is also valuable in developing the educational curriculum or test content (McGaphie et al., 1978; Raymond, 2001). The method starts with collecting the anecdotes of incidents to analyse the factors affecting the effective or ineffective performance of the individual. Once this data has been collected, the expert judgement lists the critical incidents that can be used as the content standards (Kane, 1997).

5.2 DACUM

DACUM is the acronym for developing a curriculum (Shears, 1985). It is a method for job analysis and developing the training curriculum using the DACUM chart. As the method firstly identifies the competency areas and subsequently develops the related skills, performance objectives and standards, it can be employed to identify the competency of a specific professional group. A carefully selected group of participants, who are practising in the field, is named as the chart advisory committee. They should have been working in the field for at least six years and feel comfortable giving opinions in the DACUM meeting. A researcher or the vocational instructor, who acts as the DACUM chart committee co-ordinator, should be trained and is responsible for designing the DACUM chart and sustaining the momentum of group interaction. All the skills on the chart are listed in performance terms, which can then be used to develop competency-based training. DACUM approach has been used in a lot of Canadian companies for job analysis and developing training plans. In Australia, Hobbs (2007) employed the DACUM technique to identify the scope of practice of infection control practitioners in Victoria.

5.3 Professional Performance Situation Model

The professional performance situation model was designed to develop the content categorization for the training curriculum or certification tests based on a facet approach (LaDuca, 1980; McGaphie et al., 1978). It was originally used in the medical profession and has been used for occupational therapists (McGaphie et al., 1978). The model has a three-dimensional structure, namely the client (patient), clinical problem and setting, to identify the full responsibilities of a profession. Situations based on the three dimensions are identified. As a result, full inventories of the profession can be developed. However, full inventories contain too much information and cannot be used as the content of the training curriculum or certification test (D'Costa, 1986). Therefore, a "Critical mass" has to be found to serve this purpose. This model is a concept rather than a description of the methods to identify the content of the training curriculum or certification tests (Raymond, 2001).

5.4 Task Analysis Survey

A task analysis survey is an efficient way to collect opinions from practitioners or experts using a questionnaire which lists the possible activities of the surveyed professionals. Ratings are reviewed to decide the content boundary for the test. This method is commonly employed for the licensure or certification examination (Kane, 1997). Different methods are employed to set the content standards for the examination. Some researchers identify the most important tasks from previous surveys before conducting the task analysis survey for an examination. For example, when reviewing the blueprint for an advanced practice hospice and palliative nurse certification examination, an advisory committee or expert panel reviews the last survey results to identify the core activities before surveying the practitioners (Clark, Berrry, MaSteen & Fabrey, 2009). As a result, the mean ratings of all the survey items will be high enough to represent the professional practice, and thus will be included in the examination content. Similar methods have been used by Arbet and colleagues

(Arbet, Lathrop & Hooker, 2009) when developing the content standards for certifying examinations for physician assistants.

Other researchers set up an advisory panel to review the results of a practice analysis survey. A number of criteria for item inclusion were set. For example, when Curchoe, Fabrey and LeBlanc (2008) determined the content of a certification examination for infection control, prevention and epidemiology practice, seven rules were set. Given that a significance scale was used in the survey, rule 1 was at least 84.25% of total respondents should have rated the task as significant. In the exercise, 13 items fell outside this rule, and the advisory committee finally voted to keep one item in the examination content based on their expert judgement. Rule 2 was the significance level judged by survey participants. Going through the significance scale from *somewhat significant* (3), *quite significant* (4) and *extremely significant* (5), the advisory committee decided to conclude the item was significant at the mean rating of 2.5 or above. Rule 3 was that the item should be significant to moderately experienced survey participants. The mean rating of the item should be at least 2.4 from the respondents with experience from two and six years. For the rules 4 and 5, they examined the significance levels of the items across different work settings and bed capacity. Rule 6 ensures the tasks were significant regardless of the time spent. The time spent was grouped into three groups. The item should be rated at the minimum score of 2.4 by all three groups. One item (interpret epidemiologic markers in outbreak investigations) was found outside of this rule. However, the advisory committee voted to retain this task in the examination content. Rule 7 further required that the certified participants should rate the item at least at the mean of 2.4 on the significance scale.

5.5 Entrustable Professional Activities

Ten Cate and Scheele (2007) used another approach to identify the critical professional activities to be the test content as these investigators considered that the core competency identified for a profession is usually too general, and thus too broad and difficult to assess. They proposed to work out a two-dimensional matrix on each general competency. Critical activities, known as entrustable professional activities of the general competency, will be identified by experts. These are well defined, limited activities in the range of general competencies for the purposes of the test.

5.6 Expert Consensus – The Major Component

After reviewing different methods on setting content standard for a test, it is noted that expert consensus is an important component in content standards setting. While some methods use consensus in qualitative items development (e.g. the critical incident technique, entrustable professional activities), others determine the cut-off level based on the quantitative information and the context. “Curriculum hypertrophy” is used to describe the situation where the curriculum content is too much (Arthur & Baumann, 1996). This is also common when developing the content for competency assessment, such as certification content, when task analysis or practice analysis survey is used (Curchoe, Fabrey & LeBlanc, 2008; Ten Cate & Scheele, 2007).

While the professional core competency is a comprehensive description for a profession, it is usually too much to include everything in the content for the assessment and only the most important competency items are tested due to limited resources (D'Costa, 1986). Defining the most important competencies or content is not easy. Expert opinion was used by Arthur and Baumann (1996), which involved considering other factual data by literature review, including the magnitude of the illness, case fatality rates, lost quality of life and duration of ill health. The concurrent burden factor of the illness was worked out based on the factual data; a formula was set to determine the indices for each health issue. Quality input from experts was based on the priorities of provincial/ local surveys on health related issues. Ranks were assigned according to the indices and survey priorities. This method proposes qualitative judgements based on the quantitative information with calculations to prioritise the curriculum content. However, the paper did not give a definitive conclusion on how to set the content standards.

All the methods of content standards setting involve expert consensus, in terms of quantitative and qualitative decisions. With the quantitative information, setting the content standards relies on the qualitative judgement of the experts. Validity in qualitative research refers to "trustworthiness" (Rolfe, 2006). Trustworthiness is a matter of persuasion that the practices are visible and auditable, meaning that the reader can track and verify the research process from the research report. Rolfe (2006) agreed with Sandelowski's idea (1993) that repeatability of a result (that is, the reliability) for qualitative research is not essential when reality is assumed, and it is rather a matter of judgment instead of the rigorous application of technique. In short, the rejection of the reliability in the qualitative research favours its validity or trustworthiness.

6 Conceptual Process of Identifying Competency

The various methods on identifying competency discussed above are not used exclusively during the identification procedure. To ensure the rigorousness of the process, a combination of methods is usually used. Patterson, Ferguson and Thomas (2008) used the observation method to start with the competency identification. The observation was then verified by a focus group, critical incidents interviews and literature review. The authors claimed that the qualitative development of competency is standard practice in the literature. Since the practices of healthcare specialists involve a lot of personal judgement and mental application that cannot be observed, other supplementary methods have to be adopted when drafting the competency comprehensively.

6.1 Functional Analysis

Competency standards can be identified by functional analysis. Functional analysis focuses on individual's outcomes. It is rather a job-oriented approach analysis utilized for describing standards as expected by the employment. Adopting a top-down approach, it breaks an individual's role in a particular occupational area into purposes and functions until the performance criteria are met (Mitchell, 1989). The author emphasised that the functional analysis is not a method, but only an approach.

6.2 Role Delineation

A role delineation model for healthcare professionals recommended by D'Costa (1986) explicitly describes the process. It starts from a review of the literature and other related documents to establish the rational roles of practitioners. With input from subject matter experts, the empirical roles of practitioners are developed. Lastly, with input from field practitioners, the appropriate roles of the practitioners are identified. Roles have responsibilities. Responsibilities are simply the competencies of the practitioners when both are expressed in behavioural or action statements. The role delineation process identifies the comprehensive responsibilities or competencies for the particular group of practitioners.

7 Competency Assessment

In the process of professional development, identifying professional competency is its first step only, while its ultimate goal is the competency assessment (Axley, 2008). Walsh and Betz (2001) defined that competency assessment is a psychological process to understand people and help them to cope with a problem.

7.1 Methods of Assessment

In order to collect evidence to evaluate an individual's competency, different methods of assessment can be used (Mitchell, 1989). Sources of evidence may be classified as performance evidence and capability evidence (Eraut, 1994). Some sources belong to both types of evidence. Capability evidence of assessment is used to supplement performance evidence. Common methods of competency assessment are discussed below.

7.1.1 Observation

Direct observation on normal practice or indirect observation through video recording belongs to performance evidence assessment (Eraut, 1994). These methods are suitable for many types of competency and they are the most valid evidence. In most cases, questioning of candidates is carried out at the same time of observation.

7.1.2 Observation of Simulation Exercise

Simulation exercise, also known as objective structured clinical examination (OSCE), is a "second-best" solution and it is used when direct observation is not feasible (Eraut, 1994; Watson, Stimpson, Topping & Porock, 2002). This exercise provides mainly capability evidence and some performance evidence. Candidates are expected to respond to rare, dangerous or expensive situations. With simulations, candidates are able to cover a wide range of situations in a short period of time. There are agreed criteria for the assessment.

OSCE is commonly used for evaluating clinical professionals, for example, doctors and nurses. In assessing recently graduated doctors in early residency in an emergency department, correlation was found between the scores of OSCE and clinical performance. However, no correlation was identified between systems-based practice, interpersonal and communication skills, and professionalism competencies (Wallenstein, Heron, Santen, Shayne & Ander, 2010). Hobgood, Riviello, Jouriles and Hamilton (2002) reviewed several methods that can be used to assess communication and interpersonal skills of healthcare workers; these methods include checklist, self-assessment, peer review, patient survey, direct observation, portfolio, simulations, oral examination, OSCE and objective structured video examination. They concluded that standardized patients (simulators) and direct observation are most likely helpful methods to evaluate the competency in communication and interpersonal skills. They further concluded that a useful evaluation method for a professional competency may not be a solution for another.

7.1.3 Portfolio

A portfolio is a kind of formative assessment (McMullan et al., 2003). It is defined as "…… a visual representation of the individual, their experience, strengths, abilities and skills." (McCready, 2007, p 144). Containing rich personal and professional content, the portfolio is promoted as a tool for career enhancement because it can be used for self-assessment and planning for personal development (Casey & Egan, 2010; Leach, 2008). Apart from private use, the portfolio is also used for professional purposes, e.g., providing evidence of experience or competence for prospective employers during selection or interview processes (Timmins, 2009). It is also useful to reflect the clinical competence of the professionals (Redfern, Norman, Calman, Watson & Murrells, 2002). Portfolios and other log-books provide performance evidence mainly, and indicate capability evidence, too (Eraut, 1994). A log-book serves as a good basis for questions but it should not be considered as evidence in general. A portfolio, if including reflective reports prepared by candidates themselves on their own professional work, can be used as a supplement to direct observation. A portfolio is usually classified as evidence of capability rather than of performance. Although there is little evidence to show the link between theory and practice for the use of a portfolio, it can be a catalyst for the growth of a student. The continuous nature and structure of active involvement encourages students to develop self-reflection and control their own lifelong learning (McMullan et al., 2003). There is conflict in the portfolio between its aim and use for summative assessment as it can become assessment-led, meaning that students can write what they think the assessor wants to read rather than their innermost thoughts and feelings.

7.1.4 Written Examinations, Assignments, Interview

Written examinations, work-related assignments and interviews are evidence of capability. They are used to assess the candidate's cognitive processes that cannot be directly observed. The ability to understand clients, problem and situation analysis, discuss the values of alternative approaches and evaluate professional practice are included in these assessment methods (Eraut, 1994).

However, this knowledge-based assessment has not been agreed upon in the literature as a valid clinical competency assessment (Watson et al., 2000).

Watson and colleagues suggested that direct observation was the best competency assessment method (Watson et al., 2002). McMullan and colleagues objected to this saying that assessing competency by observing the performance alone was not enough (McMullan, Endacott, Gray, Jasper, Miller, Scholes & Webb, 2003). Integrated assessment methods should be used because the attributes would not be used independently in real life. Direct and relevant methods should be adopted to ensure the clear concept and context-specific nature of the assessment. A variety of methods, including indirect assessment of knowledge, should be used to increase the validity of the assessment (Casey & Egan, 2010; Connally, Jorgensen, Gillis & Griffin, 2003; Griffin & Gillis, 2001; Hager & Gillis, 1995; Leach, 2008; Norman, Watson, Murrells, Calman & Redfern, 2002).

7.2 Framework of Interpreting Assessment Results

There are four functions of competency assessments, namely evaluative, diagnostic, formative and summative (Gillis & Griffin, 2008). Evaluative assessment is employed for collecting evidence to evaluate the institutions, curriculum and standards. Diagnostic assessment is to assess a candidate's learning while formative assessment is to provide information to identify the improvements in a candidate's learning, plus the growth of competency. Summative assessment is used to certify or acknowledge the accomplishment or potential of a candidate. To achieve different purposes of the assessments, different frameworks have to be employed.

7.2.1 Norm Referenced Framework

Norm referenced framework is in a leading position in interpreting assessment results in the field of education (Gillis & Griffin, 2008). This framework compares the performance of an individual candidate with those of a reference group, consisting of candidates with similar characteristics. The performances of the reference group are rank-ordered. Then, the performance of the individual is simply graded according to the rank-orders provided by the reference group. Noting that the rank order does not tell us the actual performance of an individual (Morris & Adamson, 2010). Moreover, this framework neglects the information on identifying learning difficulties and areas for learning improvement. It fails to achieve the purposes of diagnostic assessment and formative assessment. It limits the contribution to evaluative and summative assessment purposes (Gillis & Griffin, 2008).

7.2.2 Criterion Reference Framework

In contrast, criterion reference framework serves all the four assessment purposes. In this framework, the performance of an individual is compared with the described criteria on a scale of increasing competency (Gillis & Griffin, 2008). The standards, which are the minimum acceptable levels, of the competency have been decided on this continuum.

8 Concept of Validity

Validity is an important concept for a test and assessment. Different types of validity related to this research are discussed as below.

8.1 Content Validity

Content validity refers to how well the measured behaviors represent the whole domain of behaviors (Walsh & Betz, 2001). The content validity of competency tests in various work settings, such as power and paper companies, had been judged as invalid by the court in the United States of America (Thompson & Thompson, 1982). The court emphasized that the job analysis (practice analysis/ competency analysis) was considered as the foundation of many personnel practices. To ensure the valid content of a test, the starting point is a job analysis involving the experts or professionals in the field. The judge enforced that being a content valid test; three criteria should be adhered to:

1. The knowledge, skills and abilities to be tested must be critically related to successful job performance;
2. Portions of the test should be accurately weighted to reflect the relative importance to the job;
3. The level of difficulty of the test material should match the level of difficulty of the job.

Larson and colleagues reported the validity of the certification test for infection control practice. Using different panels of experts, they prepared the content outline beginning with the identification of the practice dimensions (Larson, Elsenberg & Soule, 1988). Task statements were then developed based on the practice dimensions and related knowledge statements were finally written up. This development process linking content outlines of the certification examination with the practice is the criteria of content validity.

It was reported in the United States that, in a 1975 court case, a trooper examination in New York was judged as invalid content because a task-oriented analysis was not done during the examination development and linkage between the examination content and the actual tasks was not found (Thompson & Thompson, 1982). This implied that the examination was not developed based on the professional standards. The judge concluded that the examination did not focus on troopers' actual duties.

From the above court case, we learned that the linking of context from practice to certification content is a matter of concern (content relevance). The judge in the abovementioned case also noted that the portion of the test should be accurately weighted to reflect the relative importance of the job (Thompson & Thompson, 1982). This involves translating the ratings from the experts or practitioners in the developing process to the weighting of the test content (content representativeness). Content relevance and content representativeness are the two aspects of content validity (Messick, 1993). There are a few translating processes for the content weights.

The traditional practice analysis survey serves two purposes in content validity. The first one is to identify the competency items through collecting opinions from field practitioners. The second purpose is to establish the weights for the test specification during development of the test plan. A few methods of assigning weights are discussed below.

8.1.1 Holistic Judgments

A holistic judgment involves assessing the weights of test specifications by a panel of subject matter experts (Raymond, 2001). They are not told about the use of the weighted assignment but are requested to assign a percentage to each content category to make the whole to 100%. Group discussion and adjustment are allowed.

8.1.2 Linear Model

Linear model is very commonly used and is convenient to establish the weight in the process-oriented test plan (Raymond, 1996; Raymond, 2001). The process-oriented test plan is the commonest format for a credentialing examination (Raymond, 2001). It describes the actual practice and is very useful in performance-based examination. The rating of frequency and criticality of each task will be combined to a single index of task importance. Each task's overall importance (I_i) is lineated with its frequency (F_i) and criticality (C_i). The ratio between them is that the criticality is given twice the emphasis of the frequency. The equation of the model is:

$$I_i = F_i + 2C_i$$

The main advantage of this model is its simplicity. However, Kane and colleagues believe that this linear model does not generate a very useful index (Kane, Kingsbury, Colton & Estes, 1989), and that the interpretation of just adding up the frequency and criticality of the task is not clear at all.

8.1.3 Multiplicative Model

Kane and colleagues proposed a multiplication model (Kane, Kingsbury, Colton & Estes, 1989). The model assumes that the importance of a task is based on its criticality and frequency of occurrence, and that the overall importance can be obtained by multiplying these two variables. To assure the two variables contribute equally to the index of overall importance, an exponent of 3.235 is added to the criticality before multiplying it with the frequency. The mathematical interpretation will be:

$$I_i = F_i(C_i)^{3.235}$$

8.1.4 Hierarchical Ranking

Hierarchical ranking is a simple and direct method (Raymond, 2001). Some processes rank the task directly, while others may rank the related components for the task, such as frequency and criticality. If criticality is assumed to be more important than frequency, the task shall be ranked with the criticality as the first priority and then frequency.

8.1.5 Rasch Measurement

When transforming the Rasch measurement results to the weight of competency item, Spray and Huang (2000) combined three scales into one hierarchical ordering before Rasch-analysing the data. As an example, frequency scale (F) and consequence scale (C) is used to illustrate the principle of hierarchical ordering. The priority ordering was determined as consequence and then frequency (C:F). Hence, the scale option on consequence (three options) is ranked as first priority and then frequency scale (five options); as a result, 15 ranks (3 x 5) are listed. The results of two scales were combined into one by fitting into this new hierarchical ordering. These new orderings were then Rasch-analysed to gain the item locations in logits, which can be translated to content weight directly after its proportioning. In this research, frequency is not the consideration. A single scale directly relating to item importance is used in the opinion survey. The step of hierarchical ordering is not necessary. The survey data can be simply Rasch-analysed and transformed to the item content weight. The competency items with proportioned weights contribute to the content blueprint of the certification programme.

The issue of content validity is crucial in this research. When developing the content for the certification examination for infection control nurses of Hong Kong, linking the practice to the examination content is essential. On the other hand, the content weights are also critical to represent the importance of the particular tasks. The Rasch measurement identifies the competency items objectively and at the same time lineates the ratings on the Likert scale to reflect the importance of the tasks. These two functions fulfill both the foundation of content validity for a test and the court requirement (Messick, 1993; Thompson & Thompson, 1982).

8.2 Criterion-related Validity

Predictive validity and concurrent validity are forms of criterion-related validity. Test scores are assessed with the criterion practice or compared with the scores of other criterion test. These types of validity are evaluated after the tests have been conducted. They are important in competency assessment but beyond the scope of this research.

Predictive validity refers to the degree that the present status of the test predicts the status of future performance (Portney & Watkins, 2000; Walsh & Betz, 2001). High predictive validity of a test can be demonstrated when there is high correlation between the test scores and the performance or practice. Ramsey and colleagues conducted a study on predictive validity of the certification examination of physicians. Statistical analysis showed that it was that particular status was the major factor influencing the performance of the physicians. This demonstrated that the predictive validity of the certification examination was high (Ramsey, Carline, Inui, Larson, LoGerfo & Wenrich, 1989).

Concurrent validity refers to the degree of current status of a test being comparable with the status of the criteria (Portney & Watkins, 2000; Walsh &

Betz, 2001). Gerrow and colleagues used correlation test of the scores to demonstrate the concurrent validity of the dental certification examination with the performance of students in their final year of a university programme (Gerrow, Murphy, Boyd & Scott, 2003). The results showed the high level of concurrent validity of the certification examination.

8.3 Construct Validity

Messick opined that construct-referencing is the basis of all measurement. The construct validity represents the central principle in measuring educational and psychological issues (Messick, 1975; 1981). A construct is an abstract concept of the test and cannot be observed directly. When the test has the ability to measure this abstract concept, it is construct-valid. Construct validity also answers the concerns of content validity and criterion-related validity (Walsh Betz, 2001). In addition, it should be defined according to the underlying theoretical trait. Measurement methods like factor analysis and Rasch measurement are useful to check the construct validity of the test (Portney & Watkins, 2000). However, Rasch measurement is the most effective when one factor or highly correlated factors are dominant (Schumacker & Linacre, 1996).

Two major types of threats to construct validity are acknowledged. One is “construct under-representation” which indicates that the test is not adequate enough to include the important domains of the construct. The other threat is “surplus construct irrelevancy” which indicates that the test contains irrelevant portions, such as excess reliable variance, for interpreting the construct of the test (Messick, 1993).

9 Concept of Reliability

This research identifies the core competency of infection control nurses of Hong Kong. As competency is considered as an underlying trait, measuring its dimension to assess the homogeneity of the set of competencies will influence the subsequent test development (although it is beyond the scope of this research). Different tests/ surveys are applied during the competency identification process. The instruments for measurement and the raters do affect the reliability of the final product of this research, thus having impact on the subsequent research work.

9.1 Internal Consistency Reliability

Internal consistency reflects the extent of homogeneity of the test/ survey items. A reliable test contains items that can reflect the candidates' true scores. Item analysis helps to examine this characteristic of the test/ survey instrument (Portney & Watkins, 2000). Internal consistency is related to "unidimensionality", meaning that the test/ survey items reflect one dimension rather than several dimensions (Walsh & Betz, 2001). The Rasch measurement is a good tool to measure an accurate internal consistency that person reliability statistics are used as the indicators.

9.2 Rater Reliability

Inter-rater or intra-rater reliability influences the reliability of the test/ survey instrument when the professional judgement of the assessors is required. Hence, training assessors on using the scoring instrument, such as the rubrics of the test, is essential (McMullan et al., 2003). Objective structured clinical examination has fewer problems of socialization of the assessor than continuing assessment by mentor or preceptor (Watson et al., 2000).

Studies show low inter-rater reliability among portfolio assessors because a portfolio contains material of a highly personal nature. If the number of learning outcomes is reduced in order to increase the reliability, the validity of the assessment will be decreased although some researchers commented that portfolio assessment had no validity at all (McMullan et al., 2003).

9.3 Test-retest Reliability

Test-retest reliability refers to the degree of stability of the test/ survey instrument over time. The test/ survey instrument is considered as reliable if the test/ survey scores are similar when repeated tests/ surveys are conducted in a time interval (Walsh & Betz, 2001). An instrument with satisfactory test-retest reliable result is a pre-requisite for a reliable research output. This research involves a series of rating processes. A test-retest reliability will be checked for the major instrument to ensure the quality of the research output.

10 Conclusion

This chapter discussed the concept of competency. The methods of identifying competency have also been reviewed. It was noted that no single method is sufficient to identify professional competency in a valid way, therefore, a number of methods should be adopted in the process. To work out suitable content for an assessment, expert consensus in a qualitative setting is unavoidable. No single method of competency assessment is the best. Methods are complementary among themselves based on the reliability, feasibility and resources, among other factors. Therefore, a combination of different assessment methods improves the validity of the assessment programme. Concepts of validity and reliability were discussed in this chapter as these are important issues throughout this research. Content and construct validity are crucial in the stage of content development for the certification, while internal consistency is concrete for the identified core competency. Rater-related reliabilities are critical during the process as professional judgments of different expert groups are involved.

This research work starts with identifying the core competency of infection control nurses and then links the findings to the certification content. Based on these concepts, it is crucial to use the appropriate methods to work them out in order to achieve the required validity and reliability.

CHAPTER 6

CONCEPTUAL DESIGN OF THE RESEARCH

1 Introduction

As discussed in the background of this research, developing a local certification programme for infection control nurses and building a process model for the content of certification programme has become urgently required. After giving some basic background into the research aim, objective and research questions, this chapter will discuss the basic concept of developing a certification programme, and the conceptual framework of this research.

2 Research Aim and Objective

The overall aim of this research is to build a process model for developing the content of the certification programme for healthcare practitioners of Hong Kong. In this research, the target group is infection control nurses but the process applies to other healthcare professionals as the foundation of the model is based on the concept for all healthcare professionals. The objective of this research is to identify the critical competency for infection control nurses in Hong Kong. Figure 6-1 depicts the structure of core competency of the specialist profession and its relation to external environments. The core competency of a specialist profession is necessary for daily practice and training up specialists. There are various levels of importance in the core competency of the specialist profession. Critical competency is the most important portion of core competency. In addition to daily practice and education, critical competency serves as the content of certification for the profession.

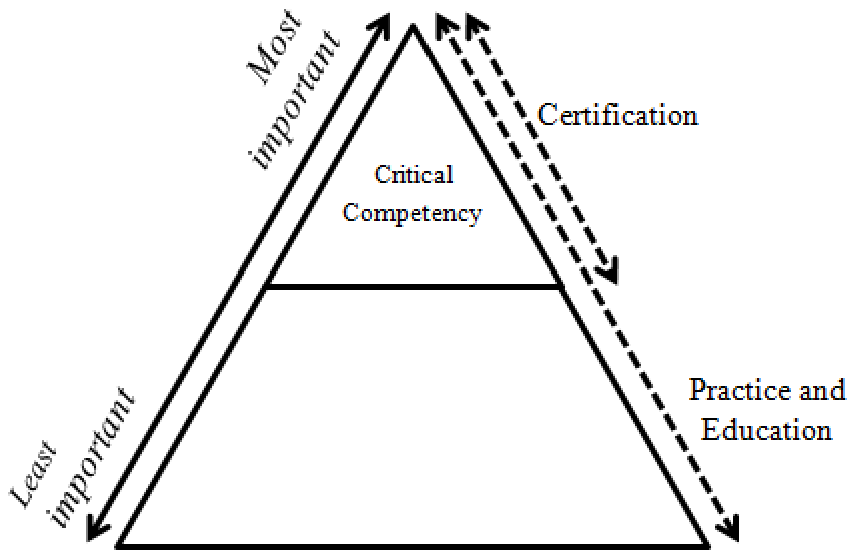

Figure 6- 1: Structure of core competency for a specialist profession

The structure in Figure 6-1 applies to core competency of infection control nurse specialists of Hong Kong. With the critical competency of infection control nurses of Hong Kong identified, at the end of this research, a process model for developing a content blueprint for certification is derived for healthcare professionals.

3 Research Questions

The main research question for this research is:

> What is the critical competency for infection control nurses of Hong Kong?
>
> Subsidiary research questions are:
>
> 2) To what extent are the perceptions of importance of infection control nurses influenced by the nurses' background characteristics?
>
> 3) To what extent can perceptions of importance be used to identify the critical competency (the most important portion of core competency) for infection control nurses?

The three research questions look into the framework and methods of identifying the critical competency and the respective content weights for infection control nurses. Hence, a process model for developing the content of certification programme for healthcare practitioners of Hong Kong will be established.

4 Basic Concept of Developing a Certification Programme

Certification is one of the processes commonly used to regulate the practice of nurse specialists (International Council of Nurses, 2005a). A certification programme is an assessment tool for certification. To ensure the validity of a certification programme, the content of the programme has to be linked with the professional practice of the regulating nurse specialists (D'Costa, 1986; Larson, Elsenberg & Soule, 1988; McGaphie, 1980; Tannenbaum & Wesley, 1993). A simplified process of certification programme development is illustrated in Figure 6-2.

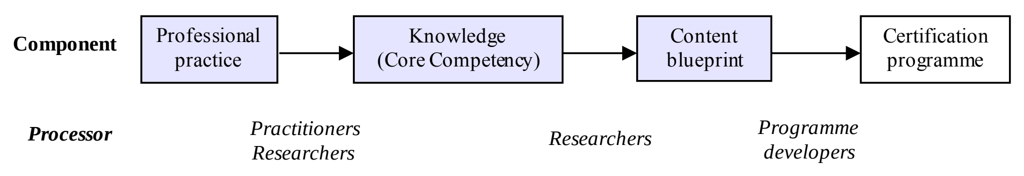

Figure 6- 2: A simplified process of certification programme development

The development process of a certification programme starts with the recognition of professional practice. Based on the practice, the practitioners and the researchers identify the core competency of that particular group of practitioners. It is a process of knowledge development translating the practice to core competency. Researchers suggested that competencies were the beginning of understanding about the requirements for an effective workforce (Hase and Saenger, 2005; McGaphie, 1980). Competency-based approach professional development for healthcare workers was first introduced in 1980s (Pillay, 2010). In addition to the knowledge acquirement, defining, teaching and assessing related competency is also important. So, defining the core competency for the practitioners is the first thing for professional development (Axley, 2008). It is also critical to link the practice to professional competency when developing a certification programme.

When the professional core competency is in place, it is essential to further identify the most important portion of core competency (critical competency) to work out the content blueprint for a certification programme, which is the basis for which the programme developers use to construct the certification programme for the particular group of practitioners.

This research aims at developing a methodology to establish the content blueprint of certification programme for healthcare practitioners of Hong Kong. It covers the first three parts of the process of certification programme development (shaded areas of Figure 6-2). The last step, constructing the certification programme based on the content blueprint will be left to the experts of educational field, the programme developers. The methodology of this research builds a process model for developing a content blueprint of certification programme for Hong Kong infection control nurses. The same model can be used to develop the content blueprints of certification programmes for other healthcare professionals as the concept of identifying competency (role delineation) by D'Costa (1986) used in this research applies to all healthcare professionals.

5 Practice Levels for Infection Control Nurses in Hong Kong

Based on the illustration in Figure 6-2, at first, this research has to identify the core competency of the target group of practitioners. Infection control nurses are the dominant workforce in the field of infection control in Hong Kong. Clear differentiation of the practice level of infection control nurses is not in place. There are different position ranks for infection control nurses in public hospitals, namely, Registered Nurse, Nursing Officer, Advanced Practice Nurse and Senior Nursing Officer. Position ranks are even more diversified in private organizations. In any case, all the nurses involving the work in infection control field are addressed as infection control nurses for the purposes of this thesis.

Infection control nurses at the specialist level are recognised in the United Kingdom and Australia (Gardner et al., 1962; Law, 1993; Victorian Specialty Interest Group Members, 1982; Winchcombe, 2000). In United States, certification system is exercised to acknowledge the specialist position for infection control practitioners.

Roles of nurse specialists were summarized as practitioners in direct care, teachers, consultants, researchers, change agents and managers (Cattini & Knowles, 1999). Davies and Hughes (1995) identified nine areas of competency of nurse specialists, including 1) clinical expertise, 2) critical thinking and analytical skills, 3) clinical judgement and decision-making, 4) leadership and management, 5) communication, 6) problem solving, 7) collaboration, 8) education and research, and 9) programme development. In 1993, the Hospital Authority of Hong Kong executed a pilot scheme on nurse specialists (Hospital Authority, 1992). Twelve nurse specialist categories were created for experienced clinical nurses. At that time, a nurse specialist in the Hospital Authority was defined as “a registered nurse who, after a significant period of experience in a specialised field and with additional nursing education, acts as a nurse adviser to the clinical team and clients, develops client-patient services, and undertakes research and teaching" (Hospital Authority, 1992, p.5). Wong (1997) reviewed the practice of nurse specialists in one hospital in Hong Kong where this pilot scheme was implemented. She found that nurse specialists advised patients via professional consultation. They were capable of exercising professional judgement and make decisions on their nursing work. However, the study reported that the boundaries of a nurse specialist were not clear. A few years after the pilot scheme, the role of nurse specialists in hospitals of Hong Kong was further confirmed as direct clinical care, setting and maintaining clinical standards, staff development, research and project work (Wong, 2001).

In the review by Jones (2005), relationships with other key personnel, and role definitions and expectations were the most widely identified factors affecting the effective practice of nurse specialists. Clearly defining the roles of nurse specialists explicitly tells the nurse specialists about their work or behavioural boundaries and allows other healthcare team members to recognize and form reasonable expectations on the nurse specialists, thus reducing conflicts between each other. This is exactly the situation in Hong Kong, including the field of infection control. The generalist and specialist practices of infection control nurses should be clearly defined.

6 Differentiated Practice Model

The practice levels in a professional group can be defined by differentiated practice model based on the complexity of the practice. The differentiated nursing practice model is used to describe the discrimination of roles and functions of registered nurses based on some criteria, which may be education, clinical experience or competence (Baker, Ransom, Lamm, Conly, Winter, Carpenter, Robbeloth & McCoy, 1997; Malloch, Milton & Jobes, 1990). The purposes of using this differentiated practice model are to:

- Optimise care by matching nursing competencies;
- Use the scarce resources effectively and efficiently;
- Pay scales according to education, expertise and productivity;
- Encourage application of nursing knowledge to increase job satisfaction;
- Increase loyalty to employer; and
- Enhance the prestige of the nursing profession.

To differentiate the competency-based curricula and outcome practice of graduated nurses between Associate Degree Nursing Programme and Bachelor of Science (Nursing) Programme, Primm (1987) used differentiated practice model to identify the differences between candidates of the two education programmes based on three basic components, namely provision of care, communication and management of care. This is an educational level of application of differentiated practice model.

In clinical practice setting, Malloch and colleagues (1990) launched the model in two hospital units to sort out the roles of case managers and case associates based on the expected knowledge, skill and motivation. Formal education or clinical experience was not considered in the differentiation exercise. Although salary was not linked to the differentiated practice at that time, a number of nurses received the clinical ladder promotion after implementing the model. The differentiated roles were recognized by the peers, administrators, patients and other healthcare team members.

In Hong Kong, the Hospital Authority adjusted their previous core competency framework for registered nurses (Hospital Authority, 1997) to a new core competency model for enrolled nurses, registered nurses and advanced practice nurses, which was published after a pilot exercise and consultation (Hospital Authority, 2005). The initiative based on the differentiated practice model to build different levels of core competency of nurses working in the Hospital Authority, including enrolled nurses, registered nurses and advanced practice nurses. Ten functional competencies are included:

Therapeutic and caring relationship;
Care management;
Knowledge and skill application;
Quality and risk management;
Operation and resources management;
Personal qualities;
Professional attribute;
Team work;

People development; and
Service development

There are three practice levels of nurses in the framework, namely, enrolled nurses, registered nurses and advanced practice nurses. After defining the core competencies of the first practice level (enrolled nurses), additional core competencies for the higher level of practice (registered nurses) are documented compared with the immediate lower practice level (Hospital Authority, 2005). For example, enrolled nurses are the first practice level in the framework. After listing the core competencies of enrolled nurses, only additional core competencies for registered nurses are listed. For the practice level of advanced practice nurses, only additional core competencies compared with registered nurses, are listed. This means that the nurses at each practice level require equipping the core competency at that particular level and those required in the lower practice level(s). The concept of this differentiated practice is depicted in Figure 6-3.

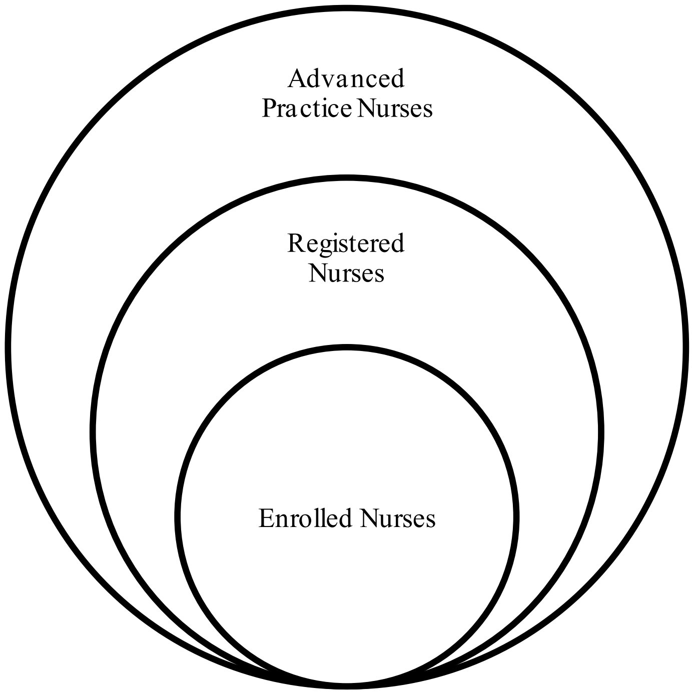

Figure 6- 3: Core competency model for nurses in the Hospital Authority (Hospital Authority, 2005)

Although it has been reported in the literature that the differentiated practice model is used to discriminate the roles and functions of registered nurses (Baker, Ransom, Lamm, Conly, Winter, Carpenter, Robbeloth & McCoy, 1997; Malloch, Milton & Jobes, 1990), the initiative of the Hospital Authority applies this model beyond the practice of registered nurses. This illustrates the practice of the Hospital Authority converting enrolled nurses to registered nurses through participation in a conversion programme, which is an educational exercise. The practice conversion has been promoted as the professional and career development for enrolled nurses in the Hospital Authority of Hong Kong.

6.1 Core Competency Model of A Profession

Based on the concept of differentiated practice model and the core competency model for nurses in the Hospital Authority, the core competency model can be generalised to a profession. The first practice level is generalist practice and the second practice level is the specialist practice. A specialist is defined as a practitioner who has an additional level of competency compared with a generalist. Therefore, a specialist should already possess the core competency of a generalist. Figure 6-4 elaborates the core competency concept of a profession.

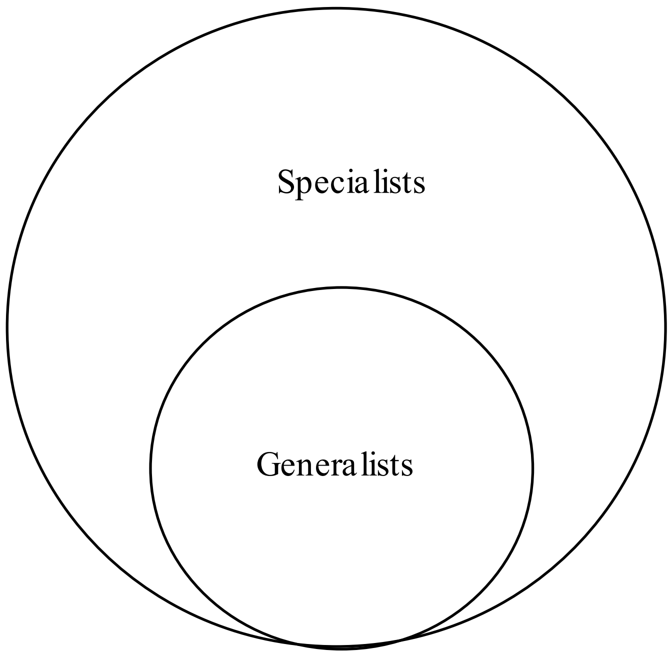

Figure 6- 4: Core competency model for a profession

In such circumstances, when identifying the core competency of a specialist, it is not necessary to document core competency relating to the generalist level.

Instead, only core competency additionally required by a specialist level should be clearly defined.

6.2 Core Competency Model for a Nursing Profession

When such core competency model is applied to the nursing profession, the first level of nursing practice is the nurse generalists and the second level is the nurse specialists (Figure 6-5). The nurse generalists here refer to the registered nurses. This adheres to the differentiated practice model that was originally designed for registered nurses (Baker, Ransom, Lamm, Conly, Winter, Carpenter, Robbeloth & McCoy, 1997; Malloch, Milton & Jobes, 1990). It also acknowledged that the core competency frameworks designed by the regulatory body for nurses in Hong Kong for registered nurses and enrolled nurses are different (The Nursing Council of Hong Kong, 2004; 2010). With this model, the core competency for nurse specialists only describes the additional core competency required by nurse specialists and mention of the core competency for nurse generalists is not necessary. Applying this to the present research, core competency for infection control nurse specialists should only describe the additional core competency at the specialist practice level.

Using differentiated practice model to define the core competency of practitioners at each practice level, defining the core competency with a consistent framework facilitates a clear differentiation of the practitioners of individual levels within the profession.

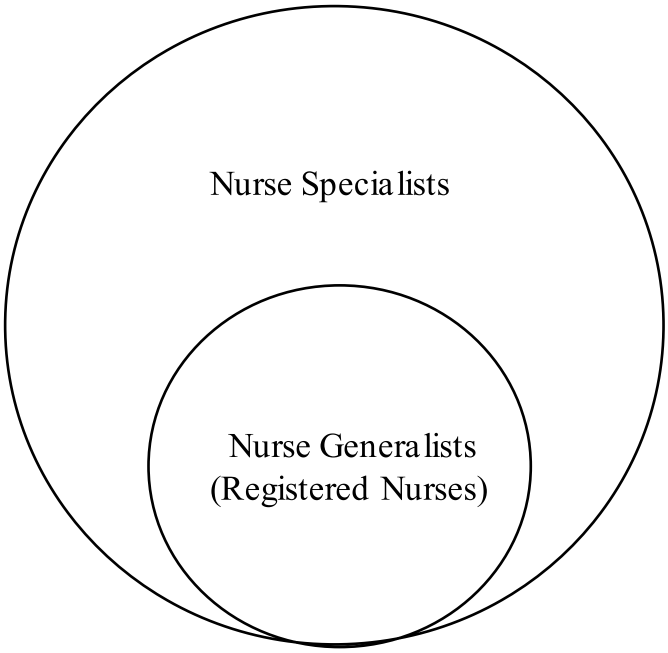

Figure 6- 5: Core competency model for nursing profession

7 Core Competencies for Registered Nurses in Hong Kong

Eraut (1994) commented that many professions do not document their competency standards, thus making it difficult to find competent, qualified people and to decide upon the validity of their assessment systems. Competency is essential for the nursing profession, and this sentiment is echoed by many practitioners and researchers (Axley, 2008). However, providing a clear theoretical definition of competency is the first step for the profession. The ultimate goal of defining competency is to assess the competency of nurses and healthcare providers in order to maintain safe care, protect the consumers and support the credibility of nurses.

As the regulating body for nurse generalists, The Nursing Council of Hong Kong has defined the core competencies for nurse generalists (Registered Nurses) of Hong Kong (The Nursing Council of Hong Kong, 2004). Before finalising the document, it has been gone through a vast consultation with nursing professionals in major healthcare organizations (including the two major public sectors, the Hospital Authority and the Department of Health), nursing education institutes and professional bodies for nursing education. It represents the views and opinions of the nursing profession in Hong Kong, which is local-context specific and should be applicable to education, practice and professional development. The scope of core competencies of a registered nurse (General) consists of five competency areas (Figure 6-6). They are:

- Professional, legal and ethical nursing practice;
- Health promotion and health education;
- Management and leadership;
- Research; and
- Personal effectiveness and professional development.

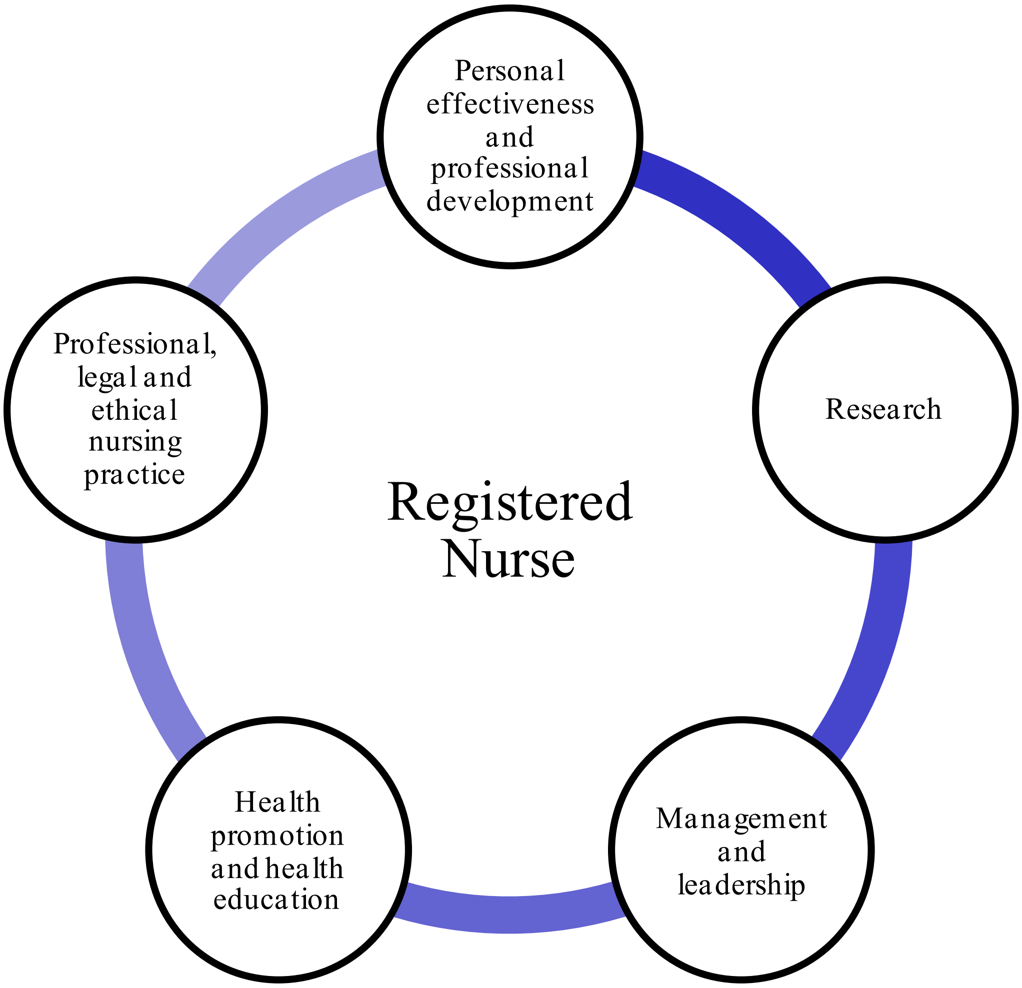

Figure 6- 6: Core competency areas of registered nurses (RNs) (general) in Hong Kong

The "Professional, legal and ethical nursing practice" area demonstrates the nurse generalists are proficient in applying nursing theories, evidence-based nursing knowledge, problem solving skills and therapeutic techniques to perform professional nursing duties safely, legally, ethically and effectively. The "Health promotion and health education" area shows that the nurse generalists are able to work with other partners, such as other healthcare providers, clients, families and the community, in preventing illness, promoting and protecting the health of the individual and society. The “Management and leadership” area illustrates that the nurse generalists are able to execute effective managerial and leadership skills when providing quality nursing care. They are also able to initiate and implement change conducive to the improvement of healthcare provision; contribute to healthcare policy formulation when working with other healthcare team members and community sectors. On the other hand, they are able to assess and manage risks and crises. The “Research” area demonstrates that the nurse generalists can apply the knowledge and skills in nursing research and collect, analyse, interpret and use the research data to improve nursing and healthcare practices. The “Personal effectiveness and professional development” area shows that the nurse generalists are able to maintain their own physical, mental and emotional well being, and develop and maintain nursing as a profession and maintain the individual’s status as a professional registered nurse. These five competency areas contribute to the core competency of a registered nurse in Hong Kong. Under each competency areas, roles and respective required abilities, knowledge, skills and attitude of the registered nurses (general) are defined.

Due to the separate registration for registered nurses in general and psychiatric practices, The Nursing Council of Hong Kong prepared another set of core competencies for registered nurses (psychiatric) (The Nursing Council of Hong Kong, 2005). This set of core competencies were derived from the same five core competency areas of registered nurses (general). The document has also undergone a wide consultation with nursing professionals in varies practice settings and educational institutes.

8 Core Competency Framework for Nurse Specialists

Apart from the practice levels differentiated based on the complexity of practice, nurses are a specialist occupation where roles are clearly defined, known as specialties (Cheah & Moon, 1993). There is no clear definition for nursing specialties. Under the medical model, nursing specialties are defined by body-systems under medical or surgical streams, such as renal care, orthopaedics. Others utilize the disease-based approach (such as diabetes, human immunodeficiency virus infection) and age-based approach (such as geriatric, paediatric). Some nursing specialties cross over the body-systems and disease-based approaches. Specialties of intensive/ critical care are related to the state of patient/ client. Infection control addresses the infection related issues that involve all patients and staff across all the services in the hospital, which may be regarded as a kind of disease-based approach.

Core competency of nurse specialists is essential for regulating the specialist practices. In the United States, the practice level of nurse specialists is regulated by licensure for Advanced Practice Registered Nurses (APRN) (The APRN Consensus Work Group & the National Council of States Boards of Nursing APRN Advisory committee, 2008). Clinical nurse specialists are one of the roles of advanced practice nurses. The National Association of Clinical Nurse Specialist prepared the core competencies for clinical nurse specialists as the basis for educational purposes because the licensure for Advanced Practice Registered Nurses is based on the accredited education programmes (Baldwin, Lyon, Clark, Fulton & Dayhoff, 2007). The nursing specialty then develops the specialty-specific context to work out the related core competencies for curriculum development for education (Zuzelo, 2003).

Like the Hospital Authority of Hong Kong, Kingston Hospital NHS Trust in the United Kingdom developed a framework on core competencies for clinical nurse specialists. The framework defines the generic core competency at the specialist level without specialty-context. The usage for the framework is mainly for performance appraisal, job specification design for human resources, marketing and training needs identification for the nurse specialists (Cattini & Knowles, 1999). The framework is a job-oriented purpose rather than profession-oriented.

The Nursing Council of Hong Kong is the regulatory body for nurse generalists in Hong Kong. However, regulating nurse specialists is out of its scope of function. Without any formal regulating system in Hong Kong thus far, voluntary regulation by the profession itself is warranted. For this purpose, core competency is the first thing which must be identified (Hase & Saenger, 2004). Defining the core competency of nurse specialists in a generic approach without specialty-context only serves half the purpose. A more efficient approach is to identify the core competency for a particular group of nurse specialists directly, which is up to the desired practice level with specialty-context. This core competency is specific, and can be used directly once prepared, to facilitate the further professional development activities, such as education and certification programme development.

In this research, core competency for infection control nurses at the specialist level of Hong Kong will be identified.

9 Core Competency Framework for Infection Control Nurses of Hong Kong

Defining the competency for nurse specialists by individual specialty seems to be at its infancy. In 2010, The Nursing Council of Hong Kong published another paper of core competency for paediatric and adolescent nurses (The Nursing Council of Hong Kong, 2010b). This paper is not as detailed as previously published core competency documents for registered nurses, but it does provide the training content with minimum contact hours that are required for paediatric and adolescent nursing. Although the paper is simple, the content is again derived based on the five competency areas for registered nurses (general/ psychiatric).

Identifying competency should be conducted with a reference to some categorization scheme. An acceptable scheme should be conscientious application of guided intelligence, which is subject to public examination and empirical validity (LaDuca, 1980). This argument is in line with Messick's advice that at the test construction, domain specifications serve as the boundary of the test. It is the total body of knowledge of the intended constructed test (Messick, 1993).

The five competency areas used by The Nursing Council of Hong Kong serve as the framework to derive the core competency for registered nurses (general/ psychiatric) and nurse specialists for paediatric and adolescent care. It is believed that these five competency areas are the basis of core competency for the nursing profession in Hong Kong. Identifying the core competency for infection control nurses at the specialist level, based on these five competency areas in this research will be comprehensive and local-context specific. Although this research will identify the critical competency (the most important portion of core competency) for infection control nurse specialists, the initial stage must identify the core competency of this group. The drafting process will be based on the five competency areas of registered nurses of Hong Kong from the Nursing Council of Hong Kong. As discussed in the competency model for a nursing profession, core competency of the nurse generalist has been embedded in the core competency of a nurse specialist (Figure 6-5). The core competency of a nurse specialist only mentions the additional core competency required from the nurse generalist. Therefore, the same framework is adopted for identifying the core competency for infection control nurse specialists. The graphic presentation of this core competency concept is depicted in Figure 6-7.

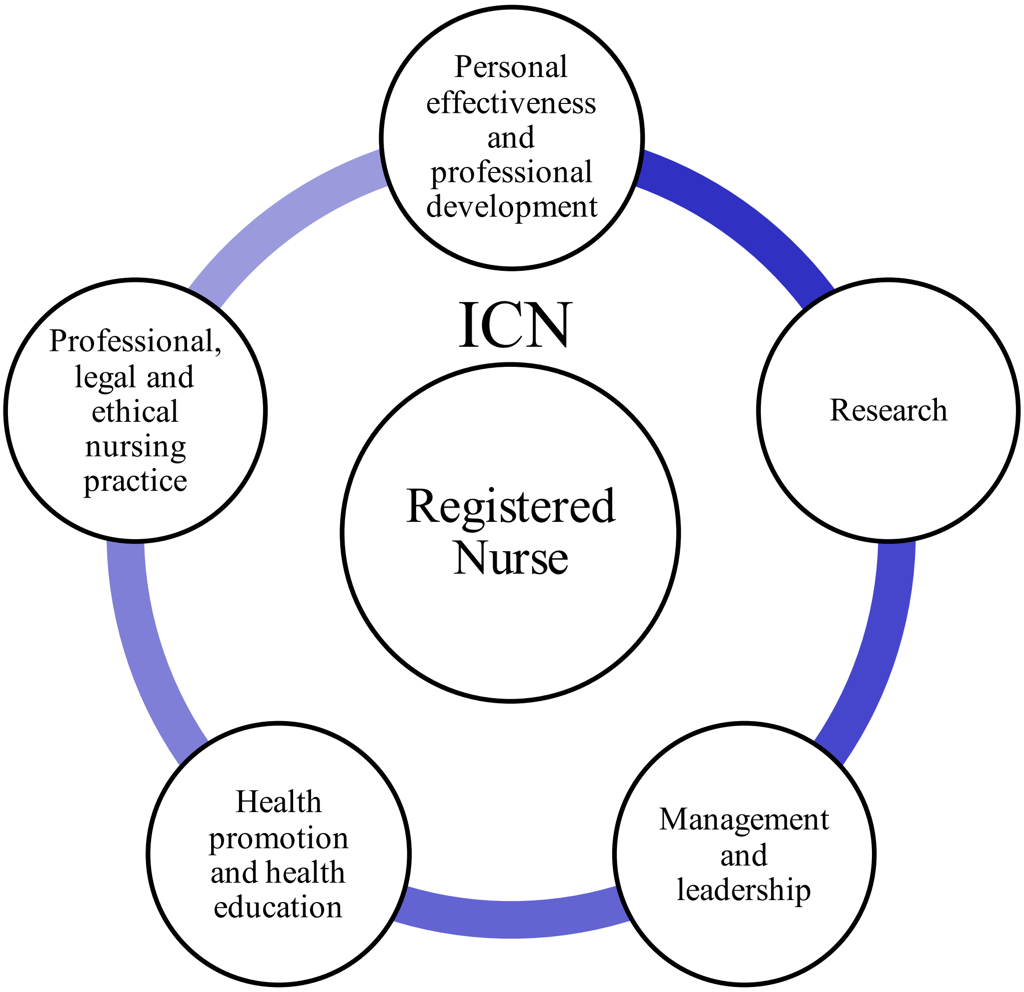

Figure 6- 7: Concept of core competency for infection control nurses (ICNs) at specialist level of Hong Kong

10 Conceptual Process for Identifying Competency

The above sections elaborate the conceptual framework to identify the contextual content of core competency of infection control nurses of Hong Kong. Before examining the conceptual process for identifying the competency, the concept of role functions and competency is must be defined.

Competency is the knowledge, skill or attitude that enables practitioners to perform their responsibilities (Jackson et al., 2007), the responsibilities being simply their role functions (D'Costa, 1986). Role delineation is a systematic process examining the role functions of a specific group of practitioners. Figure 6-8 describes the role delineation process of how the role functions are delineated from the practice to the appropriate role of the specific group of practitioners.

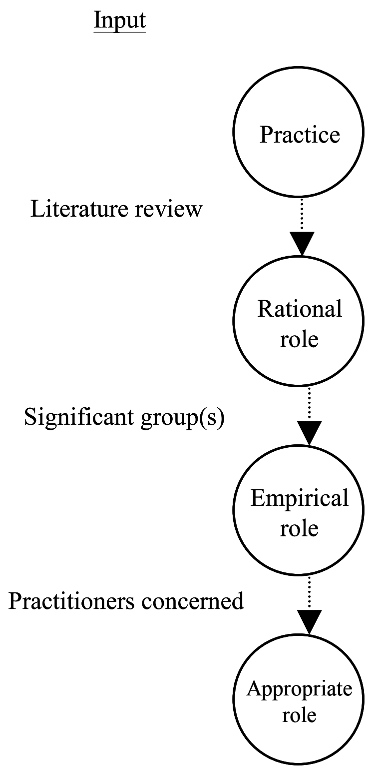

Figure 6- 8: Process of role delineation

There are three stages in role delineation (D'Costa, 1986). In the first stage, rational roles are derived through available job analysis research and other descriptive data analysis including literature review. In the second stage, with the input of significant groups, such as subject matter experts, the empirical role of the practitioners is established. Third stage is a consensus-generating process. It involves all or significant field practitioners concerned to empower the previous empirical findings. The final product of role delineation is the appropriate role for the practitioners.

Establishing the role functions of a specific group of practitioners are pre-requisites for identifying the competency of the practitioners. According to the behaviourist theory, competency is the outcomes of a practitioner who produces specific desired behaviours (Albanese, Mejicano, Mullan, Kokotailo & Gruppen, 2008). This kind of descriptor for competency is known as task-oriented descriptor, which starts with an action verb to describe the desired behaviour of the practitioners (Raymond, 2001). It was found that higher inter-rater reliability was demonstrated in task-oriented descriptors in job analysis surveys (Dierdorff & Wilson, 2003). Interestingly, when the competencies are described in a form of action or behavioural outcomes, these action or behavioural statements describe the corresponding role functions as well. In this presentation, role functions and competency items are identical (D'Costa, 1986; Defloor et al., 2006; Lenburg, 1999; McMullan et al., 2003). Hence, the concept of role delineation applies to identify competency for practitioners.

When the process of role delineation is adopted to identify the competency of a specific group of practitioners, the relationships between the two processes is parallel (Figure 6-9). Both role delineation and competency identification have a common origin, the practice of a specific group of practitioners. Once the role is found in the stage of role delineation, corresponding competency of the practitioners is identified.

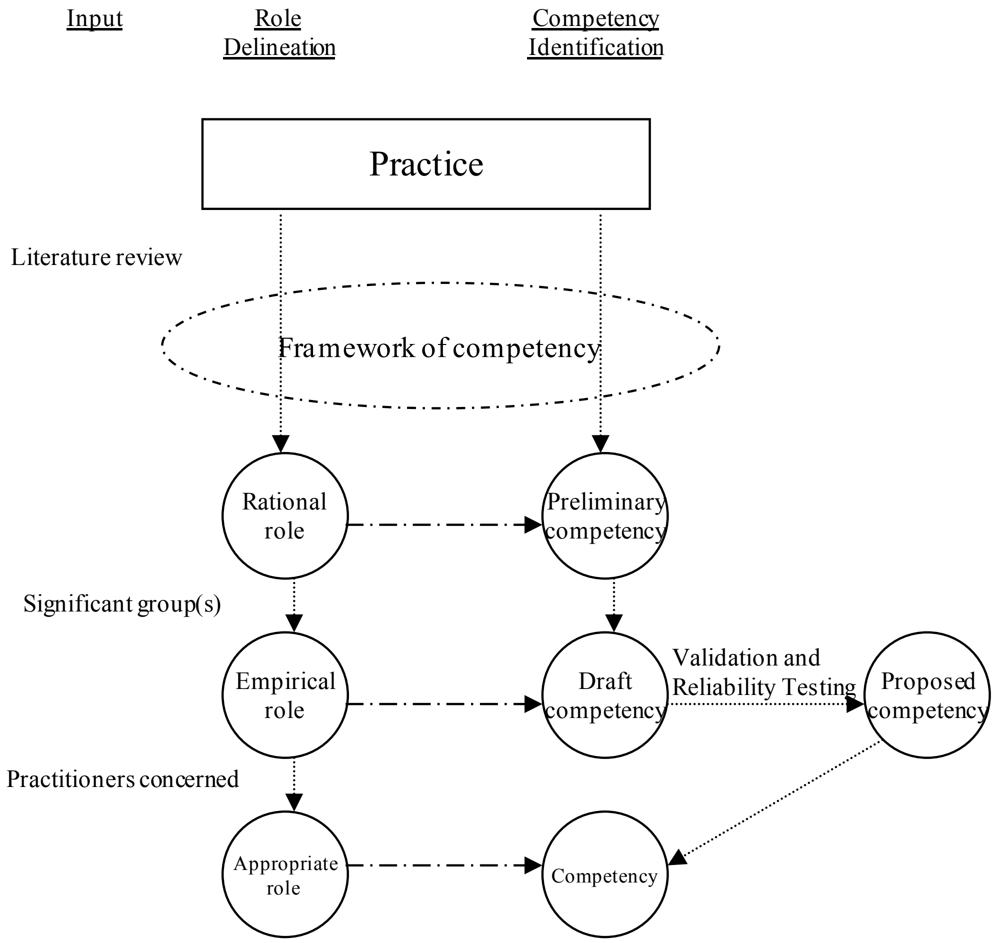

Figure 6- 9: Relationship between role delineation and competency identification

In the role delineation process, professional practice and literature review help to derive the rational role of the practitioners. When applying to competency identification, this process establishes the preliminary competency. With the input from the significant group(s), such as subject matter experts, the empirical role of the practitioners is derived from the rational role. When applying to competency identification, this process identifies the draft competency. After some validating and reliability testing procedures, the proposed competency is derived and it serves as the questionnaire content for the next process. With input from practitioners in role delineation, the final appropriate role can be derived from the empirical role. The competency of this group of practitioners is then derived. As a result, a comprehensive list of competencies is established. The entire process is suggested adhering to a conceptual framework (LaDuca, 1980) where the core competency framework of registered nurses of Hong Kong is used in this research.

11 Defining Critical Competency

A comprehensive list of core competencies for a group of practitioners allows people to understand the meaning for a profession. However, it is not yet ready for developing a content blueprint for the certification programme. A sound certification programme cannot include too many competency items for assessment. With reference to the core competency structure for a specialist profession in Figure 6-1; critical competency is the most important portion of core competency of the profession. A content blueprint is a list of critical competency items with content weights. The corresponding content weight represents the importance level of each critical competency item (D'Costa, 1986; Southgate et al., 2001). The weights are generated during the process of developing the appropriate role of the practitioners. These weights are proportionate within the critical competency boundary to generate the content blueprint of the certification programme.

12 Purpose and Significance of this Research

Infection control is a nurse specialist practice with growing importance (Law, 1993; Winchcombe, 2000). Severe Acute Respiratory Syndrome in 2003 and the influenza pandemic in 2009 alerted the public and government worldwide of the importance of infection control and the competency assessment of infection control nurses. A regulatory system for nurse specialists commonly in the form of certification is necessary for post-basic nurse specialization, including infection control nurses. However, Hong Kong lacks certification programmes or other forms of regulatory system to nurse specialists' practices. Although the certification programme from the United States is open to overseas candidates, it is not, however, appropriate for the local infection control nurses because the professional practice is local-context specific. Therefore, it is essential to establish a local-context specific certification programme. Before developing a certification programme, its core frame, the content blueprint must be identified accurately because it determines the scope of up-to-date practice or responsibility of nurse specialists in the programme.

This research aims at establishing a content blueprint of a certification programme for healthcare professionals of Hong Kong. In the meantime, the feasibility of basing the conceptual framework of nurse generalists of Hong Kong to construct the core competency for infection control nurses is tested

(Figure 6-7). It is important to detect a universal framework to identify the core competencies for different practice levels and different specialties for the nursing profession in Hong Kong. The proposed core competency framework of the nursing profession of Hong Kong is depicted in Figure 6-10. The findings will help in identifying the advancement indicators for the nursing profession of Hong Kong.

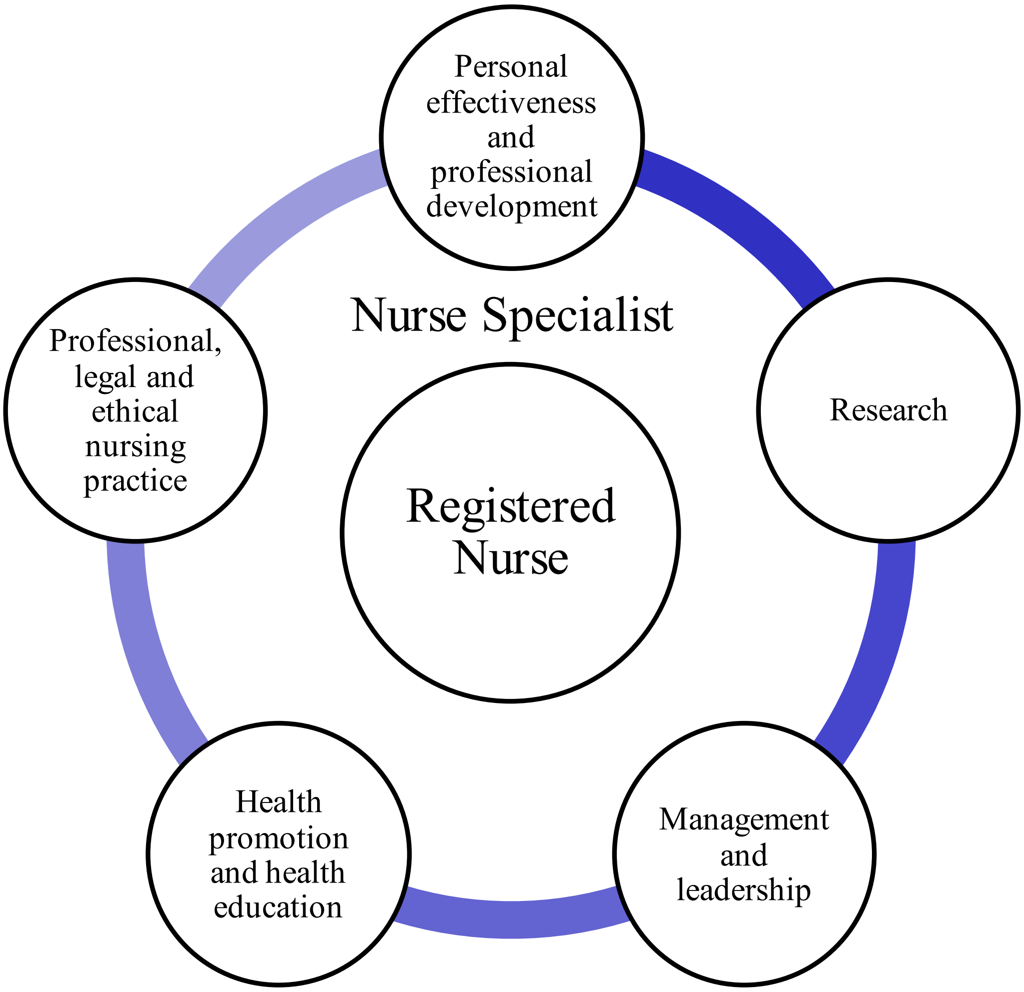

Figure 6- 10: Concept of core competency for nursing profession of Hong Kong

Apart from establishing the core competency of infection control nurses, the research process also identifies meaningful and representative importance levels of individual core competency items. This is essential for differentiating the critical competency within the core competency of infection control nurses as the critical competency is the content for the certification programme.

With establishing the content blueprint for certification for infection control nurses, it creates a process model for developing the content blueprint for certification for all healthcare professionals. This is because the conceptual process used in this research is originated from the role delineation concept for the healthcare professionals (D'Costa, 1986). With the content blueprint developed for infection control nurses of Hong Kong in this research, programme developers can develop and regularly revise the content of certification programme for infection control nurses. With this model, it is possible to create or revise the certification content for other healthcare specialists.

This research bases a local-context-specific framework to identify the core competency for a group of nurse specialists using a well accepted role delineation model for healthcare professionals. Besides investigating the core competency for infection control nurses and building a process model, the influence of the research participants' background on importance perception of individual core competency items will also be examined. On the other hand, the content of the certification programme, which is contributed by the critical competency of infection control nurses in this research, will be compared with other overseas certification programme. All these findings are critical for our future development of the nursing profession, including the infection control specialty. The process model for certification content for healthcare professionals, to be built in this research, will benefit the professional advancement of all healthcare professionals of Hong Kong.

This chapter has introduced the conceptual design of identifying the core competency of infection control nurses and the role delineation concept. In the next chapter, the research methodology of this research will be elaborated.

CHAPTER 7

METHODOLOGY

1 Introduction

This research is an investigative study to establish a content blueprint of certification programme for infection control nurses in Hong Kong. It uses quantitative methods as well as qualitative judgements by experts and practitioners. This chapter is going to discuss the design and methods used to establish a content blueprint of certification programme for infection control nurses in Hong Kong. After introducing the operational definitions used in this research, the research questions will be recapitulated. Then, the research design and methods are explained phase by phase including sampling and participants, instrument used, data collection and data analysis.

2 Operational Definition

The operational definitions of terminologies in this research are "infection control nurse (ICN)", "core competency", "preliminary core competency", "draft core competency", "proposed core competency", "critical competency", "content blueprint" and "certification programme".

Infection control nurse	"Infection control nurse" is defined as a nurse specialist who received training on infection control with the responsibility of infection control programmes in hospitals.
Core competency	"Core competency" is the capability of a practitioner who is able to produce specific desired behaviours. It refers specifically to a specialist requirement in addition to generalist requirement that is infection control nurse in this research.
Preliminary core competency	"Preliminary core competency" is the output of literature review when identifying core competency of infection control nurses. It needs several research processes before becoming the core competency of infection control nurses.
Draft core competency	"Draft core competency" is the advanced product of preliminary core competency. It is the output of Delphi survey after the experts reviewed the preliminary core competency.
Proposed core competency	"Proposed core competency" is the advanced product of draft core competency. It is the output when validity and reliability of the draft core competency has been established.
Critical competency	"Critical competency" of infection control nurses is the most important part of the core competency of infection control nurses that must be fulfilled. In this research, critical competency is the content boundary for the certification programme of that particular group of practitioners.

Content blueprint	A “content blueprint” of the certification programme is a list of critical competency items of the specific group of practitioners with corresponding content weights attached.
Certification programme	“Certification programme” is a programme used to assess the competency level of individual practitioner of specific specialty. The programme is not necessary a written test only, but consisting of a variety of assessment methods.

3 Research Questions

To recapitulate, this research aims at answering the following main research question and three subsidiary research questions.

The main research question for this research is:

> What is the critical competency for infection control nurses of Hong Kong?
>
> Subsidiary research questions are:
>
> 2) To what extent are the perceptions of importance of infection control nurses influenced by the nurses’ background characteristics?
>
> 3) To what extent can perceptions of importance be used to identify the critical competency (the most important portion of core competency) for infection control nurses?

This research is divided into three phases. The design and methods used are outlined in Figure 7-1.

Phase One	**Review literature** to identify preliminary core competency categories of ICNs
	Delphi survey to identify the draft core competency categories of ICNs
	Review literature to identify preliminary core competency items under the draft categories of ICNs
	Delphi survey to identify the draft core competency items of ICNs
	Questionnaire survey to **establish content validity** of the draft core competency of ICNs
	Repeated questionnaire surveys to **establish reliability** of the draft core competency scale (internal consistency, test-retest and rating scale) of ICNs
	Outcome of proposed core competency of ICNs

↓

Phase Two	Develop the opinion survey questionnaire using the proposed core competency of ICNs and the importance scale
	Collect ICNs' views by **cross-sectional survey design** using the ICN opinion survey questionnaire
	Analyse the survey data using **Rasch measurement**
	Outcome of core competency of ICNs with level of importance attached to each core competency item

↓

Phase Three	Use **qualitative experts consensus** to define the most important core competency items (critical competency) of ICNs to be included in local ICN certification content blueprint
	Rasch-based calculation to ensure the true critical competency items are included in the certification content blueprint
	Outcome of the critical competency and content blueprint of certification programme for ICNs of Hong Kong

(ICN = infection control nurse)

Figure 7- 1: Research design and methods

Phase One is the preparatory work of Phase Two to identify what the core competency of Hong Kong infection control nurses is. This yields a list of proposed core competency items of infection control nurses. The list is the base for preparing the survey questionnaire in Phase Two.

Phase Two aims at consolidating the core competency items from the proposed core competency item list and exploring the importance levels of individual core competency items as perceived by local infection control nurses. The outcome of this phase is a comprehensive list of core competency items with their perceived levels of importance attached.

The comprehensive list of core competency items for infection control nurses is too long for a certification programme. Phase Three aims at identifying the most important core competency items (critical competency items) to be included in the certification programme and to decide the content weights to each item in the trimmed list, that is, to establish a content blueprint of certification programme for infection control nurses.

4 Research Design and Methods

The methods used in this research are explained phase by phase.

4.1 Phase One: Proposing the Core Competency

Phase One was to identify a list of proposed core competency items of Hong Kong infection control nurses. Literature review and expert consultation were employed to establish preliminary core competency and draft core competency of Hong Kong infection control nurses respectively. After establishing the validity and reliability, we called the draft core competency as proposed core competency. Three methods were involved in this phase, namely, Delphi survey, content validity survey and repeated surveys for reliability estimates. The procedures and corresponding outputs are depicted in Figure 7-2.

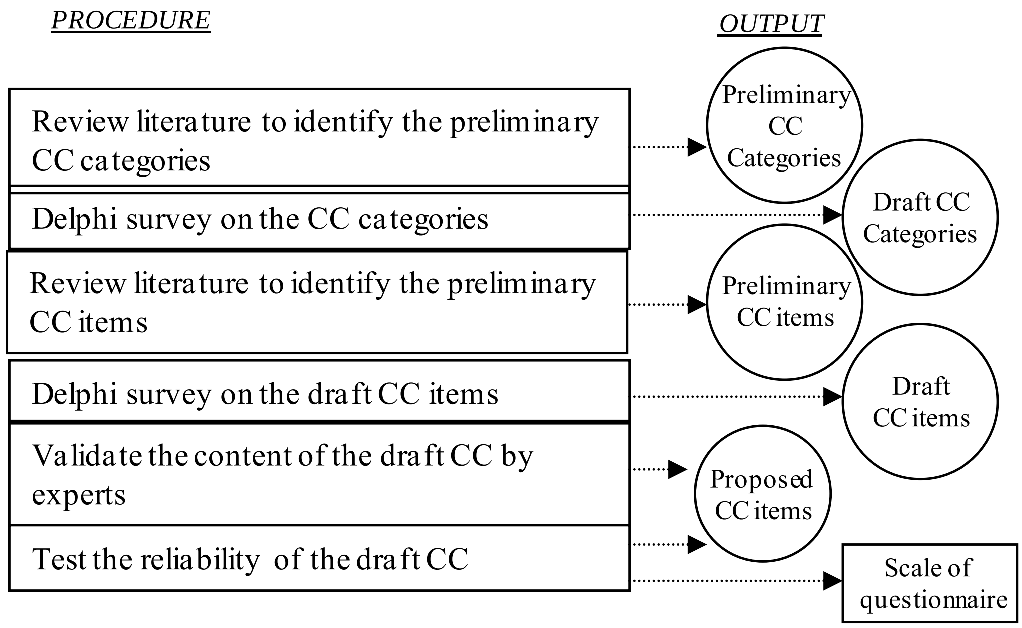

Figure 7- 2: Procedures and outputs of Phase One
(CC = Core competency)

4.1.1 Delphi Survey: Drafting the Core Competency

Recommendation on essential activities on infection control in hospitals were published by Centre for Health Protection of Hong Kong in 2005 (Centre for Health Protection, Scientific Committee on Infection Control [CHP, SCIC], 2005). However, the essential activities were described in a service-oriented perspective without specifying the different roles of members of hospital infection control teams. There is insufficient information on the role or core competency of infection control nurses of Hong Kong. Infection control practice standards and competency of overseas countries reflecting their local practices are available from literature. They can be used as references to ensure the practices of Hong Kong infection control nurses are up to the international standard. Infection control experts' advice is also important and it is necessary to have consensus upon receiving different opinions from experts. Delphi survey is one of the consensus methods to be used especially to find out consensus information among a respondent group (Bonner & Stewart, 2001; DeVilliers, DeVilliers & Kent, 2005; Hasson, Keeney & McKenna, 2000; Jones & Hunter, 1995).

For identifying the core competency of infection control nurses, content validity should be rigorously maintained in both the developmental and judgmental stages (Lynn, 1986). Qualitative development of professional competency is a standard process (Patterson, Ferguson & Thomas, 2008). Delphi technique is chosen as the development method because of its characteristics of anonymity. Delphi method encourages honest opinion because the panel members are not necessary to meet together thus eliminating the peer group pressure (William & Webb, 1994). In this study, Delphi group contains mixed healthcare professions including medical and nursing colleagues. It is the culture of Hong Kong people not to express their thoughts openly and its healthcare system is "doctor-led", Delphi's anonymity of participants ensures equal participation and willingness of expression of opinions of nursing participants. Among the various types of Delphi, conventional Delphi is employed to collect the inputs from the subject matter experts to yield a list of draft core competency items under various categories.

4.1.1.1 Participants and Sampling

The content judgment of a high-state test in the United States emphasizes that the judgers should have relevant training, with experience and qualification in content judgement (Grant & Davis, 1997). In Hong Kong, among local infection control professionals, persons with training and experience on content judgment in infection control specialty are limited. Jones and Hunter (1995) suggested that the basic selection criteria for Delphi survey mainly relied on their clinical expertise and those with research experience were preferred. Powell (2003) also opined that the most knowledgeable experts should be invited. In this study, the Delphi experts were purposively selected (purposive sampling). The Delphi group had six subject matter experts, including two infection control officers and four infection control nurses. All of them are the leaders of infection control services in large hospitals and/ or clusters in public services. Apart from the duties in hospital and cluster levels, these infection control nurses and infection control officers also actively participate in various infection control related activities at the corporate level of Hong Kong healthcare system.

Public hospitals of Hong Kong are grouped into seven clusters based on their geographic locations. A cluster consists of a few hospitals of different range of services, including acute and long term care. The inclusion of experts from different clusters is essential because their decision may represent a diversity of practices from various geographic cultures across Hong Kong territory. One infection control officer, who was the cluster leader in the time of study, has been subsequently promoted in 2010 to be the Chief Infection Control Officer of Hospital Authority, who is the organization-wide leader. The other infection control officer is the adviser of the newsletter of local infection control professional group and locally organized infection control conference. For the experts of infection control nurses (ICN-experts), one of them is the key leader of the infection control profession and organizes regular training for infection control nurses. The other three ICN-experts play active roles in the local infection control conferences recently. In short, the clinical expertise of this Delphi group represents diversified settings and public hospitals of Hong Kong.

4.1.1.2 Instrument

A series of questionnaire survey were adopted to collect the input from the Delphi experts. To draft the core competency for infection control nurses, preliminary core competency based on literature review served as the initial questionnaire content. The subsequent questionnaire content was based on the feedback of the experts and further literature review.

Design

Phase One aims at drafting the core competency for infection control nurses of Hong Kong. The consulting content, which was the core competency categories or items in this survey, was listed on the questionnaire. The participants were invited to rate either "agree" or "disagree" on the listed content (Fitch et al., 1996). A column of remarks was posted for collect the experts' opinion specifically for the corresponding content. Each questionnaire had a free-text area to allow the experts to fill in the additional content or other comment.

Questionnaire Content

The questionnaire content of Delphi survey was the preliminary core competency of infection control nurses of Hong Kong. Reviewing literature to draft the core competency proposed by D'Costa (1986) is commonly adopted by the researchers (Calhoun, Davidson, Sinioris, Vincent & Griffin, 2002; Leach, 2008; Patterson, Ferguson & Thomas, 2008; Staggers, Gassert & Curran, 2002). The investigator reviewed the local and international literature and practice standards. The core competency framework for registered nurses of the Nursing Council of Hong Kong was employed during the drafting (The Nursing Council of Hong Kong, 2004). The five competency areas are:

1) professional, legal and ethical practice;
2) health promotion and health education;
3) management and leadership;
4) research; and
5) personal effectiveness and professional development.

This literature review process was repeated and interchangeably with the Delphi rounds. Delineating the categories from a knowledge pool is considered as a starting point for developing a comprehensive competency-based scheme

(Griffin, Cuc, Gillis & Thanh, 2006). The categories of the preliminary core competency were developed first followed by the items under the categories.

Literature review on the core competency of infection control nurses mainly included the core competencies for infection prevention and control practices in the United Kingdom (Infection Control Nurses Association, 2004), professional and practice standards of North America (Horan-Murphy et al., 1999) and recommended infection control activities by official organization of Hong Kong (Centre for Health Protection, Scientific Committee on Infection Control, 2005). References from other countries were also reviewed. Under the five competency areas, 13 preliminary core competency categories for infection control nurses were concluded (Appendix 7-1). They are:

1) Surveillance
2) Consultation
3) Occupational health
4) Infection prevention and control practice
5) Education
6) Team and service management
7) Programme management and evaluation
8) Partnership
9) Outbreak investigation and control
10) Research and development
11) Qualification
12) Continuing education and development
13) Professional development

The preliminary core competency categories for infection control nurses serve as the content of the first Delphi questionnaire (Appendix 7-3). The subsequent questionnaires could be referred to Appendices 7-4, 7-5 and 7-6. The references for the literature review on core competency items for infection control nurses are listed on Appendix 7-2.

4.1.1.3 Data Collection

Email was the main method of communication used in this Delphi survey that was commonly used by researchers (Holey, Feeley, Dixon & Whittaker, 2007; Jones & Hunter, 1995; Whitehead, 2008; Williamson, 2007). Although the Delphi experts knew the members of the panel, they do not share their inputs among themselves. The questionnaires were sent in a group email but experts were advised not to share their answers when returning the input. The investigator, that is me, acted as the study coordinator and decision maker to review all returned comments and to make modification when necessary before starting the next round survey. Direct discussion with subject matter experts via email, by telephone and face-to-face was sometimes required to clarify information in their replies.

Drafting Core Competency Categories

The preliminary core competency categories of infection control nurses derived from literature review of local and international standards form the content of first round Delphi survey questionnaire (Appendix 7-3). The preliminary core competency categories were listed on the questionnaire to collect the opinions of the panel experts. The experts were asked if they agreed or disagreed with

13 categories on the questionnaire (Fitch et al., 1996). All the agreed and modified categories were also listed on the subsequent questionnaires to give the experts a comprehensive idea. Each questionnaire had a free-text area to allow the experts to fill in the additional categories or other comments. A few rounds were held until a consensus on the core competency categories was reached. This resulted in the draft core competency categories.

Drafting Core Competency Items

With the Delphi experts approved the draft core competency categories, preliminary core competency items were developed under the categories according to literature. The preliminary core competency items were then transformed to the questionnaire format. The experts were asked if they agreed or disagreed with the listed items (Fitch et al., 1996). All replies were returned by email. They were reviewed and modified when necessary. The revised questionnaires with both the agreed and modified items were sent to experts for next round comments via email. Each questionnaire had a free-text area to allow the experts to fill in the additional items or other comments. It took several rounds until consensus was achieved, and the draft core competency items of infection control nurses were fixed.

Delphi process is usually time consuming and lengthy. To minimize the drop out of the experts throughout the process, all the identified potential expert participants were well informed about the procedures and time commitment expected before they agreed to be the participants (Hasson et al., 2000). Reminder emails and phone calls were used when the experts did not return their answers by the deadline. In this study, a minimum of 70% of response rate was observed to maintain the rigour of Delphi technique (Sumsion, 1998).

4.1.1.4 Data Analysis

Level of Agreement

Several persons are less likely to make a wrong decision than a single person (DeVilliers et al., 2005). Phase One employed Delphi approach to collect the wisdom, knowledge and experience from the experts. Consensus of the subject matter experts was the ultimate goal. However, literature review shows a wide range of consensus level, from 55% to 100% using in different studies (Fitch et al., 1996; Payne, Fineman & Wall, 1976; Staggers, Gassert & Curran, 2002; Sumsion, 1998; William & Berry, 1999; Williams & Webb, 1994; Williamson, 2007). In Phase One, the different scenario of consensus for 6-expert Delphi survey is tabulated in Table 7-1. Out of six experts, if one expert disagrees, the agreement level is 83%. If two experts disagree, the agreement level drops to 67%. Agreement level of 90% can never be reached unless all six experts have the same opinion. Balancing between reliability of result and the small number of expert available, 80% or more of the agreement level is considered as reaching consensus in this study. This is a common agreement level used in different Delphi research (Staggers et al., 2002; William & Berry, 1999).

Table 7- 1: Agreement levels of 6-expert Delphi group

No. of disagreed experts	No. of agreed experts	Agreement level
1	5	83%
2	4	67%
3	3	50%

Inter-Rater Reliability Estimates

In healthcare sciences, researchers usually use the content validity index to quantify the content validity. However, statisticians have commented that this proportion agreement method increases the risk of chance of agreement (Wynd, Schmidt & Schaefer, 2003). Therefore, Wynd et al. (2003) suggested reporting both the content validity index and Kappa coefficient, when developing instruments, to increase the confidence in content validity. It is because Kappa coefficient is a measure of inter-rater agreement beyond chance. The content validity is contributed from both the developmental stage and the judgmental stage of instrument development (Lynn, 1986). Both the developmental stage and the judgmental stage of this study, that were the Delphi survey and the content validating survey respectively, involved experts' opinion. Two different groups of experts rated the responses of each item freely, without any pre-set quantity of assignment. This is the characteristic of free-marginal distribution (Randolph, 2005). The fixed-marginal Kappa, such as Cohen's, Scott's and Fleiss' are not applicable as they may vary substantially according to the characteristics of marginal distributions. The free-marginal multi-rater Kappa should be used, as it is not influenced by the proportion of responses in items and rater bias (Randolph, 2005). The fixed-marginal Kappa statistics in this research were worked out by the Online Calculator of University of Joensuu, Finland (Randolph, 2005, 2008).

The values of Kappa statistics range from +1.00 to -1.00. A positive Kappa means the agreement is more frequently than expected by chance. A negative Kappa value indicates the agreement is less frequently than expected by chance.

The value of +1.00 shows perfect agreement between raters, while -1.00 means total disagreement. A zero Kappa means that the agreement is less than the expected by chance. Most researchers agreed that value of 0.6 as the minimally acceptable Kappa statistics to evaluate the agreement of raters (Wynd et al., 2003). Cicchetti (1984) employed a set of parameters to interpret Kappa statistics, which is tabulated in Table 7-2.

Table 7- 2: Interpretation of Kappa statistics

Kappa statistics	**Strength of agreement**
< 0.40	Poor
0.40 – 0.59	Fair
0.60 – 0.74	Good
0.75 – 1.00	Excellent

Instead of giving a full set of interpretation, Randolph (2008) proposed that a Kappa of 0.7 or above is considered as adequate inter-rater agreement. This study referred these recommendations to evaluate the Kappa statistics.

4.1.2 Content Validity Survey

In Phase One, local experts were invited to prepare the draft core competency of infection control nurses. Such drafting process for the core competency is considered as one of the content validation processes (Lynn, 1986). After Delphi survey, this draft core competency items underwent further content validity assessment, which was the judgmental stage of the core competency development (Lynn, 1986). Content validity was established with the input of the content experts through a questionnaire survey.

Content validity is important for a questionnaire (Portney & Watkins, 2000). It refers to the adequacy of the content of the questionnaire or test for the intended measurement. In this content validity survey, I checked if the draft core competency represented the core competency of infection control nurses of Hong Kong.

4.1.2.1 Participants and Sampling

Assessing the content validity is a subjective process. While Lynn (1986) suggested a minimum of three content experts should be invited, Davis (1992) proposed that two reviewers would be acceptable. Grant and Davis (1997) emphasized that selecting subject matters experts in a rigorous manner was more important than the number of experts in the panel. In this study, experts of infection control field, the infection control officers who lead the infection control teams in large public hospitals and clusters, were the appropriate participants. An expert panel that consisted of three infection control officers was invited. They came from different major public hospitals of different clusters in Hospital Authority (A cluster is a group of hospitals in the same geographic area). All of them actively contribute to infection control at the corporate level of Hospital Authority on top of their duties in respective hospitals.

4.1.2.2 Instrument

A questionnaire consisting of the draft core competency items of infection control nurses identified from the Delphi survey was employed. The experts were asked to rate the draft core competency items in terms of relevance to the competency of local infection control nurses. A 4-point ordinal rating scale was used by referencing Lynn's suggestion (1986). The rating scale is listed in Table 7-3.

Table 7- 3: Rating scale in the questionnaire for content validation

1 =	The item is not representative of the core competency of ICN
2 =	The item needs major revisions to be representative of the core competency of ICN
3 =	The item needs minor revisions to be representative of the core competency of ICN
4 =	The item is representative of the core competency of ICN

(ICN=Infection control nurses)

At the end of the questionnaire, the experts were asked if all the essential content domains were included in the draft core competency list. If essential contents were considered missing, they were requested to specify the missing content. The questionnaire for content validity survey is displayed in Appendix 7-7.

4.1.2.3 Data Collection

The questionnaire is a self-administered one. It was sent out to the experts by email individually. The experts were requested to return the answers by the deadline. Reminder email was sent if the expected return was not received. Clarifications via telephone discussion or email were initiated if necessary.

4.1.2.4 Data Analysis

Consensus Estimates for Content

Content validity indices (CVIs) were used to evaluate the consensus estimate for the content, which was the draft core competency of Hong Kong infection control nurses. Lynn's method (1986) was used to analyse the ratings of the returned questionnaire prior calculation. The ratings were grouped into two responses, namely, agree and disagree. Rating 1 and 2 were "disagree" and rating 3 and 4 were "agree". Two types of CVIs were evaluated. The scale-level CVI was worked out by the total number of items that all experts rated as "agree" divided by the total number of items in the questionnaire. Another approach of scale-level CVI by averaging method was also worked out. To compute, item-level CVI was computed for each item as number of experts agreed the item, divided by number of experts. Averaging all these item-level CVIs resulted in scale-level CVI (averaging method) (Polit, Beck & Owen, 2007). CVI values range from 0 to 1. For interpretation, the CVI, Davis (1992) suggested that investigators should target 80% or better agreement among the content reviewers when developing new instruments. However, she did not explain the rationale behind.

Inter-Rater Agreement Estimates

Two parameters were used to check the inter-rater agreement level. They were inter-rater agreement statistic and the Kappa's statistic.

The inter-rater agreement of the content experts was calculated by the number of items that all the experts rated as disagree" plus the number of items that all the experts rated as “agree” then divided by the total number of items in the questionnaire (Davis, 1992; Grant & Davis, 1997). The value ranges from 0 to 1. The agreement level of 0.7 is considered as acceptable (Davis, 1992).

The CVI represents the validity of the draft core competency of infection control nurses. Wynd, Schmidt and Schaefer (2003) suggested working out the Kappa coefficient together with the content validity index for considering the quality of content validity assessment. Pilot and colleagues (2007) supported this proposal as they demonstrated an example that the scale-level CVIs were drastically varied when using different approach to compute.

Using Kappa statistics should be careful. Researcher reported that when fixed-marginal Kappa, such as Cohen’s Kappa and Fleiss’s multi-rater Kappa, is used in free-marginal situation, the value of Kappa varied significantly when the number of raters or the number of categories varies even if the items stay in the same number (Randolph, 2005). The free-marginal is defined as the rater is free to assign the items into categories without pre-set limitation on their frequency. To solve the problems, free-marginal multi-rater Kappa is recommended. Based on this rationale, both the content validity indices and free-marginal Kappa were used to evaluate the content validity of the draft core competency of infection control nurses. Free-marginal multi-rater Kappa statistics were worked out by the on-line Kappa calculator from the University of Joensuu, Finland (Randolph, 2005, 2008). Table 7-2 was referred to interpret the Kappa’s values.

4.1.3 Repeated Survey Method for Reliability Assessment

Besides validity, reliability is also important in a questionnaire or a test. After content validity was established, it came to the reliability assessment. Reliability refers to the extent of the accuracy of measurement. In this study, internal consistency of the variables, test-retest reliability to measure the stability of the response variables and reliability of the rating scale were examined.

4.1.3.1 Participants and Sampling

To establish the reliability of the instrument for an opinion survey for the practice, the field practitioners, i.e. infection control nurses, should be involved as they are familiar with the practice and are in practice. However, the participants taking part in this instrument development phase are not suggested participating in the next phase of the infection control nurses' opinion survey because the two groups of participants have independent roles in two parts of this research. The participants in the opinion survey contributed to the research data while the participants in the reliability testing procedures were involved in the instrument development. The two groups of participants should be separated to avoid contamination of the research data through repeated surveys in two phases.

Unfortunately, the population of existing infection control nurses of Hong Kong is small, only around 120 in number. Therefore, all the currently existing infection control nurses had been well reserved for the infection control nurses' opinion survey to maintain an adequate sample size. Nurses who had previously worked as infection control nurses (i.e. ex-infection control nurses) were invited to investigate the reliability in this study. However, it was difficult to recruit adequate number of ex-infection control nurses due to lack of accurate information system in Hospital Authority or in the field. Snowball sampling is one of the non-probability sampling techniques when the potential subjects are difficult to identify (Portney & Watkins, 2000), like the situation in this study. I firstly identified some ex-infection control nurses through the network of existing infection control nurses. Subsequently these ex-infection control nurses referred some more subject participants to take part in this reliability study through the chain referral mechanism. Participants were recruited as many as possible.

4.1.3.2 Instrument

The draft core competency items developed by Delphi survey were transformed into a questionnaire for reliability testing. As the participants were going to answer two identical questionnaires, to avoid rater bias, the sequence of the draft core competency items in each questionnaire were randomly assigned.

A single rating scale on importance was used in this study. There were four rationales to use a single rating scale. First, using two or more scales increased the workload of participants. Second, using two scales have higher reliability but one of the common combined scales, criticality scale, was less objective in measurement (Raymond, 2001). Third, using three scales did not increase the reliability of the results than using two scales (Raymond, 2001). Fourth, the single rating scale on importance was sufficiently reliable and direct to the intended measurement of this study (Dierdorff & Wilson, 2003; Tannenbaum & Wesley, 1993). For the number of categories used in the rating scale, research results did not consistently favour the optimal number of response categories of Likert scale (Adelson & McCoach, 2010). Large number of response categories contributed to finer measurement but may have added measurement error when the respondents could not differentiate the adjacent categories in a reliable manner (Fisher, 2006; Lopez, 1996). On the other hand, studies found that missing the neutral position on the scale would lead to greater tendency of the participants giving no response (Guy & Norvell, 1977). With the above considerations, an importance rating scale in a traditional one-stage format consisting of a neutral point of "undecided" was used (Albaum, 1997). The categories of Likert scale included very important (5), important (4), undecided (3), not important (2) and not very important (1) (Wright & Masters, 1982). The scale of this survey questionnaire would be the same as that of opinion survey questionnaire to be used in Phase Two, where this survey served as the pilot. Besides rating the core competency items, participants were also requested to give their demographic information in the first questionnaire. The questionnaire for the first survey is displayed in Appendix 7-8.

4.1.3.3 Data Collection

Ex-infection control nurses were invited to answer two identical questionnaires, except the sequence of the questionnaire content was different. Questionnaires were sent to the participants by email, except special requested for other means of distribution. Participants were asked to rate each core competency item from the scale of "very important" to "not very important". Answers were returned either by email, fax or post. The two questionnaire surveys were conducted two weeks apart in order to eliminate the memory effect (Lynn, 1986; Norweg, Whiteson, Demetis & Rey, 2006; Rossen & Gruber, 2007).

4.1.3.4 Data Analysis

Demographic data were summarized by Statistical Product and Services Solutions (SPSS) version 15.0. Other reliability estimates, including test-retest, internal consistency and rating scale analysis were checked.

Test-Retest Reliability Estimate

Test-retest reliability was analysed by SPSS version 15.0 using Spearman rank correlation coefficient (Spearman's rho). It is a non-parametric test to measure the correlation on two sets of ordinal data (Portney & Watkins, 2000). The means of each item on the first and second tests were calculated. The correlations between two respective means were then compared. The value of correlation coefficient is a measure of strength of association between two variables. The interpretation of the coefficient suggested by Portney and Watkins (2000) tabulated in Table 7-4 provided a yardstick to the test-retest reliability analysis of this study.

Table 7- 4: Interpretation of correlation coefficients

Correlation coefficient	Strength of relationship
0.00 – 0.25	No or little
0.25 – 0.50	Fair
0.50 – 0.75	Moderate to good
>0.75	Good to excellent

It is suggested that the interpreting the correlation coefficient should not be a strict cut-off, where other factors, such as sample size, types of variables, may influence the results.

Internal Consistency Reliability Estimates

The data of the first survey was used to check the internal consistency of variables, which is the homogeneity of the variables in the scale. Winsteps 3.61.2, which is a Rasch measurement software package, was used. Cronbach's alpha and person reliability estimates were examined to check the internal consistency for the draft core competency.

According to Fisher (2007), person reliability estimates in Rasch environment are interpreted as Table 7-5.

Table 7- 5: Interpretation of person reliability

Person reliability estimates	Interpretation
<0.67	Poor
0.67 – 0.80	Fair
0.81 – 0.90	Good
0.91 – 0.94	Very good
>0.94	Excellent

Cronbach's alpha served similar function of person reliability estimate. However, its value is always overestimated due to different computing method. Its reference range (George & Mallery, 2003) is tabulated at Table 7-6. Cronbach's alpha of greater than 0.7 is the common standard for internal consistency reliability estimate in many studies (Rattray & Jones, 2007; Shultz & Whitney, 2005).

Table 7- 6: Interpretation of Cronbach's alpha

Cronbach's alpha	**Interpretation**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Questionable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

Rating Scale Analysis

A rating scale in a questionnaire provides response categories for participants to rate their answers. The scale is not functional when there are too few or too many response categories (Fisher, 2006; Lopex, 1996). When there are too few categories, participants cannot pick their real responses. However, if the categories are too many, it will confuse the participants as they cannot differentiate the differences between the adjacent categories. Therefore, each response category should have its distinct position in the scale, which is functional. The rating scale analysis checks the structure and function of the rating scale. The diagnostics were performed by Winsteps 3.61.2 in this study. Graphic presentation and statistics on thresholds were examined. The optimal distance of the thresholds between adjacent response categories of a functional scale should be within 1.4 and 5.0 logits (Bond & Fox, 2007).

4.1.4 Outcome of Phase One

After establishing the validity and reliability for the draft core competency, Phase One yielded the proposed core competency, including a list of core competency items for infection control nurse practice.

The draft core competency list identified by literature review and Delphi experts in Phase One went through the content validity assessment. Reliabilities of the internal consistency and test-retest were also ensured. Conservative approach in removing items in this stage was adopted to avoid eliminating important items in this early phase. These procedures results in a list of more than comprehensive for the practice of Hong Kong infection control nurses (proposed core competency), and all core competency items were going to be confirmed by the on-the-job infection control nurses in Phase Two opinion survey. The rating scale diagnosis settled the importance level categories for the Phase Two questionnaire.

4.2 Phase Two: Opinion Survey

Phase Two, which informed a comprehensive list of core competency items, aimed at identifying the core competency items from the proposed core competency and exploring the perceived level of importance of individual core competency items among local infection control nurses, which would be a comprehensive list of core competency items.

Phase Two was an Opinion Survey with local (Hong Kong) infection control nurses on their perceived level of importance to core competency items. The opinion survey in Phase Two was a cross-sectional design. A questionnaire was used to collect the practice opinion from field practitioners. They were the infection control nurses in this study. Inviting infection control nurses to participate in this phase (Phase Two) is a political motive to create buy-in and recognition of the practitioners (D'Costa, 1986; Hasson et al., 2000). This opinion survey formed structured "conversations" between investigator and participants (Wright, 2002). It served three functions in the whole research work. First is to identify the appropriate core competency items from the proposed ones. Second is to decide the importance level of each core competency item for infection control nurses. Third is to allocate the content weights to the tasks in the blueprint of certification programme.

Practice analysis survey is a commonly used method to collect the input from the field practitioners to identify the practice of a profession. The certification examination of Certification Board of Infection Control and Epidemiology, Inc. (the CBIC certification examination) for infection control practitioners in the United States uses practice analysis to identify the tasks of infection control practitioners as the foundation of the certification examination (Curchoe et al., 2008; Feltovich & Fabrey, 2010; Goldrick, 2002; 2005). Other professional groups also use practice analysis as a means to establish their certification examination (Arbet et al., 2009; McMillan, Heusinkveld, Chai, Miller-Murphy & Huang, 2002). Practice analysis identifies the current practices of infection control practitioners in the United States by asking the participants' opinion about the significance of a task in practices are different from responsibilities. Some responsibilities may be omitted in current practices. Unlike practice analysis, role functions are the responsibilities for the practitioners, which embed the futuristic meaning of the practices to include all responsibilities (D'Costa, 1986). Based on this rationale, this research employed an opinion survey instead of practice analysis. The survey aimed at identifying the core competency for local infection control nurses, which was a comprehensive role function/ core competency beyond the content of certification. Figure 7-3 depicts the procedure and outputs in Phase Two.

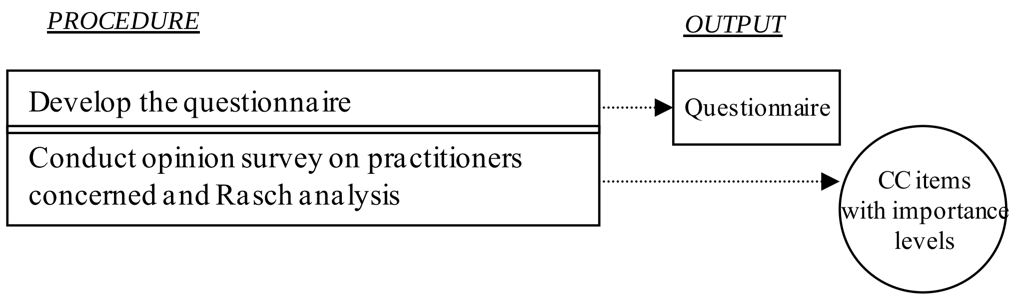

Figure 7- 3: Procedure and outputs of Phase Two
(CC = Core competency)

4.2.1 Participants and Sampling

A cross-sectional email survey design was used to collect Hong Kong on-the-job infection control nurses' views. This opinion survey intended to collect views of the field practitioners on their daily appropriate infection control practices. Potential participants of this opinion survey were on-the-job infection control nurses of all public and private hospitals in Hong Kong. By estimation, the whole population of on-the-job infection control nurses (working by the time of September 2008) was around 120. Most of them were working in public settings and the others were working in twelve private hospitals (The Hong Kong Private Hospitals Association, 2011). This was a small scale email survey, which would not cause resource problems and should be manageable. To reduce the possibility of sampling bias, I decided to include in this survey the whole population of infection control nurses who were still working by the time of September 2008.

4.2.1.1 Inclusion Criteria

There was no registry of infection control nurses in Hong Kong. All on-the-job infection control nurses were identified by the name lists provided by the in-charges of infection control nurses or heads of infection control teams of individual hospitals/ clusters in the territory. In the community of infection control nurses in Hong Kong, periodic meetings are conducted for information and experience sharing between public and private hospitals. I can reach the in-charges of infection control nurses and the heads of infection control teams easily through these meetings as I am an active local infection control nurse. I requested them to provide me with a complete name list of nurses working in the infection control teams of their hospitals/ clusters in September 2008.

4.2.1.2 Exclusion Criteria

Not all those name-listed nurses working in infection control teams were necessarily potential participants for this opinion survey. A few infection control nurses who had been invited to sit on the expert panels for other phase of studies (Phase One and Phase Three) were excluded. Nurses claimed to work in the infection control teams but without infection control clinical duties, so-called line managers, were also excluded. These line managers may not receive the training on infection control. They did not clinically responsible for the infection control programmes in hospital. Instead, they were the managerial supervisors of infection control nurses. As infection control teams in hospitals were not departments, infection control nurses were assigned from nursing departments to form the infection control teams. Therefore, these line managers did not practise infection control, but looking after the nurses in the infection control teams under the administrative perspective.

4.2.2 Instrument

A self-administered questionnaire was used to collect infection control nurses' views on levels of importance of the various proposed practices. The proposed core competency item list of Phase One was used to form the content of the questionnaire. As recommended in the Competency Outcome and Performance Assessment (COPA) model (Lenburg, 1999), all the proposed core competency items were written as behavioral statements starting with verbs to reflect practice-related abilities. This format also promoted better understanding of the participants for rating the questionnaire.

In Phase One, a five-point Likert-style rating scale, including options of (1) not very important, (2) not important, (3) undecided, (4) important and (5) very important, was used. The reliable rating scale on importance founded in Phase One was used in this survey. However, the term "undecided" was replaced by the term “neutral” in this questionnaire. It is found that the word “neutral” is better than “undecided” as the word “undecided” seems to convey some negative meaning to respondents’ (infection control nurses in this survey) responsibility or ability, for example, not making decision or failing to make a decision. Demographics of the participants were also requested in the questionnaire.

In this phase (Phase Two), participants were asked to rate the level of importance to each of those proposed core competency items using the following 5-point Likert scale response options: (1) Not very important, (2) Not important, (3) Neutral, (4) Important, and (5) Very important (Wright & Master, 1982; Shultz & Whitney 2005). The questionnaire is displayed in Appendix 7-9.

4.2.3 Data Collection

Email survey has demonstrated its strength in terms of speed of response. However, the response rate is often a concern. In the review of Sheehan (2001), among the 31 email surveys from 1986 to 2000, a mean response rate was 36.83%; indeed, the rate decreased from 61.5% in 1986 to 24.0% in 2000. This may have been due to increasing use of email surveys. Low response rate induces sampling bias. For traditional mail surveys, a response rate of 40%, 50% and 60% are considered as average, good and very good respectively (The University of Texas at Austin, Division of Instructional Innovation and Assessment, 2007). It is observed that email surveys accept slightly lower response rates than those of traditional mail surveys.

To facilitate a higher response rate of the participants, this email opinion survey adopted pre-notification and follow-up strategies. In particular, a follow-up message for email surveys has been found to increase the response rate by 25% (Sheehan, 2001). All potential participants in this survey were pre-notified by an invitation through email or by telephone before sending the questionnaire. Email invitations were tried initially. Infection control nurses of public hospitals were contacted through intranet emails of Hospital Authority at their workplaces, and infection control nurses of private hospitals were invited through personal email addresses. Potential participants, who could not be reached by email, were invited by telephone communication. In these invitations, either written or verbal consent to participate the survey were elicited. Infection control nurses with consents given were requested to provide their email addresses for delivering questionnaires individually or by batch. All consenting participants received the questionnaire together with the information sheet to specify their right in participation via their self-provided email addresses. To facilitate honest responses, no personal identifiers were labeled on the questionnaire. Questionnaires were sent out to participants in several batches by dates, and ten days were given for participants to complete and return the questionnaires by fax or by email. The deadline (date) for reply, the email address and the fax number were clearly stated in the questionnaire instructions. To promote the response rate by using follow-up strategy, reminder emails were sent individually or by batch before and near their deadlines.

4.2.4 Data Analysis

Apart from identifying the core competency of infection control nurses from the opinion survey, identifying the perceived levels of importance of each core competency item was another objective of this study. Using Rasch measurement for data analysis served both purposes in one step approach and it was the appropriate method to analyse the ordinal data in this survey. The item locations identified by Rasch measurement presented in logit scale, were the importance levels of individual core competency items in this study (Rasch, 1980). These importance levels were directly transformed to the content weights of the core competency items (Spray & Huang, 2000; Wang, 2009). On the other hand, Rasch measurement is a powerful tool to evaluate the construct validity as its principles are related to the Messickian construct-validity issues (Baghaei, 2008). Different aspects of data analysis in this survey are explained in the following sections.

4.2.4.1 Demographics

SPSS version 15.0 was used to analyse the demographics of the participants. The findings of demographic data provided information for subsequent sub-group analysis in this study.

4.2.4.2 Rasch Measurement

Rasch measurement is a one-parameter item response theory model (Bond & Fox, 2007). Winsteps 3.61.2 instantiated Rasch measurement was used for data analysis in this study. Rasch measurement provides different models to handle both dichotomous data and multiple-response options data (Andrich, 1978a;

1978b; 1978c; Rasch, 1980; Wright & Masters, 1982). In view of using 5-category rating scale for perceived importance in this survey, the Rasch Rating Scale Model in Winsteps was used (Linacre, 2006).

Person and Item Parameters

For participants' rating data, Rasch measurement reports a person-estimate in logit-scale and an item-estimate in logit-scale (Rasch, 1980). The person scale shows us the different behaviors of persons in rating the questionnaire, such as easier or harder to endorse the important items in this study. They are the person locations. One set of item category response (in logits) that is common for all core competency items is reported in the model. They are the item locations. The set of core competency items is called the core competency scale, the ultimate finding of this analysis. For the purpose of this survey, this core competency scale informs a comprehensive list of core competency items and their respective perceived importance in logits.

The Rasch measurement helps to construct the core competency scale by indicating unsatisfactory data. The quality of data is controlled by inspecting, then perhaps removing the misfitting person responses and the misfitting item responses in this study. Item fit statistics are important for constructing and calibrating the scale, which is the core competency scale in this research. Person fit statistics are also valuable in evaluating the validity of scale (Wright & Masters, 1982).

The objective of Phase Two was to identify the core competency items that contribute to the scale. Therefore, the person parameters were firstly examined to remove all the unsatisfactory performed persons before checking the item parameters.

Treatment of Extreme Scores

Extreme scores are also called as zero and perfect scores. They are extreme, but indefinitely located measures (Wright, 1998). The extreme scores may happen in either situation. First, one respondent rates the same extreme category throughout the questionnaire that is named as extreme person. Second, all the respondents rate the same extreme category for one item that is named as extreme item. The standard errors of these extreme scores are infinitively large that containing little information of the variables (Schumacker & Smith, 2007). To avoid misleading interpretation of the reliability estimates, extreme scores should be removed before data analysis. Using Winsteps software for data analysis, the extreme scores are automatically removed.

Determining the Fit of the Model

Winsteps programme provides a Rasch data quality control mechanism by comparing actual person-item frequencies against the prediction of the Rasch model based on the person-estimates and item-estimates (so-called Rasch model's expectation). If persons and items behave as the Rasch model predicted, they fit into the Rasch model. When they perform outside the expectations of Rasch model, i.e., in a more erratic or haphazard way, the quality of the responses is inferior and indicates misfitting persons and misfitting items (Wilson, 2005).

Fit is a key quality control mechanism in Rasch measurement and the indicators used are called fit statistics. There are two types of fit statistics, infit and outfit (Bond & Fox, 2007; Granger, 2007). Infit is a weighted residual-based statistic, while outfit is unweighted. Infit statistics are more sensitive to the behaviours of on-target observations. Outfit statistics are the unweighted estimates of response residuals and tend to be influenced by off-target observations (Wright & Masters, 1982). Both infit and outfit statistics are routinely expressed in two forms: unstandardised mean squares (MNSQs) and standardized (normalized) *t*-values (ZSTDs). The mean square values show the amount of variation between the observations and the Rasch model's expectation. The expected value of Rasch model is one. Mean square values are always positive, exceeding one to indicate more variation observed than expected, while less than one indicates fewer variations in observations than expected. Reasonable values for such survey purposes usually range from 0.75 to 1.33 (Bond & Fox, 2007).

The standardized infit and outfit *t*-values are the transformations of weighted mean squares to a standard normal distribution (Wilson, 2005). Then *t*-values are expected to have a mean of zero and standard deviation near of one when the data conform to the model. Under the sample size between 30 and 300, *t*-values beyond the range between –2 and +2 indicate the observed data are less compatible with the model's expectation ($p < 0.05$). Positive *t*-values show that the response information is more haphazard than expected (underfit/ misfit) while negative *t*-values indicate a Guttman-like response pattern (overfit). Infit and outfit *t*-values are often adopted as the major indicators to diagnose fit or misfit (Bond & Fox 2007). It is noted that *t*-values more likely show significance in many items ($p < 0.05$, less compatible with the Rasch model's expectation) when larger sample sizes are used. There are no hard-and-fast rules for acceptability cut-offs in diagnosing misfit. Misfit may be considered when both infit *t*-value and infit mean square exceed their expected values (Wilson, 2005), with using outfit statistics as additional indicators for further fit examination, such as to investigate the measurement context (Bond & Fox, 2007).

I set in this study misfit diagnosing criteria for item- and person-estimates by referring to their reasonable values: infit *t*-values greater than 2.0 and infit mean squares greater than 1.33. These criteria should be more than sufficient for the purpose of initial identifying misfit for the survey of infection control nurses (Linacre, 2003). After diagnosing the misfitting persons and items, further examination of the misfitting persons / items, such as item text, was carried out subsequently (Bond & Fox, 2007; Rasch, 1980; Wilson, 2005). On the other hand, infit *t*-values less than –2 or infit mean squares less than 0.75 were considered as overfit (Bond & Fox, 2007), and they were considered not to be a threat to quality measurement for the purpose of this study.

Differential Item Functioning

Differential item functioning (DIF) analysis was used to examine if there were any significantly different patterns of results between meaningful subgroups of infection control nurses that is the item bias. A significant result for DIF might possibly lead to a decision to make more than one certification content blueprint for local infection control nurses. In this study, the subgroups were classified based on the relevant demographic findings. During the analyses, the two subgroups in a pair were identified to be first person class and second person class respectively. DIF measures were based on the differences between the item measures for each subgroup; i.e., DIF contrast of an item is the difference of first person class measure and second person-class measure. A significant DIF contrast is often defined as half of the standard deviation (SD) of the whole scale (Conrad, Conrad, Dennis, Riley & Funk, 2009). This is a simple and practical test but does not have any statistical information to support the result. DIF analysis is influenced by the sample size of the subgroups where the DIF values shift accordingly. For this reason, Tristán (2006) suggested that a DIF significance test was needed to robust against the samples size. In this study, a more circumspect approach was used. When DIF contrast of an item was 0.5 logits and greater, a statistical test for the significance was checked by Winsteps software programme (Linacre, 2006). Mantel-Haenszel test is sometimes considered as the best method to detect DIF for dichotomous data (Linacre & Wright, 1989). Mantel extended the procedure for using in polytomies (Mantel, 1963; Linacre, 2006). Being a non-parametric test, Mantel-Haenszel test was used in this study with small sample size. Significance of Mantel-Haenszel test was checked when the absolute value of DIF contrast was greater than 0.5 logits. *P*-value less than 0.5 was considered as significance of the test.

Rating Scale Analysis

While the participants respond to only one option (response category) on each item, the reporting of category threshold estimates for each item is an additional feature of Rasch Rating Scale Model. One set of rating scale thresholds that is common for all items, is reported in the model (Bond & Fox, 2007). The information helps to analyse the function of the rating scale used in the survey. To be considered as a functional rating scale, the probability curves of the response categories should demonstrate distinct positions on the rating scale. On the other hand, the optimal distance of the thresholds between adjacent response categories should be within the optimal distance between 1.4 and 5.0 logits (Bond & Fox, 2007).

Reliability Estimates

In statistical terms, person reliability (person-measure-reliability) is the degree of reproducibility of person measures orderings, where a person measure refers the total responses to the item-questions of a participant. Similarly, item reliability (item measure reliability) is the degree of reproducibility of item measures orderings, where an item measure refers the total responses of all persons to that item. The values of these reliabilities range between 0 and 1. The reliability computed by Rasch measurement is a range of values where the true reliability within the range. The real reliability is the lower boundary and the model reliability is the upper boundary. When the noises are removed, the true reliability approaches to the model reliability.

Person reliability of Rasch measurement is similar to the "conventional reliability coefficient", Cronbach's alpha. However, person reliability of Rasch measurement is a better indicator than the "conventional reliability coefficient", Cronbach's alpha. It is because, first, Cronbach's alpha is estimated based on the Classical Test Theory that assuming the non-linear raw scores as linear scale. Second, Cronbach's alpha includes all the samples (including the extreme persons) in the variance analysis. Since extreme scores do not have error variance, including these scores decrease the average error (Schumacker & Smith, 2007). Person reliability in Rasch model excludes the extreme person(s) in its standard errors computation. With the different person data inclusion criteria for the analysis, Cronbach's alpha usually overestimates the reliability, as against Rasch measurement underestimates it (Linacre, 2006). When the items are internally consistent, the model is able to estimate each person's ability or location. Unlike the conventional reliability coefficient, the standard error of Rasch measurement is not sample specific. It is a sample-free test to check the characteristic of a set of items in a test (Wright & Masters, 1982).

Both person and item reliabilities share the same magnitude of interpreting the estimates. The reliability is considered as poor if the estimate is less than 0.67. The estimates between 0.67 and 0.80 is considered as fair, between 0.81 and 0.90 is good, between 0.91 and 0.94 is very good and greater than 0.94 is excellent (Fisher, 2007). For Cronbach's alpha, the common standard is greater than 0.7 (Rattray & Jones, 2007; Shultz & Whitney, 2005). The Winsteps programme provides both the conventional and Rasch reliability estimates. They were both examined to check the performances of persons and items in the result chapters.

Validity Estimates

The requirement of Rasch model is that measurement must be unidimensional, or in a single dimension (Bond & Fox, 2007; Granger, 2007). Dimensionality is measuring the construct of a test or a scale that is the construct validity. To analyze the construct in this study, principal component analysis of residuals in Winsteps programme was used to identify the possibility of multiple dimensions. The Rasch dimension is the first dimension. Therefore, the first contrast in the analysis is actually the second possible dimension in the data set. For data interpretation, a large proportion of variance for more than 60% with less than 5% of residuals of unexplained variance in the first contrast was considered as unidimensional, representing the construct of the scale was valid (Baylor, Yorkston, Eadie, Miller & Amtmann, 2009).

4.2.5 Output of Phase Two

The proposed core competency established in Phase One was objectively validated. Phase two identified a comprehensive list of core competency items for infection control nurses of Hong Kong. On the other hand, according to the item measures identified from the Rasch measurement, the perceived levels of importance of infection control nurses on individual core competency items were identified. These importance levels (in logits) were the content weights of the core competency items after some mathematics handling. This was explained in the next phase.

4.3 Phase Three: Defining Critical Competency and Building the Content Blueprint

The core competency for infection control nurses developed in Phase Two (with perceived important levels in logit) was a comprehensive list of items including all expected work behaviours for local infection control nurses. Thus, it was useful for establishing both training programmes and credentialing activities for Hong Kong infection control nurses, such as certification. For a training programme for infection control nurses, the whole core competency can be adopted depending on the resources available. However, a certification programme only needs to include the most important core competency items (D'Costa, 1986; Southgate et al., 2001). The core competency established in Phase Two would be too long for the certification purpose. It was not practical to include such a sizeable material to form the content blueprint of a certification programme for infection control nurses. Including only the most important core competency items would suffice, but not to miss any important core competency items in the content blueprint. This step, to trim the core competency list to fit into a certification programme was one of the most important and difficult tasks for the researchers or test developers responsible for such process (Meskauskas, 1986). The most important part of core competency for the group of practitioners, was called as critical competency, in this research.

The objective of Phase Three was to define the critical competency from the core competency of infection control nurses of Hong Kong. Experts' consensus was sought. The choice of consensus method used depends on the characteristics of the problem encountered, experts employed and resources available. The problem to be solved in Phase Three was defining the most important core competency items, critical competency, which would be included in the certification programme. Formal consensus methods, like Delphi method, nominal group technique and RAND/ UCLA appropriateness method use explicit statistical techniques to calculate the consensus results (Halcomb et al., 2008). Such statistically defined consensus is convincing. To yield a statistical significant result, adequate samples to participate in the exercise are necessary. However, the number of infection control experts in Hong Kong is small. It would be difficult to generate a statistical defined consensus in this situation. In this regards, qualitative approach on expert consensus was employed (Abraham, Collins & Martindale, 2006). A questionnaire survey was used for the expert consensus in this phase. The procedures and outputs of Phase Three are depicted in Figure 7-4.

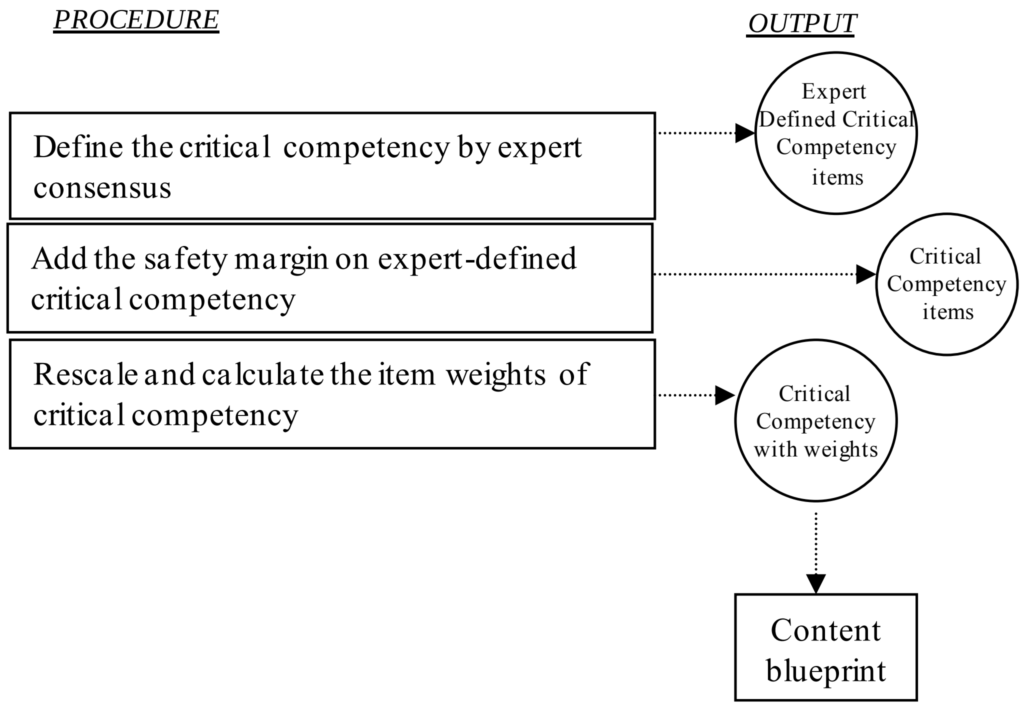

Figure 7- 4: Procedures and outputs of Phase Three

4.3.1 Participants and Sampling

Although the number of experts in infection control field in Hong Kong is limited, the experts were carefully selected to represent the profession as the appropriateness of the expert selection affected the result of consensus (Fink et al., 1984). The experts were expected to produce a sound decision and justification in this exercise.

A panel of six subject matter experts consisting of three infection control officers (ICOs) and three infection control nurses were selected purposively (purposive sampling). Originally, it was intended to re-invite all six experts taking part in drafting core competency in Phase One, as they were the leaders of large Infection Control Teams in public hospitals and actively involved in the corporate-wide decision level of infection control issues. However, only five of them were selected because one infection control nurse expert changed to other specialty after the drafting process. The sixth expert, an infection control officer of a university hospital in Hong Kong was newly invited in this phase of study. All the six invitations were sent by email. The details of individual expert panel members are listed in Table 7-7.

Table 7- 7: Details of expert panel members

Code	Specialist	Status in infection control field	Involvement in this research
A	ICO	Hospital and cluster leader	Phase One and Three
B	ICO	Leaders of two acute hospitals	Phase One and Three
C	ICO	Hospital and cluster leader	Phase Three
D	ICN	Hospital and cluster leader	Phase One and Three
E	ICN	Hospital and cluster leader	Phase One and Three
F	ICN	Hospital and cluster leader	Phase One and Three

4.3.2 Instrument

A self-administered questionnaire was used to collect the opinion from the experts in Phase Three. The core competency items of infection control nurses developed in Phase Two were transcribed into a questionnaire. All the items were listed from the most important item to the least important item. Some items had identical importance levels. Ranks of importance were assigned on each item based on their importance levels. Same rank was allocated if the items had identical importance levels. Only the ranks and the item descriptions were provided in the questionnaire. No importance levels in logit were given.

The works of Phase One and Phase Two were briefly introduced in the questionnaire. Experts were requested to read through all the core competency items in the questionnaire carefully and to decide the position of a cut-off line dividing the list into: 1) the most essential items, above the cut-off line; and 2) the preferred items, below the cut-off line. They were further reminded to put the cut-off line between the items of different ranks, so that items with the same rank would go to either the most essential items or the preferred items. Besides, the experts were requested to justify their decisions. A reply slip was provided for the experts to fill in their answers. A sample of the questionnaire is displayed in Appendix 7-10.

4.3.3 Data Collection

The questionnaire survey was used to collect opinions of individual experts. It was essential to collect individual experts' view separately. Their independent inputs were useful to reflect their own original opinions without cross-fertilization of ideas (Abraham et al., 2006). To conduct the survey, the questionnaire was sent to the experts by email individually. If their replies needed clarification, individual discussion through email or telephone was used. A reminder email was sent if the experts did not reply by the deadline. A consensus meeting had to be held if no consensus could be made basing on the replies (Verduijn et al., 2008).

4.3.4 Data Analysis

Qualitative Analysis

The returns from the experts contained the proposal on the essential core competency items (critical competency items) and their justification. The proposed splitting points and their justifications were examined by the investigator. The final decision on the cut-off for critical competency would be made based on the contextual analysis of all returned justifications. The justifications became the important argument of the final decision making. They should be sound and rational to support and conclude the corresponding splitting point. By qualitative approach, experts' views were concluded that the relevant list of core competency items (critical competency) for infection control nurses of Hong Kong was defined, which was named as expert-defined critical competency.

Rasch-Based Calculation

It is believed that error-free measurement on education and psychology is impossible as there is a measurement gap between the true score and observed score. To ensure that true critical competency was included in the certification programme, a measurement error should be added on the expert-defined critical competency (Osterline, 2010). As the standard deviation of the measurement error, standard error was used as the measurement error indicator, which was the safety margin of the measurement. Before splitting the core competency list from Phase Two, all the core competency items were on a linear scale according to their importance level (Granger, 2007). The true cut-off was defined from the expert-defined cut-off (in logit) in addition to the standard error of the last defined essential core competency item (critical competency item). The mathematical formulation for the true cut-off logit would be:

(Cut-off + Standard error) logits

The revised cut-off set the boundary of importance levels of true critical competency, which would be included in the certification programme.

Rescaling the Item Measures

The Rasch model transformed the perceived importance level in ordinal scale (rating scores) into item measures in logit scale, thus establishing the core competency scale. The perceived importance of item measures on the core competency scale behaved in a linear manner. They could be simply converted to the content weights of the core competency items for the certification content blueprint by linear mathematical process (Spray & Huang, 2000). In the results of the Phase Two, items measures were presented in both negative and positive values on the linear core competency scale. The larger negative logits indicated the more important items, while the larger positive logits indicated the less important items. The value of item measures and its important level was inversely related. In order to calculate the content weight for certification purposes, these item measures in logits should be reversed to all positive values. The positive value facilitated the weight proportioning when the larger logits indicated more important items. Although Spray and Huang (2000) performed reversing procedure manually, I did it by Winsteps software. It was easily done by the "Scaling calculator" under the "help" function in the software (Granger, 2007). As all the core competency items were ready in the Winsteps environment, they were rescaled directly before splitting into critical competency items.

Weighting the Critical Competency

The critical competency items served as the content boundary of content blueprint. Individual critical competency items carried weights of contents and formed the content blueprint. The item weights were commonly presented in percentage. This section described the weighting procedure for the critical competency items.

The importance levels of the critical competency items had been worked out in Phase Two. The rescaling procedure converted all the importance levels into positive values. The positive logit values were ready to be transcribed as the weights of individual critical competency items. Proportioning of the positive logit values within the boundary of critical competency items resulted in the weights of the competency items contributing to the content blueprint of certification programme for infection control nurses of Hong Kong.

4.3.5 Output of Phase Three

Phase Three identified the critical competency of infection control nurses of Hong Kong and its respective content weights. This established a content blueprint for certification programme for infection control nurses of Hong Kong.

5 Ethical Considerations

This research was approved by the Human Subjects Ethics Sub-committee of the Hong Kong Polytechnic University. The participants of all phases of the research were only required to express their opinions through answering the questionnaire(s). Before each phase (or each part) of the study, the participants were informed about the study objectives and their roles through a written information sheet (Appendices 7-11 to 7-15). Verbal explanation was given upon requested. All studies only started after verbal/ written consents had been obtained.

6 Summary

The infection control nurses' core competency in various contexts was the main finding in each phase, namely, proposed core competency in Phase One, core competency in Phase Two and critical competency in Phase Three. By using action/ behavioural statement descriptions, core competency and role functions of infection control nurses are identical. Infection control nurses' core competency was identified based on the concept of role delineation, which was the method to establish role functions.

Phase One was the preparatory work to develop the infection control nurses' opinion survey questionnaire of Phase Two, including its content and rating scale. The content of questionnaire was the proposed core competency items list. Its establishment relied on both literature inputs and experts' inputs. The rating scale was the perceived importance level in ordinal scale. The ordinal data rejected all data analysis in classic test theory paradigm in subsequent data analysis of survey in Phase Two.

After developing the questionnaire for opinion survey, local infection control nurses' opinions were collected in Phase Two as competency assessment in a certification programme should reflect their daily practice. Data collected in this Phase Two-survey was infection control nurses' perceived importance levels of individual core competency items. The ordinal data were analysed by Rasch measurement. There were at least three advantages to use Rasch specifically in this survey data analysis. First, Rasch's data quality control mechanism facilitates the objective decision on data inclusion and exclusion. Second, Rasch converts the importance level in ordinal scale to interval scale so that subsequent parametric statistical analysis can be used. Third, Rasch translates the importance level of core competency items to the content weight of core competency items directly, which is required to develop the content blueprint of certification programme in Phase Three.

While Phase Two yielded a comprehensive list of weighted core competency items of Hong Kong infection control nurses, the subject matter experts were requested to shorten the list to fit into the local certification programme in Phase Three. Because of limited number of experts in the field and wide range of possible answers, expert consensus in qualitative approach was used to define critical competency of infection control nurses. After some Rasch-based calculations, the true critical competency was identified as the content blueprint of certification programme.

In order to develop a successful certification programme for a profession, the programme developers or educators, who are often not the practitioners of the field; have to rely on a sound and valid content blueprint that contains the most important core competency of the practitioners. The involvement of field practitioners is the most suitable. This three-phase research demonstrated how the local infection control nurse specialists certification programme content blueprint was formed by involving the inputs from literature, experts and practitioners. The methods used in this research informed a process model to develop the content blueprint of certification programme of healthcare professionals using the concept of role delineation (D’Costa, 1986).

CHAPTER 8

PHASE ONE — RESULTS AND DISCUSSION

1 Introduction

This chapter and the next two (i.e. Chapter 9 and 10) are going to report the findings of the three-phase research by phases. First of all, this chapter informs the findings of Phase One of establishing the proposed core competency for infection control nurses of Hong Kong. The chapter divides into three sections. The first section describes the drafting of core competency through the Delphi process. The second section notifies the content validity of the draft core competency, and the third section reports the reliabilities of the draft core competency and the proposed rating scale for the questionnaire survey in Phase Two.

2 The Draft Core Competency

2.1 Literature review

In Phase One, I started with studying literature to work out the preliminary competency categories (Griffin, Cuc, Gillis & Thanh, 2006). Competency areas for registered nurses derived from the Nursing Council of Hong Kong (2004) were employed as the conceptual framework to identify the preliminary core competency for infection control nurses in specialist level. The Delphi process firstly confirmed the core competency categories, and then followed by the core competency items. Based on the draft competency categories from the Delphi experts, I then developed the preliminary competency items from the literature again. Overseas and local competency, practice standards, recommended activities and research articles related to roles of infection control nurses were reviewed. Duties and expected performance were identified to feed into the draft competency categories. A detailed reference list on preliminary core competency categories and items were documented in Appendices 7-1 and 7-2.

2.2 Findings of Delphi Survey

A total of four rounds of Delphi surveys were conducted. The first and second rounds were used to develop the draft core competency categories and the third and forth rounds were to develop the draft core competency items. The four questionnaires used for Delphi survey are listed in Appendices 7-3, 7-4, 7-5 and 7-6). From literature review, the first questionnaire included 13 preliminary competency categories (Table 8-1).

Table 8- 1: Preliminary core competency categories for infection control nurses under basic competency areas of registered nurses of Hong Kong

Competency areas	Preliminary core competency categories for infection control nurses
Professional, legal and ethical practice	Surveillance
	Consultation
	Occupational health
	Infection prevention and control practice
Health promotion and health education	Education
Management and leadership	Team and service management
	Programme management and evaluation
	Partnership
	Outbreak investigation and control
Research	Research and development
Personal effectiveness and professional development	Qualification
	Continuing education and development
	Professional development

To compare the preliminary core competency category with infection control leading countries from overseas, the United Kingdom (Infection Control Nurses Association, 2004) and North America (Horan-Murphy, Barnard, Chenoweth, Friedman, Hazuka, Russell, Foster, Goldman, Bullock, Docken & McDonald, 1999), Figure 8-1 shows the mapping of core competency categories between the three countries. Among 13 preliminary core competency categories for infection control nurses of Hong Kong, 11 of them were common to the three regions. However, the category of “partnership” was only shared by United Kingdom and Hong Kong, while category of “qualification” was observed in Hong Kong and North America only. This analysis showed that the preliminary core competency categories prepared by literature review in this study reflected the required infection control practice comprehensively, which were comparable with the international infection control leading countries. These competency categories were ready to be proceeded in consulting the experts through Delphi survey.

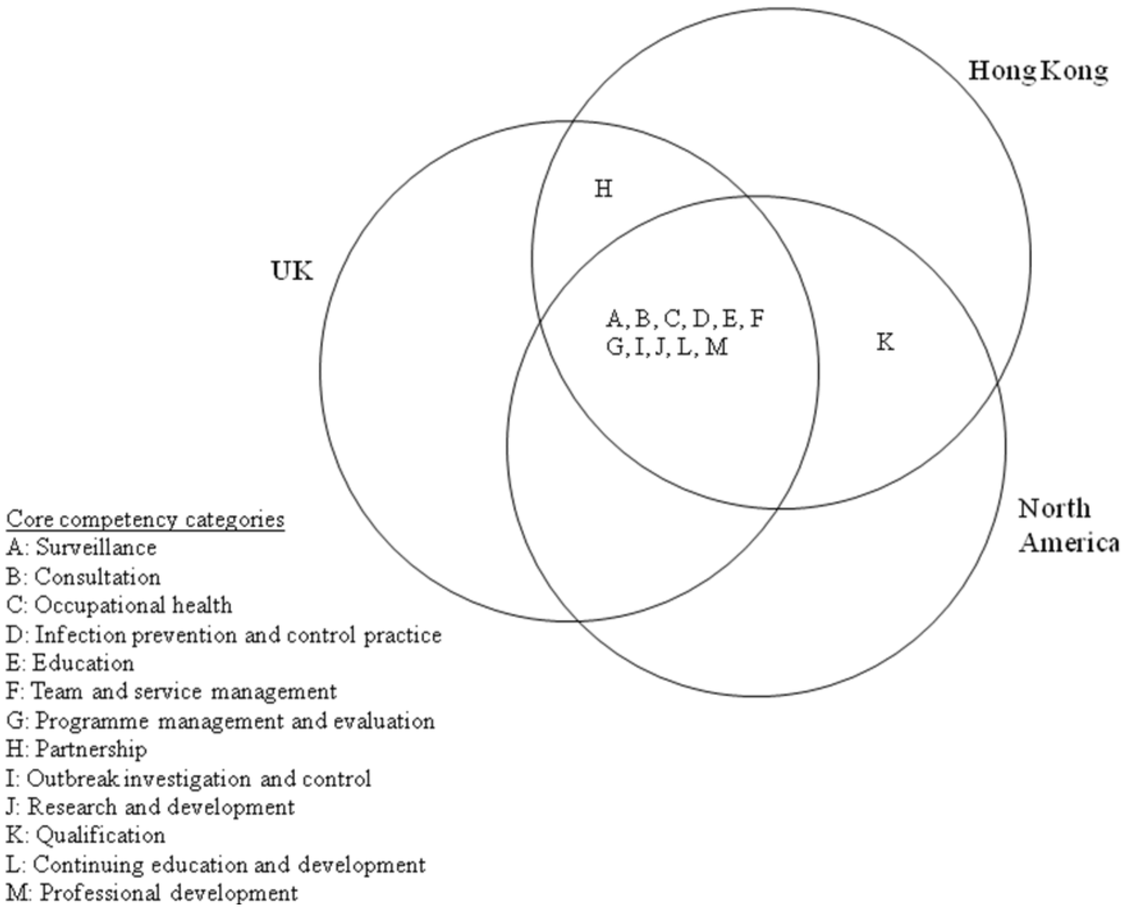

Figure 8- 1: Mapping of preliminary core competency categories of Hong Kong infection control nurses with those in the UK and US

Table 8- 2: Result of Round 1 of Delphi survey

Competency category	Agreement	Action
1. Surveillance	100%	Confirmed
2. Programme management and evaluation	100%	Confirmed
3. Consultation	83.3%	
4. Occupational health	66.7%	To include under "infection prevention and control" as suggested
5. Infection prevention and control	100%	Confirmed and to rephrase as "evidence based practice of infection prevention and control"
6. Education	100%	Confirmed and to include 'coaching' as suggested
7. Team and service management	83.3%	Confirmed
8. Partnership	50%	To elaborate as suggested
9. Outbreak investigation and control	83.3%	
10. Research and development	83.3%	
11. Qualification	50%	To elaborate as suggested
12. Continuing education and development	66.7%	To elaborate as suggested
13. Professional development	50%	To elaborate as suggested
Other comments: Include more elements or skills related to quality management, leadership, interpersonal communications, data management, resource management, etc.		To insert these elements into relevant categories

Items that 80% or more of experts agreed

After Round 1, eight categories achieved more than 80% agreement, ranged from 83.3% to 100% (Table 8-2). The category "occupational health" was suggested putting under the category of "infection prevention and control". The category of "infection prevention and control" was suggested to rephrase as "evidence based practice on infection prevention and control". Four categories, namely, "partnership", "qualification", "continuing education and development" and "professional development" got low agreement (less than 70%) and diversified comments from the experts. Other comments on requesting more categories related to quality management, leadership, interpersonal communications, data management, resource management, etc. were received.

For Round 2 survey, four disagreed categories of Round 1 were modified and comments were integrated (Table 8-3). In Round 2, one expert did not respond, and the response rate dropped from 100% to 83.3%. All four categories, namely, “partnership”, “qualification”, “continuing education and development” and “professional development” were confirmed by agreement of 80% or greater (Table 8-4). Furthermore, experts suggested that the category of “professional development” go to the category of “continuing education and development” and that “partnership” should be renamed as “team work and partnership’. As a result, a total of 11 draft core categories were agreed (Table 8-5).

Table 8- 3: Competency categories modification for Round 2 of Delphi survey

Competency category		Remarks
Round 1	**For Round 2 circulation**	
Surveillance	1. Surveillance (include data management and quality management)	Confirmed
Programme management and evaluation	2. Programme management and evaluation	Confirmed
Consultation	3. Consultation	Confirmed
Infection prevention and control Occupational health	4. Evidence based practice on infection prevention and control (include occupational health)	Confirmed
Education	5. Education (include coaching)	Confirmed
Outbreak investigation and control	6. Outbreak investigation and control	Confirmed
Research and development	7. Research and development	Confirmed
Team and service management	8. Team and service management (include leadership and resource management)	Confirmed
Partnership	9. Partnership (with other teams and disciplines	
Qualification	10. Qualification (mainly infection control training)	
Continuing education and development	11. Continuing education and development (self development)	
Professional development	12. Professional development (for infection control profession)	

Table 8- 4: Result of Round 2 of Delphi survey

<table>
<tr><th>Competency category</th><th>Agreement</th><th>Action</th></tr>
<tr><td>1. Surveillance (include data management and quality management</td><td colspan="2" rowspan="8">Agreed in round one survey</td></tr>
<tr><td>2. Programme management and evaluation</td></tr>
<tr><td>3. Consultation</td></tr>
<tr><td>4. Evidence based practice on infection prevention and control (include occupational health)</td></tr>
<tr><td>5. Education (include coaching)</td></tr>
<tr><td>6. Outbreak investigation and control</td></tr>
<tr><td>7. Research and development</td></tr>
<tr><td>8. Team and service management (include leadership and resource management)</td></tr>
<tr><td>9. Partnership (with other teams and disciplines)</td><td>100%</td><td>Confirmed and to rephrase as “team work and partnership”</td></tr>
<tr><td>10. Qualification (mainly infection control training)</td><td>80%</td><td></td></tr>
<tr><td>11. Continuing education and development (self development)</td><td>100%</td><td></td></tr>
<tr><td>12. Professional development (for infection control profession)</td><td>80%</td><td>Confirmed but to put together with “continuing education and development”</td></tr>
</table>

Based on the 11 draft core competency categories from Round 2, 58 preliminary core competency items were generated according to the literature review (Appendix 7-2). These 58 preliminary core competency items were listed on the questionnaire for Round 3 circulation (Appendix 7-5). According to the returns of experts in Round 3, 5 items were removed, 49 were confirmed (two items were integrated into the confirmed items as suggested) and 2 were modified for re-circulation (Table 8-6). The two modified items went through Round 4 for experts comments, and were confirmed with some modification on one item (Appendix 8-1). No further comments were received on the confirmed items. The Delphi survey for preliminary competency items stopped at Round 4, and it resulted in 51 draft competency items.

Table 8- 5: Draft core competency category

1.	Surveillance
2.	Programme management and evaluation
3.	Consultation
4.	Evidence based practice on infection prevention and control
5.	Education
6.	Outbreak investigation and control
7.	Research and development
8.	Team and service management
9.	Team work and partnership
10.	Qualification
11.	Continuing education and professional development

Table 8- 6: Endorsed result in Round 4 of Delphi survey

No.	Item	Agreement
47	Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members	100%
47	Have two to five years of experience in infection control practice	100% agreed on the item but in diversified duration. Put a range instead of a fixed period.

For the category “team service and partnership”, its name was finally changed to “collaboration and partnership. After the expert inputs by Delphi survey, it resulted in 51 draft competency items in 11 categories (Table 8-7). The free-marginal multi-rater Kappa for 51 items between six panel experts was 0.84.

Table 8- 7: The draft core competency categories after four rounds of Delphi survey (51 draft core competency items)

Core competency category	No. of core competency items
1. Surveillance	8
2. Programme management and evaluation	7
3. Consultation	1
4. Evidence based practice on infection prevention and control	4
5. Education	5
6. Team and service management	9
7. Collaboration and partnership	2
8. Outbreak investigation and control	5
9. Research and development	4
10. Qualification	3
11. Continuing education and professional development	3

2.3 Handling of Double-Barrelled Items

After the Delphi survey, in addition to the expert inputs, it was found that some of the 51 draft competency items consisted of double-barrelled sentences. For example, “report the findings to appropriate clients and give recommendations accordingly” contained two behaviours: “report the findings” and “give recommendations”. I split these items to obtain 64 draft competency items, and their wordings were further fine-tuned. These 64 behavioural statements (draft core competency items) are listed in Appendix 8-2 with re-numbering. These 64 draft competency items of infection control nurses of Hong Kong had to go through validating and reliability testing procedures before they became the proposed competency items that were ready to form the content of infection control nurses' opinion survey questionnaire in Phase Two.

3 Content Validity of the Draft Core Competency

Phase One was to develop instruments for the field practitioners' (infection control nurses) opinion survey in Phase Two. The instruments included the content of questionnaire and its rating scale. The 64 draft core competency items of Hong Kong infection control nurses were content validated before being used in the opinion questionnaire. The content validity survey was conducted employing three content experts.

Appendix 8-3 tabulated the results of content validity survey. Of the 64 draft competency items, all 3 experts gave same rating to 37 items (rated as 4). There were 48 all-agree items (all rated as 3 or 4) and there was no all-disagree item (all rated as 1 or 2). The scale-level content validity index (CVI) was 0.75 (48/64).

To work out the scale-level CVI (average method), item-level CVI had to be computed. The item-level CVI was one for the 48 all-agree items. Apart from the all-agree items, the other 16 items got various level of agreement. 13 items got two experts agreed and one disagreed contributing their item-level CVI of 0.67 (2/3). The left 3 items got one expert agreed and two disagreed that resulting the item-level CVI as 0.33 (1/3). To average out over the item-level

CVIs of 64 items, a scale-level CVI (average method) of 0.90 was resulted [(1x48 + 0.67 x13 + 0.33x3)/ 64]. The scale-level CVIs ranged from 0.75 to 0.90 when different computations were used.

Regarding the assessment of inter-rater agreement, the level was 0.75 (48/64), which was acceptable (Davis, 1992). The free-marginal multi-rater Kappa was 0.67.

Apart from rating the draft core competency items, content experts recommended that all the domains of the competency for infection control nurses were completely written down in the questionnaire. In view of the similarity in content, the content experts suggested combining the draft core categories of “consultation” and “qualification”, and giving a new name of “expert knowledge”. Items of “expert knowledge” category are listed in Table 8-8. The content experts also recommended rephrasing some statements of the core competency items to convey clear messages.

Table 8- 8: Items to be combined in the category of "expert knowledge"

Consultation

12. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control. (To modify to "Act as expert resource in infection prevention and control in clinical and organizational level"

Qualification

13. Demonstrate knowledge in areas of patient care practices.
14. Demonstrate knowledge of microbiology.
15. Demonstrate knowledge of asepsis.
16. Demonstrate knowledge of decontamination.
17. Demonstrate knowledge of adult education.
18. Demonstrate knowledge of infectious diseases.
19. Demonstrate knowledge of communication.
20. Demonstrate knowledge of programme administration.
21. Demonstrate knowledge of epidemiology.
22. Demonstrate knowledge of biostatistics.
23. Have two to five years of experience in infection control practice.
24. Completed at least a certificate-level of infection control training for infection control practitioners organized by university, university collaborated programme or equivalent.

4 Reliability of the Draft Core Competency and Rating Scale

Further to evaluating the content validity, the reliability of the items and rating scale was also important to the infection control nurses' opinion survey in Phase Two. It ensures the accuracy of measurement in the opinion survey.

4.1 Response Rate and Demographics

A total of 18 ex-infection control nurses participated in this reliability study. All returned the first questionnaires, but only 17 returned the second questionnaires. The response rate for the test-retest reliability was therefore 94.4% (17/18). The first replies, including demographics of participants, were used for checking the internal consistency of the scale and rating scale diagnostics.

4.1.1 Sex

The findings of demographic data were derived from 18 completed first questionnaires. Among the 18 participants, 14 (77.8%) were female and 4 (22.2%) were male (Figure 8-2). Half of them (50.0%) fell into the age group 31-40. The other half belonged to the 41-50 and 51-60 age groups, and they included 38.9% and 11.1% respectively (Figure 8-3).

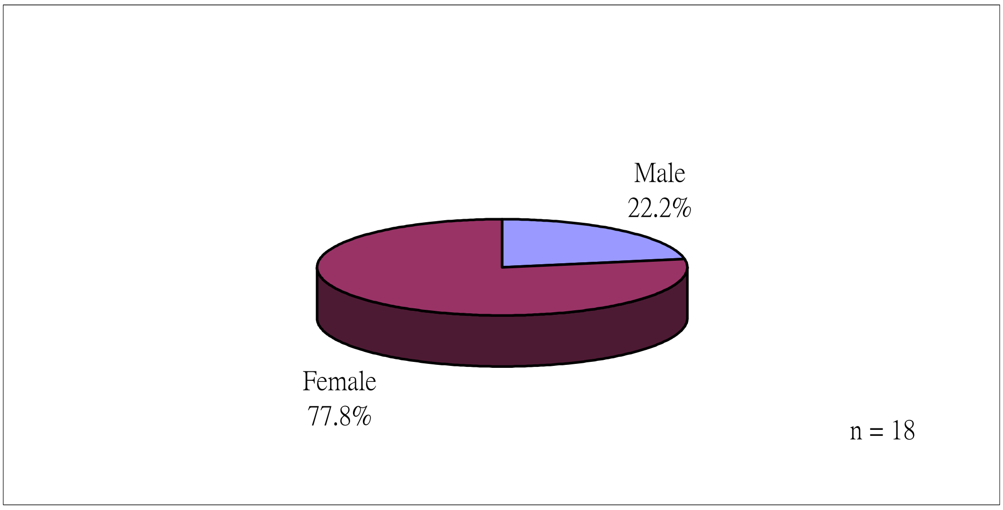

Figure 8- 2: Distribution of sex of ex-infection control nurses

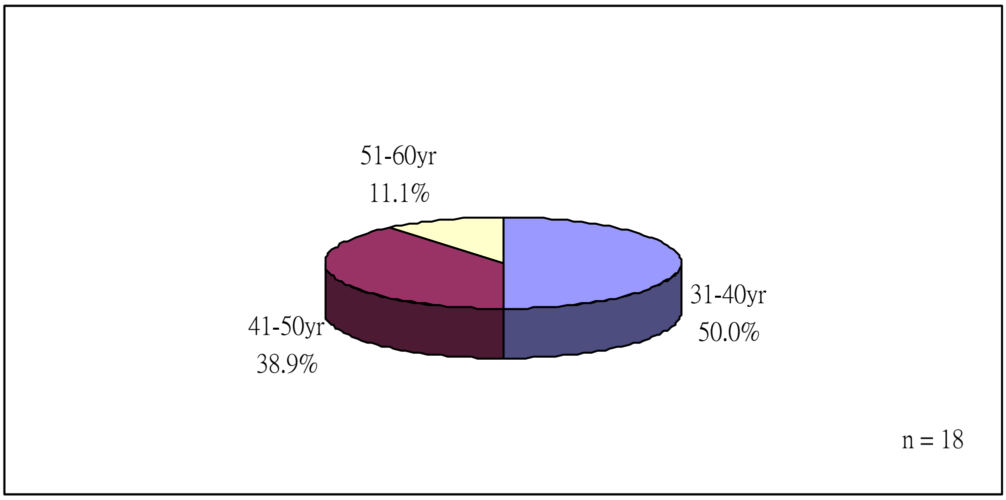

Figure 8- 3: Distribution of age of ex-infection control nurses

4.1.2 Academic Qualification

Their highest academic achievements included five levels. Of the 18 ex-infection control nurses, 5.6% achieved a certificate level, 5.6% got a diploma level, 66.7% had a bachelor's degree, 16.7% had a master's degree, and 5.6% achieved the level above master's (Figure 8-4).

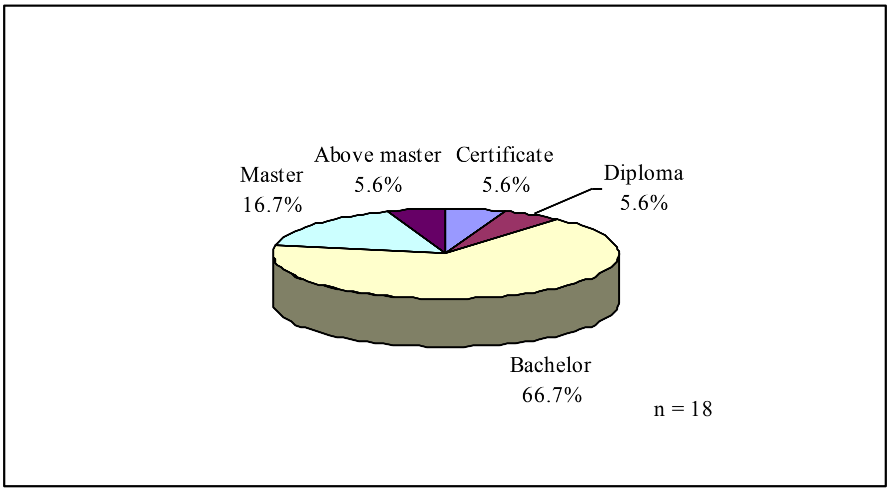

Figure 8- 4: Distribution of the highest qualification of ex-infection control nurses

4.1.3 Work Experience

Their work experience in the infection control field ranged from one to 10 years and the mean was 5.5 years. Some participants had just left the field within a year but some had left for 13 years already, before they answered the questionnaire. The mean time length from leaving the field was 2.8 years. Most of them (94.4%) had been working as full-time infection control nurses in their hospitals, and only one (5.6%) had been working part-timely (Figure 8-5). The only part-time infection control nurse spent 15% of her work time on infection control.

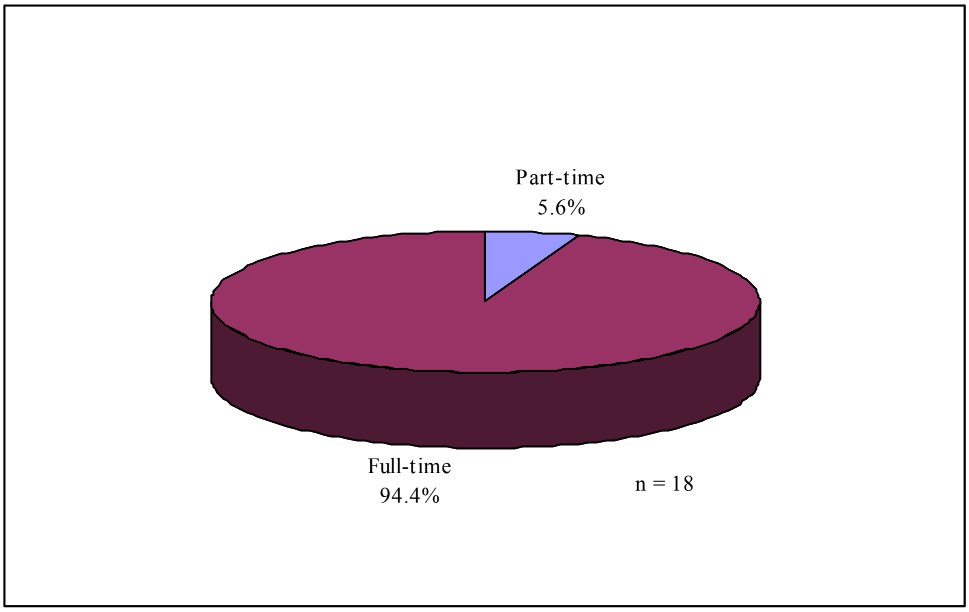

Figure 8- 5: Distribution of work time of ex-infection control nurses

4.1.4 Work Setting

All of them worked in public hospitals. Most of them (83.3%) worked in an acute setting while the others (16.7%) worked in a non-acute setting (Figure 8-6). In relation to the size of hospitals, among 18 ex-infection control nurses, 5.6% worked in a setting with fewer than 250 hospital beds, 16.7% worked in a setting with 251-500 beds, 22.2% worked in a setting with 501-750 beds, 5.6% worked in a hospital with 751-1,000 beds, and 50.0% worked in a hospital with more than 1,000 beds (Figure 8-7).

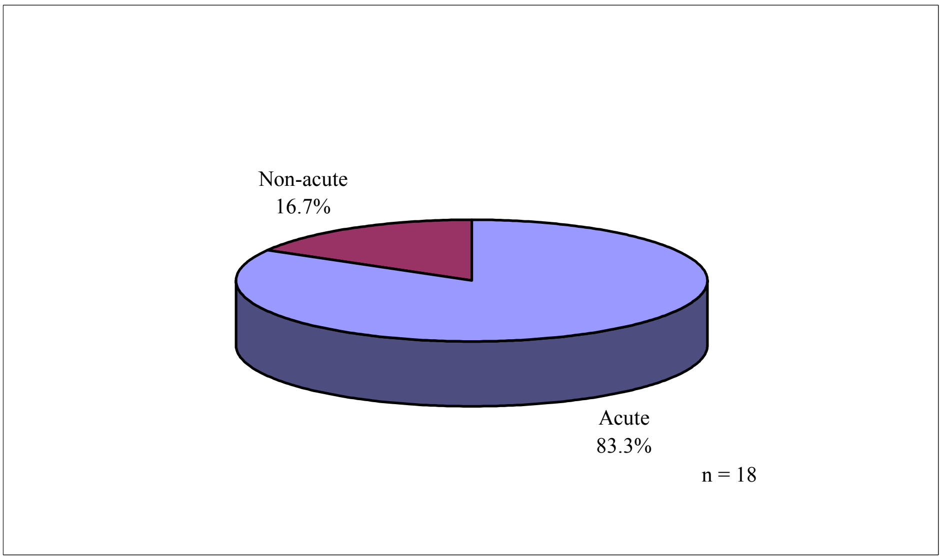

Figure 8- 6: Distribution of ex-infection control nurses by hospital setting

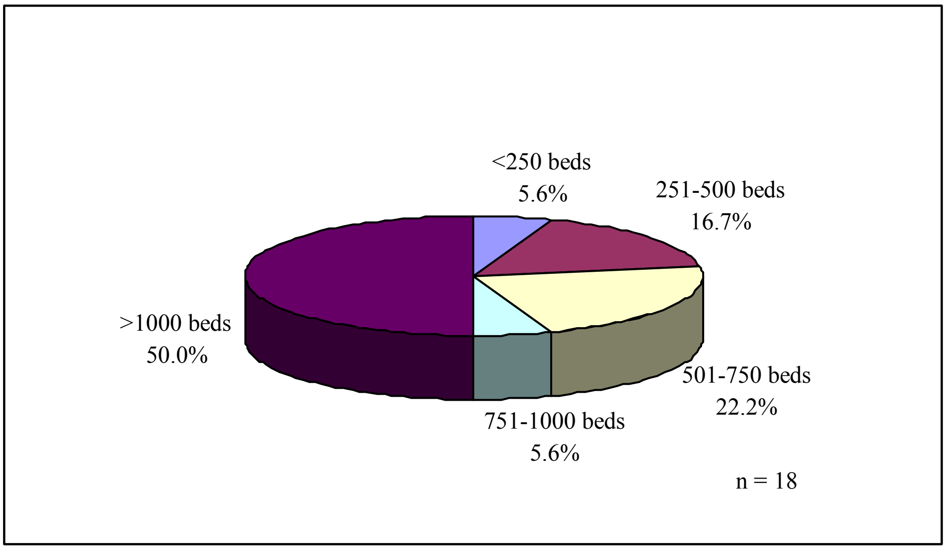

Figure 8- 7: Distribution of ex-infection control nurses by hospital size

The demographics of the samples of ex-infection control nurses and current infection control nurses in the field were comparable. Both were dominated by female staff, working in public hospitals and full-time infection control nurses.

4.2 Reliability

4.2.1 Internal Consistency

The summary statistics for 18 ex-infection control nurses and 64 core competency items are displayed in Appendix 8-4. The Cronbach's alpha for the first returns of 18 ex-infection control nurses for 64 items was 0.98. Values for person reliability by Winsteps ranged between 0.96 and 0.97.

4.2.2 Test-Retest Reliability

With only 17 completed second questionnaires, 17 pairs of data were used to check the test-retest reliability. The means of each item on the first and second tests were calculated. The correlation between two respective means was then compared. Spearman's correlation coefficient was 0.839 (p<0.000) (Table 8-9). The result supported good to excellent relationship between the means of two returns (Portney and Watkins, 2000). The questionnaire, including the content and rating scale was capable to measure the core competency items consistently even they were repeatedly measured.

Table 8- 9: Statistics table for Spearman's correlation coefficient

Correlations

			TEST	RETEST
Spearman's rho	TEST	Correlation Coefficient	1.000	.839**
		Sig. (2-tailed)	.	.000
		N	64	64
	RETEST	Correlation Coefficient	.839**	1.000
		Sig. (2-tailed)	.000	.
		N	64	64

**. Correlation is significant at the .01 level (2-tailed).

4.2.3 Rating Scale Diagnostics

Next we come to rating scale diagnostics. The analysis was based on the first returns of 18 subjects. Their 5-category rating responses to the 64 draft competency items were summarized in Table 8-10. Among the five rating categories, only four were used. No item was rated as "not very important". Only two frequencies were rated as "not important". This illustrated that all 18 ex-infection control nurses generally agreed with the draft core competency items that were identified by literature review and more importantly were further validated and modified by the Delphi experts.

Table 8- 10: Summary of category structure

Category		Observed		Rasch-Andrich threshold
Rating	***Label***	***Count***	***%***	
1	Not very important	0	0	-
2	Not important	2	0	None
3	Undecided	46	4	-2.97
4	Important	585	51	-0.98
5	Very important	519	45	3.95

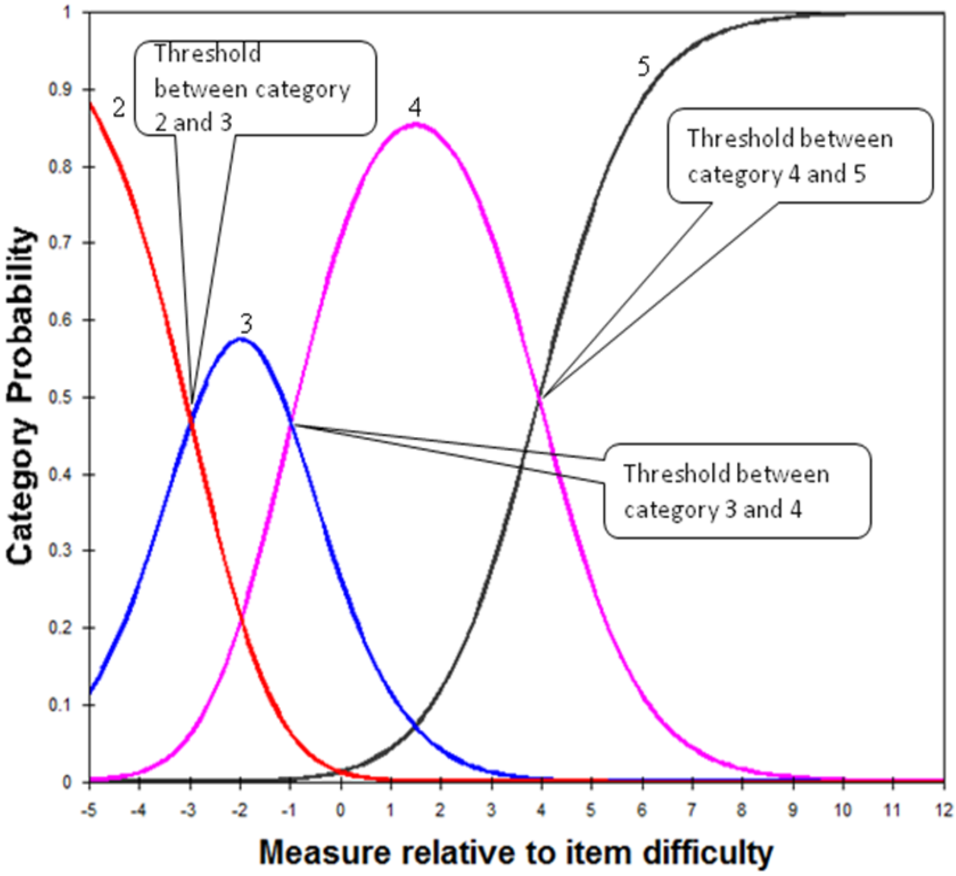

Figure 8- 8: Category response curves of the rating scale (Reliability test)

Figure 8-8 shows the category response curves of the 5-category rating scale. Omitting category 1, the other four categories had their own distinct peaks in the curves. The Rasch-Andrich thresholds were presented at the intersections of rating categories. The threshold of rating 2/3 was at -2.97 logits. The threshold of rating 3/4 was at -0.98 logits. The threshold of rating 4/5 was at 3.95 logits. When examining the Rasch-Andrich thresholds, they increased monotonically from –2.97 to 3.95 showing that the scale was ordered. The two distances between these 3 thresholds was 3.95 and 4.93 logits respectively.

They were between 1.4 and 5.0 logits. In other words, the thresholds between categories were within the optimal distance (Bond & Fox, 2007). This illustrated that each category defined a distinct position on the scale. These findings showed that this 5-category rating scale of the questionnaire was functional.

4.2.4 Double-barrelled Items and Other Literacy Problems

During the friendly discussion with the ex-infection control nurses who participated in this reliability study, comments on double-barrelled questions were received. A double-barrelled question means that the question contains more than one question and more than one answer may be anticipated. Such question may induce ambiguous answers or may result in inaccurate measurement. All the 64 draft competency items, especially those with the grammatical conjunction “and” were re-examined. At last, 11 double-barrelled items and five triple-barrelled items were found. They were split and were re-numbered as shown in Appendix 8-5.

Two original draft core competency items “(62) advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control” and “(63) update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meeting” were combined to be a new proposed item “(82) advance the relevant knowledge and skills through educational programmes, peer networking, internet access, published literature, and/ or professional meetings” due to similarity of meaning.

Finally, 64 draft competency items were split to 83 items to ensure conveying clear message in the studies. Among the 64 items, four items were rephrased to ensure their clear meaning. They are listed in Table 8-11.

Table 8- 11: Rephrased items

Original item	**Re-phrased item**
(21) Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications and make application to, modify or incorporate into own infection control programme to meet an evidence based practice	28) Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme
(31) Collaborate the integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures	43) Integrate and pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures
(39) Identify the needs of involvement of other parties in the infection prevention and control programmes	52) Recruit other relevant parties to involve in the infection prevention and control programme if necessary
(40) Coordinate and participate in inter-departmental and organization’s infection prevention and control improvement activities	53) Participate in inter-departmental and organization’s infection prevention and control improvement activities

After the above polishing exercise, the proposed core competency of infection control nurses containing 83 items were finalized, and they are listed in Appendix 8-6.

5 Discussion

In identifying the draft core competency, two rounds for categories and two rounds for items were needed to achieve consensus in Delphi process. This indicated that both the preliminary core competency categories and items derived by literature review nearly fitted the experts' thinking. This may reflect that the development of infection control in Hong Kong is similar to the overseas pioneering countries. The establishment and publications of recommended activities of local infection control service after Severe Acute Respiratory Syndrome era also facilitated the identification of core competency categories and items in this research.

The response of the experts in Delphi survey was satisfactory. All of them participated in all rounds except one declined in Round 2, and as a result the response rate dropped from 100.0% to 83.3%. Although one expert dropped out in Round 2, the recommended response rate (above 70%) still be maintained (Hasson, Keeney & McKenna, 2000).

Although Delphi survey was used to achieve consensus among experts, disagreement in some occasions occurred. The free-marginal multi-rater Kappa for 51 items between six panel experts of 0.84 indicated an excellent agreement among them (Cicchetti, 1984; Randolph, 2008). Free-marginal Kappa is applied when the raters are not forced to assign a certain number of cases to each category, like this study. The Kappa of 0.84 in this study informed that the 51 draft core competency items were well accepted among the experts.

The draft core competency (categories and items) for infection control nurses in Hong Kong was identified by literature review and the Delphi expert survey. It was the predecessor of the proposed core competency, i.e. the questionnaire content of field practitioners' opinion survey. Its content validity must be assessed. In the developmental stage of this study, the Delphi process, the free-marginal multi-rater Kappa of the 51 draft competency items was 0.84, showing an excellent agreement between experts and quantifying the content validity (Cicchetti, 1984; Randolph, 2008). As a result, all 51 draft competency items were kept. Due to double-barrelled problem, the core competency items were split to 64 items for further assessment.

In the judgmental stage, the content validating, the scale-level content validity indices (CVIs) were established by three experts with two different methods. The results were 0.75 and 0.90 respectively. The value of 0.75 was only fairly satisfactory while 0.90 was considered as achieving the standards, as 0.8 was required in normal situation (Grant & Davis, 1997; Polit & Beck, 2004). These results were conflicting and confusing. In this situation, the Kappa coefficients provided additional information on the content validity, which enhanced the quality of decision making on adding or disposing of items during the core competency identification. The free-marginal multi-rater Kappa showed 0.67, which representing a good level of agreement (Cicchetti, 1984). With the conflicting scale-level CVIs but good level of experts' agreement, I decided to keep all 64 draft items. This conservative manner to reject items was adopted in Phase One. It mainly avoided disposing important core competency items at the early phase of competency identification. Moreover, there was an objective measurement approach for decision making using Rasch measurement in Phase Two.

The test-retest reliability of the draft core competency scale was found as good. Person reliability estimates in Rasch measurement serves the same function as Cronbach's alpha. The Rasch analysis presented both estimates. The Cronbach's alpha, was 0.98, while person reliability lay between 0.96 and 0.97. Because of the different computing methods of the two parameters, Cronbach's alpha usually overestimates the value. Anyway, either parameter showed excellent internal consistency of the scale.

Rasch measurement has the work to check the function of the rating scale. The analysis showed that the proposed 5-point Likert scale on importance was functional. Each category had its distinct position in the scale. It deserved to be used in the opinion survey in Phase Two. However, the neutral point of "undecided" in the scale sent negative sense to the participants, such as do not know how to respond, or do not fulfil the responsibility of completing the questionnaire. For this, the context of neutral point was changed to "neutral" in Phase Two survey, to avoid the negative feelings of the participants.

6 Conclusion

Phase One developed the instruments for the infection control nurses' opinion survey in next phase. For developing the questionnaire content, that was proposing the infection control nurses' core competency using the role delineation guided by D'Costa (1986). The preliminary core competency of infection control nurses was comprehensively collected through literature review. Delphi group was invited to assess the preliminary core competency list. Consensus was achieved among the expert group to create a draft core competency of infection control nurses with 51 items in 11 categories. Double-barrelled items were split resulting in 64 draft items. These draft core competency items were transformed into different questionnaires to test their validity and reliability. These procedures confirmed the variables to be measured in the Phase Two and ensured the measuring scale and tool was capable. Due to limited number of infection control nurses in Hong Kong, ex-infection control nurses were invited to participate in the study of establishing the reliability. The quality of content validity was confirmed by free-marginal multi-rater Kappa in addition to content validity indices. Although values of some indices were conflicting, all 64 draft items were retained as the proposed core competency of infection control nurses. Conservative approach was used to reject the competency items in this phase of study. After a second review by investigator, some of the 64 proposed items were split because of double-barrelled/ triple-barrelled statements, and it resulted in 83 proposed core competency items of infection control nurses finally.

Phase One demonstrated the importance of literature inputs and expert inputs in identifying core competency, using the concept of role delineation (D'Costa, 1986). In the process of developing content blueprint of certification programme, literature inputs and expert's inputs provide links between the practice of infection control nurses and the content of their certification programme. A valid certification programme reflects professional practice. It is important to link up the entire programme developing steps to the practice (Larson et al., 1988). In the next chapter, I will report the findings of Phase Two, where the concept of role delineation was continued to confirm the core competency items by integrating the input from field practitioners.

CHAPTER 9

PHASE TWO — RESULTS AND DISCUSSION

1 Introduction

In Phase One, I established 83 proposed core competency items of local practices of infection control nurses. Phase Two extended my research by an opinion survey of the field practitioners (i.e. infection control nurses). This chapter reports the results of opinion survey. This is a significant chapter because the data of this opinion survey were objectively analyzed by Rasch measurement and its findings informed firstly in the territory the competency of Hong Kong infection control nurses. I start by describing the response rate and demographic information of Hong Kong infection control nurses. I then report the findings of this opinion survey mainly analysed by Rasch measurement. Lastly, I conclude this chapter by comparing the infection control practices of Hong Kong, with those of the United Kingdom and of the United States of America.

2 Findings from the Opinion Survey

The questionnaire of the opinion survey itself gave three types of data, namely demographic indicators, competency items and perceived important levels.

2.1 Response Rate and Coverage Rate

The response rate and the coverage rate of this population survey of Hong Kong infection control nurses were 81.25% and 77.78% respectively.

According to the name-lists provided, after excluding the experts and line managers, there were 117 potential participants who were on-the-job infection control nurses by the time of September 2008, 28 (23.9%) infection control nurses from private hospitals and 89 (76.1%) infection control nurses from public hospitals. One potential participant from a private hospital could not be contacted via both email and telephone. As a result, 116 invitations were made. Four of 116 potential participants (one from private hospital and three from public hospitals) refused to participate in the survey, and 112 provided their consent to participation. As a result, 112 questionnaires were sent out, 91 were returned, and the response rate was 81.25% (91/112). For an email survey, it was a very good response (The University of Texas at Austin, Division of Instructional Innovation and Assessment, 2007), as against the response rate of 27.5% for the 2009 practice analysis survey conducted by Certification Board of Infection Control and Epidemiology, Inc. (Feltovich & Fabrey, 2010). In addition, the 91 participants, who returned the questionnaire, represented

77.78% (91/ 117) of all potential participants of this survey (coverage rate): all working infection control nurses in Hong Kong in September 2008.

2.2 Demographics

The findings of demographic data provided information for subsequent sub-group analysis in the study. By using SPSS version 15.0, the frequency and percentage of demographics data were analyzed and they are summarized in Table 9-1. Note that not all indicators included all 91 participants because there were missing data. Sample ceiling or floor effects were not a consideration as entire population rather than a sample of infection control nurses were included in this study.

Table 9- 1: Demographics of infection control nurses (ICNs)

Demographics (N = 91, unless specified)		Number	%
Sex	Male	9	9.9
	Female	82	90.1
Age	21-30 years	4	4.4
	31-40 years	45	50.0
	41-50 years	36	40.0
	51-60 years	5	5.6
	Missing	1	---
Rank	Registered Nurse	45	49.5
	Senior Registered Nurse	3	3.3
	Nursing Officer or equivalent	39	42.9
	Senior Nursing Officer	1	1.1
	Ward Manager	1	1.1
	Practice Manager	1	1.1
	Coordinator	1	1.1
Highest academic qualification	Certificate	2	2.2
	Diploma	3	3.3
	Bachelor	47	51.6
	Master	39	42.9
Infection control trained	Yes	85	93.4
	No	6	6.6
Work modality	Full-time	65	71.4
	Part-time	26	28.6
Proportion of work time of part-time ICN (n=24)	<=20%	9	37.5
	21-40%	9	37.5
	41-60%	4	16.7
	61-70%	2	8.3
	Missing	2	---
Working experience in equivalent-years	< 5 years	57	64.0
	5-9 years	20	22.5
	10-14 years	10	11.2
	≥ 15 years	2	2.2
	Missing	2	---
Hospital funding	Public	71	78.0
	Private	20	22.2
Hospital setting	Acute	60	66.7
	Non-acute	30	33.3
	Missing	1	---
Hospital size (patient-beds)	≤ 250	16	17.6
	251-500	18	19.8
	501-750	12	13.2
	751-1000	6	6.6
	≥ 1000	39	42.9

2.2.1 Sex and Age

Of 91 participants, 82 (90.1%) were female. There were 90 infection control nurses (while missing one participant) aged between 21 and 60 years and 90% of them were between 31 and 50 years old.

2.2.2 Rank

The 91 infection control nurses included registered nurses, senior registered nurses, nursing officers or equivalent, senior nursing officers, ward managers, practice managers and coordinator. For this study, the junior rank, registered nurse, accounted for 49.5% of the respondents.

2.2.3 Highest Academic Qualification

The infection control nurses' highest academic qualification, from low to high, included certification, diploma, bachelor's degree and master's degree. 42.9% of participants held a master's degree.

2.2.4 Professional Training

Most (93.4%) of the infection control nurses were professionally trained in infection control.

2.2.5 Work Modality

Sixty-five (71.4%) participants were full-time infection control nurses and 26 (28.6%) infection control nurses worked part-timely. In relation to the time spent in infection control work of part-time infection control nurses, it ranged between 10% and 70% of their total working hours (n=24; mean 31.3%;

standard deviation [SD] 18.2%). As shown in Figure 9-1, nine (37.5%) of them worked 20% or less of their work time as infection control nurses, another nine (37.5%) worked for 21-40%, four (16.7%) worked for 41-60% and two (8.3%) spent 61-70% of their work time as infection control nurses.

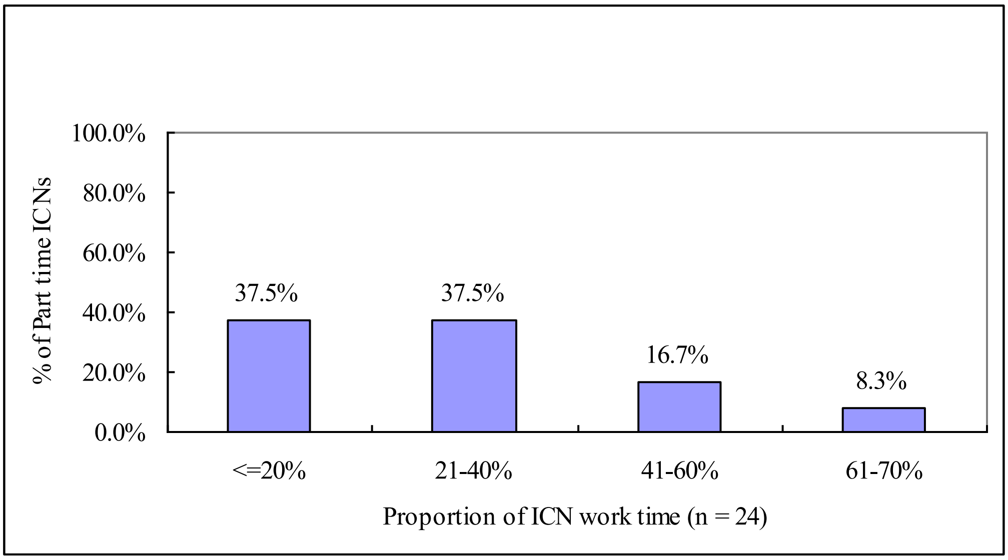

Figure 9- 1: Work time proportion of part-time infection control nurses (ICNs)

2.2.6 Work Experience in Infection Control

Of both full-time and part-time 91 infection control nurses, the mean work experience was 5.19 years (SD 4.27). It ranged from less than one year to 20 years.

Since the work experience in years of part-time infection control nurses did not tell directly their infection control-work experience in years, the infection control-work experience equivalent-year was calculated. It was obtained by multiplying the years of work experience by the proportion of infection control-work time. For example, if a part-time infection control nurse works as an infection control nurse for eight years but spent only 40% of work time on infection control, the equivalent-years of infection control nurses is 3.2 (8 years x 0.4). With this transformation, the mean work experience in equivalent-year of 89 infection control nurses (missing data in two part-time infection control nurses) was 4.36 (SD 4.15). The majority of infection control nurses (64.0%, 57 out of 89) had less than five equivalent-years of experience.

2.2.7 Hospital Information

Most (78.0%) of the infection control nurses worked in public hospitals, as against 20 (22.2%) in private sectors. This public/ private hospitals distribution is similar to that of the population of infection control nurses (76.1% vs. 23.9%) showing that the sample bias from participants regarding public/ private settings was limited.

The participants worked in hospitals of various sizes, which were arbitrarily divided into 5 groups. They were 250 or fewer patient-beds hospitals (16, 17.6%), 251-500 patient-beds hospitals (18, 19.8%), 501-750 patient-beds hospitals (12, 13.2%), 751-1,000 patient-beds hospitals (6, 6.6%) and more than 1,000 patient-beds hospitals (39, 42.9%). The last group, more than 1,000 patient-beds, was treated as large size, and the others were small-size hospitals. There were a greater proportion of participants worked in small-size hospitals. (small vs. large, 57.1% vs. 42.9%)

Of the 90 infection control nurses (98.9%, with one missing data) answering about hospital settings, 60 (66.7%) worked in acute hospitals (i.e., with a 24-hour Accident and Emergency Department (AED)) and 30 (33.3%) worked in non-acute settings (no AED).

2.2.8 Findings of Subgroups

By examining the demographic findings, participants of this survey did come from a wide range of backgrounds. It is observed that their backgrounds may influence their responses of perceived importance to core competency items. I arbitrarily identified seven pairs of subgroups of the participants (Table 9-2). These subgroups were used to subsequent analyses to check if a unique certification programme/ content blueprint is sufficient.

Table 9- 2: List of subgroups of infection control nurses (ICN-subgroups)

ICN-subgroup	Classification	
Rank	Junior rank (registered nurses)	Senior rank (other than registered nurses)
Qualification	With master's degree	Without master's degree
Infection control trained	Yes	No
Work experience	Inexperienced (Less than 5 equivalent-year)	Experienced (equal to or more than 5 equivalent-year)
Work modality	Full-time	Part-time
Hospital care type	Acute hospital	Non-acute hospital
Hospital funding	Public	Private

2.3 Rasch Analysis (Core Competency Items and Perceived Importance)

The 91 returned questionnaires provided a complete data set of 91 importance-responses in 5 categories to each of the 83 core competency item-questions. To inform a comprehensive list of perceived importance-core competency items for infection control nurses, it is preferable to have a collective perceived importance-response to each of the 83 competency items and these perceived importance-responses are on interval scale. The collective perceived importance-responses facilitate future selecting core competency items according to their importance, while the importance-responses on an interval scale make the calculation of content weights more straight-forward for developing certification content blueprints/ programmes. The survey raw data provided 91 responses to each of core competency items across 5 categories (ordinal scale). Hence, Rasch measurement was used to analyze the data of competency items and their perceived importance-responses.

2.3.1 Person Statistics

In raw data, there were 91 returned questionnaires, and each contained 83 perceived importance-responses to the item-questions. Based on the 83 responses of each participant, Rasch measurement reported the 91 person estimates (in logits). The person estimates are the positions of the participants presenting the extent to which they endorsed the items as important items. They were linear relationship lying on a scale, which was easy for managing (Granger, 2007). The summary statistics are tabulated in Appendix 9-1 and person statistics are put in Appendix 9-2.

Among 91 returned questionnaires, one rated all 83 items to category 5 of "very important" (maximum extreme score). The person rating the same categories over the questionnaire did not contribute any useful information to the analysis, i.e., which core competencies are more important. This response was treated as unhelpful and the raw data was disregarded during data analysis automatically by Rasch measurement because the standard error of such person measures tends to be very large thereby giving little information about the person's actual location (Schumacker & Smith, 2007). As a result, only 90 participants' information contributed to this analysis, and they made up 99.9% valid responses. Overall, referring to the summary statistics, the mean person estimate was 2.68 (SD 1.70) – the sample found it easy to endorse most items as important. Both infit and outfit mean squares were 1.01. The infit *t*-value was –0.2 and the outfit *t*-value was –0.3. Basically, the mean squares at the values of around one and *t*-values at around zero showed the person data fit the model in general.

With the misfit diagnosing criteria I set in this study (infit *t*-values greater than 2.0 and infit mean squares greater than 1.33), 15 potentially misfitting persons were identified from the Winsteps output (Appendix 9-2). Note that the maximum extreme score-person was not identified as misfit, and the remaining 76 fitting persons included overfitting persons and the maximum extreme score-person.

Further examination for these 15 misfitting persons was carried out. To find out the different characteristics between the fitting group and the misfitting group, I compared their demographic factors. The Chi-square and Fisher Exact tests were used for testing their associated factors, and they were calculated by Epistat version 1985. The tested factors included: not infection control trained, inexperienced (less than five equivalent-years of experience), junior rank (Registered Nurse), non-master degree holder, part-time, non-acute setting, small hospital size (≤ 1000 beds) and private hospitals. There were no associated factors for the 15 misfitting persons (Table 9-3). It was concluded that 15 (16.5%) misfitting persons were confirmed based on the Rasch analysis. No associated factors were found.

Table 9- 3: Association tests for misfitting persons

Factors	Test	*p*-value
Not infection control trained	Fisher exact	0.672
Non-experienced (<5 equivalent-year)	Chi-square	0.378
Junior rank (Registered Nurse)	Chi-square	0.604
Non-master degree holder	Chi-square	0.892
Part-time	Fisher exact	0.321
Non-acute setting	Fisher exact	0.062
Small hospital size (≤ 1000 beds)	Chi-square	0.323
Private hospital	Fisher exact	0.306

2.3.2 Item Statistics

In relation to the same data set (91 infection control nurses, 83 item-questions), Winsteps also reported 83 item-estimates. The value of each of item-estimate was equivalent to the collective importance-responses of 91 participants to an item-question. Winsteps provides statistics of item-estimate to examine their fit to the Rasch model. The summary statistics provide an overall performance of all items in the model for an analysis (Appendix 9-1).

2.3.2.1 Analysis on 91 Persons and 83 Items

The mean measure for item was 0.00 (default) and the standard deviation was 0.79. The maximum item measure was 1.72 (Item 78: Demonstrate knowledge of biostatistics) and the minimum was –2.13 (Item 74: Demonstrate knowledge of infectious diseases). The averages of the infit and outfit mean squares were 1.00 and 1.01 respectively, while the mean infit and outfit *t*-values were –0.1 and 0.0 respectively. In summary, the items fit the model. The standard deviation of 0.79 showed the items were less diversified in importance than might have been hoped. The summary statistics of this set of data (91 persons and 83 items) by Winsteps' output can be found in Appendix 9-1.

By using the same misfit diagnosing criteria as for the person-estimates analysis: infit *t*-values greater than 2.0 and infit mean squares greater than 1.33 (Bond & Fox, 2007; Wilson M, 2005), individual fit statistics of 83 items were examined (Appendix 9-3). Seven items exhibited misfit. One was considered as having marginally satisfactory fit, because of the high infit mean squares (1.36) only but acceptable infit *t*-value (2.0). It did not fulfill the misfit criteria of this analysis. The outfit statistics of this satisfactory-fit item was further examined. Its outfit mean square (1.30) and outfit t-value (1.4) were within acceptable range, thus it was concluded to be fitting. The remaining 75 items showed good fit, and among them, 13 items were overfitting. In this analysis, 7 misfitting items, which are listed in Table 9-4, were identified.

Table 9- 4: Misfitting items under the analysis of 91 persons and 83 items

Misfitting item	Description
11	Give recommendations to clients during reporting the surveillance findings.
30	Integrate relevant public health issues into practice when applicable.
44	Seek opportunities to influence policymakers.
46	Consider financial implications when initiating changes in practice.
47	Evaluate the use of technology or products to achieve cost-effective purpose.
79	Have two to five years of experience in infection control practice.
81	Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.

2.3.2.2 Analysis on 76 persons and 83 items

From the above analysis, there were 15 misfitting persons and 7 misfitting items in the original data set according to Rasch model. After removing the 15 misfitting persons, I performed a second analysis. This time, 76 persons were left in the data pool, and 83 items still remained (data of 76 persons and 83 items). The summary statistics for 76 persons and 83 items are shown in Appendix 9-4. The mean measure for items was 0.00 (default) and the standard deviation was 0.89. The maximum item-measure was 1.90 while the minimum was –2.36. The infit and outfit mean squares were 1.00 and 1.01 respectively, while the infit and outfit *t*-values were both –0.1. The data fit in overall picture.

The fit statistics of individual 83 items are detailed in Appendix 9-5. With the misfitting persons removed, six items exhibited misfit. One item was found to have marginal fit - higher infit and outfit mean squares (1.35 and 1.40) but acceptable *t*-values (Infit 1.7 and outfit 1.5). 76 items showed good fit to the model (including 9 overfitting items). The marginal fit item was "Item 6: Select a database(s) that ensures efficient data management for surveillance". Its two out of four fit statistics were misfitting. I decided to treat the only one marginally fitting item as misfitting item as the item content might refer to an information technology personnel rather than an infection control nurse. As a result, 7 misfitting/ marginally fitting items were obtained in this analysis and they are listed in Table 9-5. In contrast to the findings of the first analysis (Table 9-4), item 44 "seek opportunities to influence policymakers" showed fit, while item 6 "select a database(s) that ensures efficient data management for surveillance" became misfitting in this analysis. The performance of item 44 and item 6 were influenced by the misfitting persons. Removing the misfitting persons better confirmed these items' performance.

Table 9- 5: Misfitting/ marginally fitting items under the analysis of 76 persons and 83 items

Misfitting/ marginally fitting items	Description
6*	Select a database(s) that ensures efficient data management for surveillance.
11	Give recommendations to clients during reporting the surveillance findings.
30	Integrate relevant public health issues into practice when applicable.
46	Consider financial implications when initiating changes in practice.
47	Evaluate the use of technology or products to achieve cost-effective purpose.
79	Have two to five years of experience in infection control practice.
81	Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.

* Fitting item in the analysis of 91 persons and 83 items

Removing the misfitting (or erratic) items based on the findings of second analysis did not compromise the integrity of the overall core competency scale because other better fitting items were located close to the removed items. Therefore, a further seven misfitting/ marginal fit items were then removed, leaving 76 items exhibiting sufficient fit to the Rasch model for the purpose of constructing a list of competency items for Hong Kong infection control nurses.

<u>2.3.2.3 Analysis on 76 persons and 76 items</u>

According to the findings of the first and the second analysis, by removing 15 misfitting persons and then the seven misfitting items from the original data set, the data pool remained 76 persons and 76 items for constructing competency scale in this analysis.

In this 76-person-76-item data set, the maximum extreme score-person who rated the "very important" category over all 83 item-questions in the returned questionnaire still remained. In its summary statistics generated by the Winsteps (Appendix 9-6), only 75 persons contributed to this analysis with valid responses of 99.9%. The item measures ranged from 1.90 (Item 78: Demonstrate knowledge of biostatistics) to –2.36 logits (Item 74: Demonstrate knowledge of infectious diseases), and the mean measure located (by default) at -0.01 (SD 0.89). Infit mean square was 0.95 and the corresponding infit *t*-value was –0.3. The data generally fit to the Rasch model. Items were relatively clustered together as the standard deviation (SD) was less than one.

The item statistics for individual 76 items were tabulated in Appendix 9-7. This analysis found no more misfitting items. Figure 9-2 presents the item pathway of the 76 items and 76 persons. The majority of items lie between the boundaries of infit *t*-value of –2 and +2. Eight items sit beyond the infit t-value –2 (from –2.0 to –3.3) having small infit mean squares (0.48 – 0.70) showing that these are the overfitting items. The overfitting items are items that fit to the Rasch model better than expected, exhibiting a Guttman-like response pattern (Bond & Fox, 2007). Items with infit *t*-values equal or less than –2.0 meaning that the data is too predictable that other dimensions may be forcing the response patterns (Linacre, 2002). Another six items exhibit low infit mean squares (0.65 - 0.70) but having acceptable *t*-values. As their infit mean squares share between the values of 0.5 to 1.5, the items are still productive for measurement of the core competency scale in this analysis (Linacre, 2002). All these overfitting items were kept to avoid deleting any important items on the core competency scale. By removing the misfitting persons and the misfitting items, the core competency scale in logits was constructed based on 76 item and 76 person estimates. The 76 items located between -2.36 logits and 1.9 logits (item-measures) on this core competency scale, where the lower value of item measures, the greater is the perceived important of the items to these infection control nurses, and vice versa.

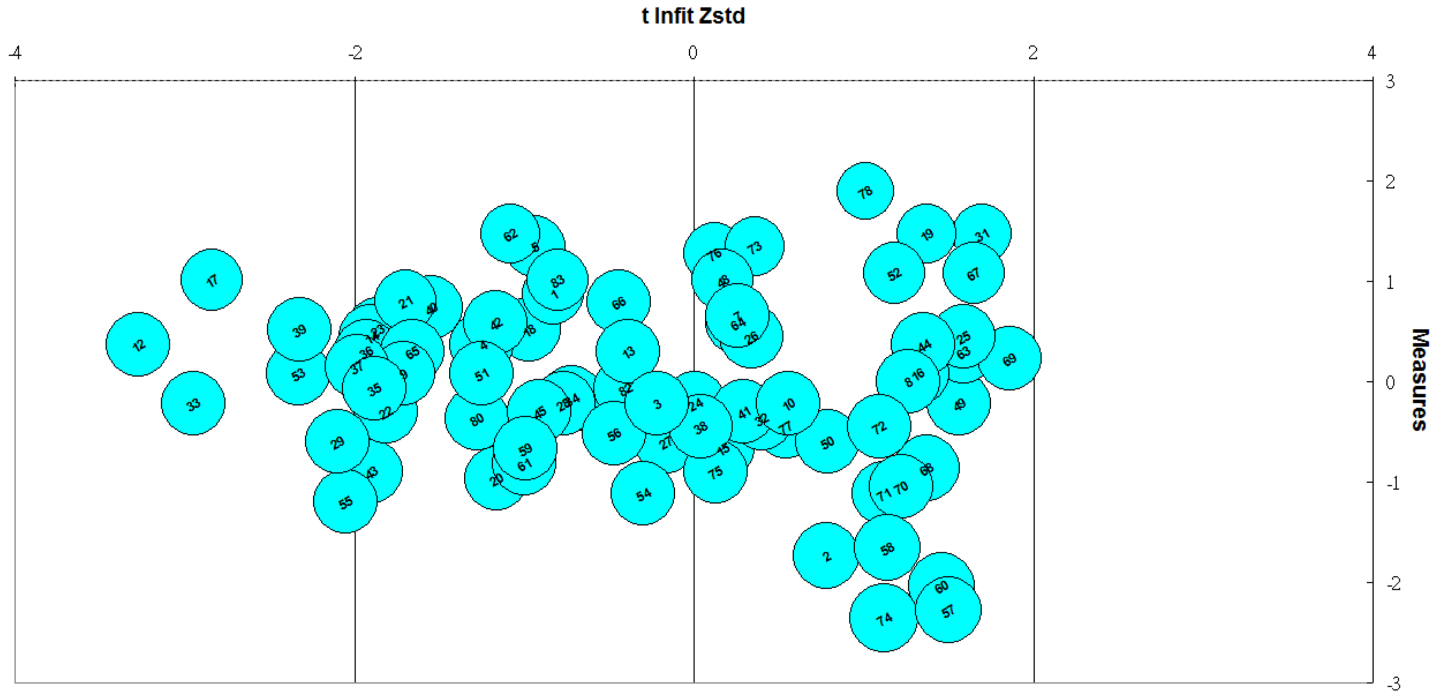

Figure 9- 2: Item pathway of 76 items and 76 persons

2.3.3 Differential Item Functioning (DIF)

There were 6 person-subgroup pairs for differential item functioning analysis. The definitions of subgroups are detailed in Table 9-6.

Table 9- 6: Definitions of subgroups for differential item functioning analysis

Classification	Subgroup-pairs	
Experience	Experienced (less than 5 equivalent work-year)	Inexperienced (more than 5 equivalent work-year)
Rank	Junior rank (Registered Nurses)	Senior rank (other senior posts)
Qualification	With master degree	Without master degree
Work-time	Full-time	Part-time
Hospital care type	Acute hospital	Non-acute hospital
Hospital funding	Public	Private

DIF was estimated between experienced and inexperienced infection control nurses (Experienced infection control nurses were defined as who having five or more equivalent-years of experience), senior and junior rank infection control nurses (junior rank was defined as Registered Nurse while others with supervisory roles were defined as senior ranks), with and without master's degree, full-time and part-time infection control nurses, those working in acute and non-acute hospital, and between public and private hospitals infection control nurses.

The summary of findings is tabulated in Table 9-7. No significant DIF contrast was identified in experience/ inexperience subgroups or acute hospital/ non-acute hospital subgroups. One DIF item was found in junior/ senior rank subgroups (Item 4). Seven DIF items were identified in with/ without master degree subgroups (Items 7, 16, 28, 29, 32, 49 and 72). Three DIF items were found in full-time/ part-time subgroups (Items 1, 44 and 70). Five DIF items were found in public/ private hospital subgroups (Items 2, 22, 26, 70 and 72). It is observed that two DIF items (item 70 and item 72) were identified simultaneously in two different subgroup-analyses. In total, 14 DIF items (18.4% of 76 items) were found. The description of DIF items is shown in Table 9-8.

Table 9- 7: Summary of differential item functioning analysis

Subgroups	No. of item with DIF contrast > 0.5 logits	Significant DIF item
Experienced vs. inexperienced	25	---
Junior vs. senior rank	31	4
With vs. without master degree	32	7, 16, 28, 29, 32, 49, 72
Full-time vs. part-time	34	1, 44, 70
Acute vs. non-acute hospital	21	---
Public vs. private hospital	39	2, 22, 26, 70, 72

A DIF contrast can have positive and negative values. DIF contrast was obtained using the DIF measure of first person class minus the DIF measure of the second person class. Thus, a positive DIF contrast means the first person class had higher item difficulty measure than did the second person class, meaning that the first person class perceived the item as less important, because larger the item measure, the perceived less importance the item. DIF contrasts and the direction of perception of DIF items in the results of pairwise comparisons were examined. Based on the sign of the DIF contrast, the direction of perception was interpreted. The DIF contrast was obtained using the DIF measure of first person class minus the DIF measure of the second person class. So, a positive DIF contrast means the first person class had greater value of DIF measure than the second person class, meaning that the first person class perceived the items less important, because larger the item measure, the perceived less importance the item. The significant results are tabulated in Table 9-8. The DIF contrasts in the table were the absolute values. The directions of perceptions between subgroups were interpreted in the corresponding DIF items. Appendices 9-8 to 9-13 show the statistics of pairwise comparisons of DIF items. The graphic presentations of DIF analysis based on each pair of subgroups are presented from Appendices 9-14 to 9-19.

Table 9- 8: Differential item functioning contrast and the direction of perception of differential item functioning items

DIF item		DIF contrast	Subgroup perceived the item more important (n)	Subgroup of harder to endorse as important item (n')
1	Design a surveillance plan for the served population(s) using epidemiological principles.	-0.60	Part-time (26)	Full-time (65)
2	Use standardized definitions to conduct surveillance.	2.20	Public hospital (71)	Private hospital (20)
4	Select appropriate indicators to benchmark externally.	-0.83	Junior rank (45)	Senior rank 46)
7	Select a database(s) that ensures accurate data management for surveillance.	-1.22	Non-master degree holder (52)	Master degree holder (39)
16	Incorporate the client needs into the programme plan.	1.34	Non-master degree holder (52)	Master degree holder (39)
22	Periodically evaluate the effectiveness of the infection prevention and control programme.	-1.75	Private hospital (20)	Public hospital (71)
26	Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.	-0.68	Private hospital (20)	Public hospital (71)
28	Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	0.54	Master degree holder (39)	Non-master degree holder (52)
29	Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	-1.04	Non-master degree holder (52)	Master degree holder (39)
32	Develop educational objectives and strategies to meet the client needs.	0.59	Non-master degree holder (52)	Master degree holder (39)
44	Seek opportunities to influence policymakers.	1.72	Full-time (65)	Part-time (26)
49	Identify opportunities for service improvement.	0.54	Master degree holder (39)	Non-master degree holder (52)
70	Demonstrate knowledge of asepsis.	-1.03	Part-time (26)	Full-time (65)
		-2.44	Private hospital (20)	Public hospital (71)
72	Demonstrate knowledge of educational skills and tactics.	-0.78	Non-master degree holder (52)	Master degree holder (39)
		0.91	Public hospital (71)	Private hospital (20)

In summary, 14 out of 76 items (18.4%) were detected as showing measurable differential item functioning. Half (7 or 50%) of these DIF items were influenced by non-master/ master degree holder subgroups. Public/ private hospital subgroups affected DIF measures in five items. Full-time/ part-time subgroups influenced three items. Junior/ senior rank influenced only one item. This clearly demonstrated that the academic qualification, hospital setting and rank of infection control nurses influenced the importance perception of some core competency items. However, Mantel-Haenszel test is reliable when the sample sizes of the groups are larger than 300 (Schulz, 1990). When the sample sizes of subgroups are less than 30, the DIF results are less sensitive. In our subgroups, part-time group and private hospital group, the sample sizes were less than 30. Therefore, it should be cautious to read the DIF items in this study as the sample size for whole group or subgroups was sub-optimal.

The aim of this research is to establish a content blueprint of certification programme for the infection control nurses of Hong Kong. Developing different certification programmes for infection control nurses with different ranks, academic qualifications, work modality (full-time/ part-time) and public/ private hospitals would not make sense. A single content blueprint for certification programme for the nursing specialty of infection control is still warranted. In this situation, the average item measures of the whole group were adopted to ensure this is a representative content blueprint of certification programme.

2.3.4 Reliability

2.3.4.1 Person Reliability

Table 9- 9: Person reliability and Cronbach's alpha

	Person reliability of Rasch measurement (true value – model value)	**Cronbach's alpha**
Interpretation	**Excellent when >0.94**	**Up to common standard when >7.0**
91 person-83-item (raw data)	0.97-0.97	0.98
76 person-83-item (excluded 15 misfitting persons)	0.98-0.98	0.98
76 person-76-item (excluded 15 misfitting persons and 7 misfitting items)	0.98-0.98	0.99

Table 9-9 presents the person reliability statistics and Cronbach's alpha throughout the Rasch analysis process and their interpretation. From the summary statistics (Appendix 9-1), when the data set contained 91 persons and 83 items, the person reliability was 0.97 (same upper and lower boundaries) for non-extreme persons (the person with extreme scores was excluded). The Cronbach's alpha was 0.98. After removing the 15 misfitting persons, the person reliability increased to 0.98 (same upper and lower boundaries) and the Cronbach's alpha remained as 0.98 (Appendix 9-4). When 7 misfitting items were further removed, the person reliability (for non-extreme persons) estimated by Winsteps programme remained at 0.98 (same upper and lower boundaries) but the Cronbach's alpha escalated to 0.99 (Appendix 9-6). The person reliability was excellent with the value of 0.98 exceeding 0.94 (Fisher, 2007). Comparing with the conventional test reliability, the Cronbach's alpha in this study was up to the common standard (>0.7) (Rattray & Jones, 2007; Shultz & Whitney, 2005). As there is an extreme person (person rated all items on the same category over the questionnaire) in the data, Cronbach's alpha overestimated the person reliability in this study. Person reliability of Rasch measurement was adopted as the appropriate indicator.

2.3.4.2 Item Reliability

Table 9-10 listed the item statistics and their interpretation throughout the Rasch analysis process. When looking into the item statistics, the initial item reliability was 0.91-0.92 (Appendix 9-1). After removing the misfitting persons, the item reliability reduced to 0.90-0.91 (Appendix 9-4). The item reliability remained to be 0.90-0.91 when the misfitting items were further taken away (Appendix 9-6). The item reliability was considered as very good at 0.90-0.91 (Fisher, 2007). The "very good" item reliability means that the order of item estimates is likely to be replicated when using another suitable sample of infection control nurses. As all the infection control nurses in Hong Kong had been recruited in this exercise, the order of the same item estimates is likely to be replicated if the survey is repeated by the same group of infection control nurses. This also shows that the range of item location (in logit) is wide (Linacre, 2006). As the Rasch reported the wide item location of 4.32 logits (-2.36-1.96), the item reliability was not as high as the person reliability was due to the small sample size (Linacre, 2006).

Table 9- 10: Item statistics and their interpretation throughout the Rasch analysis

Data set	Item reliability of Rasch measurement (true value – model value)	Interpretation
91 person-83-item (raw data)	0.91-0.92	Very good
76 person-83-item (excluded 15 misfitting persons)	0.90-0.91	Very good
76 person-76-item (excluded 15 misfitting persons and 7 misfitting items)	0.90-0.91	Very good

With the "very good" item reliability and "excellent" person reliability, I conclude confidently that the construction of 76-item core competency scale by Rasch measurement on the item location hierarchy is reproducible.

2.3.5 Unidimensionality

Dimensionality is measuring the construct of a test or a scale in general. The principal component analysis of residuals was conducted. According to the standardized residual variance scree plot for 76 persons and 76 items (Appendix 9-20), the principal component analysis of residuals showed that 77.3% of the variance could be explained by the model, and 22.7% was the total unexplained variance. Only 1.7% of total variance, accounting for 7.7% of the unexplained residuals, was left in the second dimension. Based on the literature, a large proportion of variance for more than 60% with less than 5% of residuals of unexplained variance in the first contrast showed the unidimensional scale (Baylor, Yorkston, Eadie, Miller & Amtmann, 2009). The results of this analysis fit these criteria showing that the 76-item core competency scale was unidimensional. Figure 9-3 illustrates the principal component analysis of residual on the first contrast for the 76-item core competency scale. No cluster was identified from the unexplained residuals, as the residuals appeared to be located not different from randomly.

```
      -3           -2           -1             0            1            2
      ++------------+------------+-------------+------------+------------++ COUNT
   .7 +                                        |                          +
      |                   A                    |                          | 1
   .6 +                                        |                          +
      |                                B       |                          | 1
   .5 +              C                D        |                          + 2
C     |                                        |                          |
O  .4 +                        FE              |        G                 + 3
N     |          J                        LKHI |                          | 5
T  .3 +                                 N      M   O                      + 3
R     |                            P           |          Q               | 2
A  .2 +                                  R  U  |         T      S         + 4
S     |                             Z    W    1|XV Y                      | 6
T  .1 +                                    1   |1  1                      + 3
      |                                       1|    1    1                | 3
1  .0 +--------1---------1------1-1--------1---|--1-11-1-----1----------1-+ 11
      |                         1 11           |    11          1         | 6
L -.1 +                                        |      y     z   x w       + 4
O     |                                v s     |u           t             | 4
A -.2 +                                     p  |   o     r        q       + 4
D     |                                     nk |      lm                  | 4
I -.3 +                                        |     i       j            + 2
N     |                                h       |       g    f             | 3
G -.4 +                                        |                          +
      |                                        |                          |
  -.5 +                                     e  |                  d       + 2
      |                                        |                          |
  -.6 +                               c   b    |a                         + 3
      |                                        |                          |
      ++------------+------------+-------------+------------+------------++
      -3           -2           -1             0            1            2
                                 Item MEASURE
 COUNT:        11   1   11    121122 231323612141143332131 32   3 3     1
```

Figure 9- 3: Principal component analysis of residuals for the 76-item core competency scale

2.3.6 Wright Map

Figure 9-4 is an item-person map or Wright map, of the variables. In the middle, it is the core competency scale (established by 76-person-76-item) marking -3 logits at the bottom and 10 logits at the top. The persons map on left side indicates 76 person-estimates and their locations on the core competency logit scale. The right hand side indicates 76 item-estimates and their locations on the core competency scale. Because the values of some person estimates and item estimates were close very much in this survey, the estimates seemingly on the same line horizontally may consist of different values in logits. This Wright map still shows nicely the distribution (spread) of person estimates and item estimates separately. Letters M, S and T on the core competency scale of both persons map and items map refer to their mean measures, one and two standard deviations (SD) from the mean. The mean measure of person estimates locates at 3.11 logits, while the mean measure of item estimates locates at -0.01 logit. Comparing the locations of item mean measure and person mean measure on the core competency scale, revealed that participants in this survey tended to endorse the core competency items as relatively important items.

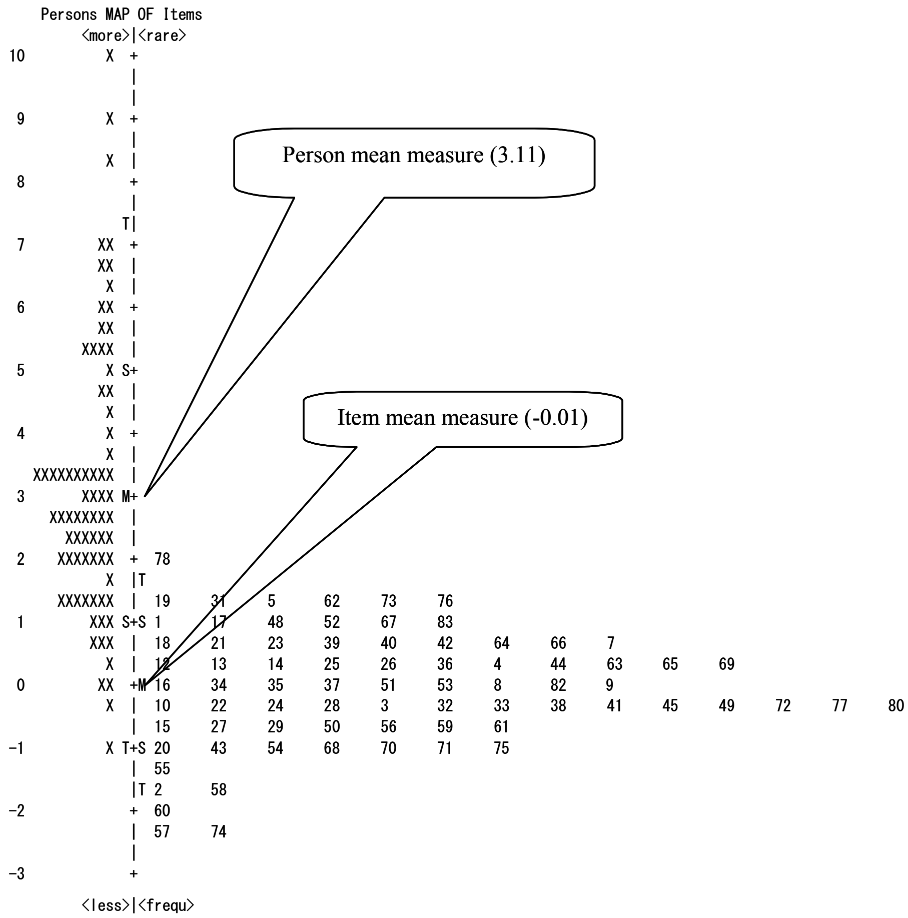

Figure 9- 4: Item-person map (Wright map) for 76-item core competency scale

2.3.7 Rating Scale Diagnostics

The rating scale of survey questionnaire included five categories, namely, (1) not very important, (2) not important, (3) neutral, (4) important and (5) very important. Figure 9-5 shows the frequency of 91 participants' responses across all 83 items to 5 rating categories. Across the five rating categories, the frequency of responses showed a negatively skewed distribution. Although there were five rating categories in the questionnaire, only four categories were used in participants' responses. None of them rated the minimum extreme option (not very important). While “not important” category and “neutral” category accounted for 0.3% (24) and 9.3% (695) of total responses respectively, the “important” category and “very important” category were 57.7% and 32.7%. Apparently, the peak response fell on the “important” category (57.7%). It is usually recommended minimal 10 responses for individual categories of a rating scale in a survey (Bond & Fox, 2007). In current result, participants made zero response to “not very important” category; they tended to rate “important” and “very important” categories up to 90.4% of total responses. This actually showed that participants endorsed the importance of the core competency items very much. It is not a surprised response because the core competency items in this questionnaire were drafted by the infection control experts.

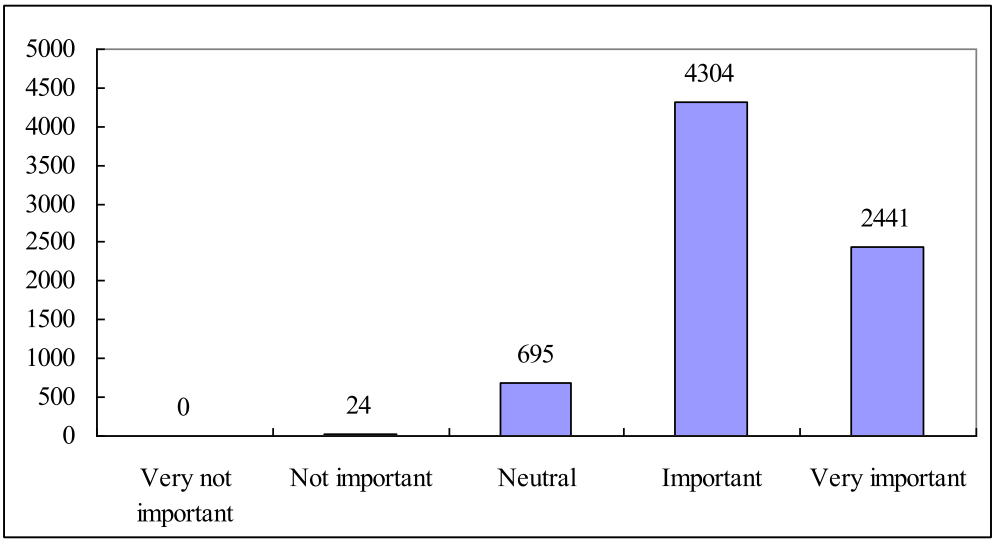

Figure 9- 5: Frequency of category responses across 83 items

Rasch measurement consists of models to handle dichotomous data and multiple-response options data. In view of the 5-category rating scale for perceived importance in this survey, the Rasch Rating Scale Model in Winsteps was used. Based on the given responses of 91 returned questionnaires, Winsteps generated four response-probability curves (Appendix 9-21), and they are re-drawn in Figure 9-6. Each curve represents one rating category. In Figure 9-6, curve 2, 3, 4 and 5 are category 2 (not important), category 3 (neutral), category 4 (important) and category 5 (very important) respectively. The curves exhibit distinct peaks, and three Rasch-Andrich thresholds between adjacent categories are clearly seen. Each threshold shows the level of the likelihood of being observed in a given response category, which is exceeded by the next higher response category. For example, in the probability graph of rating scale (Figure 9-6), threshold 2/3 at -3.19 logits shows the chance of a given response being in category 2 or category 3. Threshold 3/4 and threshold 4/5 locate at -0.44 logit and 3.63 logits respectively. For the given responses of four categories in this survey, there were three thresholds or step calibrations in the structure of rating scale. The distance between threshold 2/3 and threshold 3/4 (2.75) was closer than the distance between threshold 3/4 and threshold 4/5 (4.07), showing that the move from threshold 2/3 to threshold 3/4 was less difficult than moving from threshold 3/4 to threshold 4/5. This uneven step structure demonstrates the reality of an ordinal scale that distances between response-categories are floating.

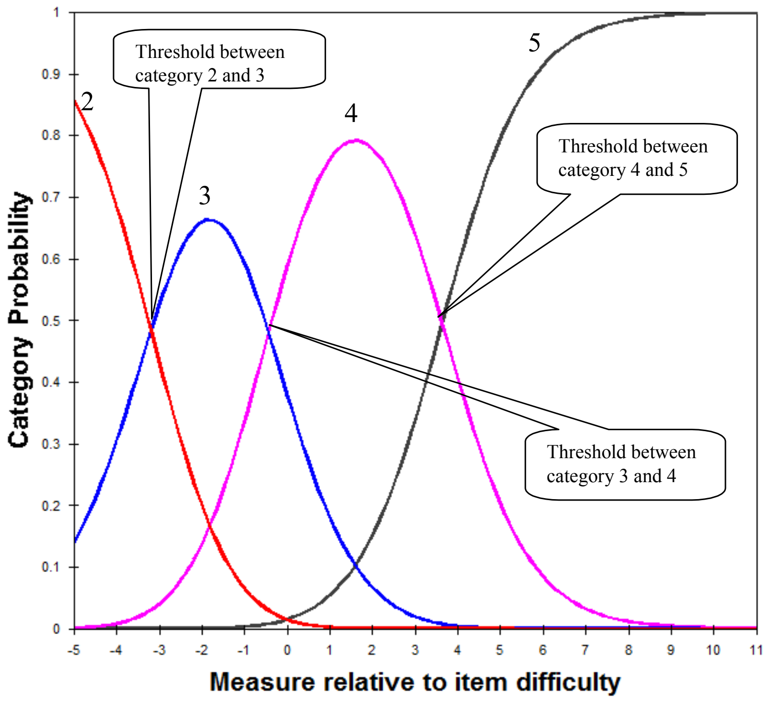

Figure 9- 6: Category response curves of the rating scale (Opinion survey)

Among the four replying rating categories, the thresholds between adjacent response categories are within the optimal distance (between 1.4 and 5.0 logits) (Bond & Fox 2007). The Rasch-Andrich thresholds increased monotonically from –3.19 to 3.63 logits. This illustrates that each category defined a distinct position on the rating scale, and the rating scale of this survey questionnaire was functional.

2.3.8 Quality of Rating Scale

The core competency scale has been established by Winsteps running Rasch measurement. Based on the statistics from the Winsteps, the quality of the rating scale can be examined in Table 9-11 (Fisher, 2007; Wright & Masters, 2002).

Table 9- 11: Quality examination on rating scale

Quality criteria		Value	Interpretation
1.	Targeting	3.12	Poor
2.	Item model fit mean square range extremes	0.48-1.39	Fair/ good
3.	Person measure reliability	0.98	Excellent
4.	Item measure reliability	0.90-0.91	Very good
5.	Person strata separated	9.08	Excellent
6.	Item strata separated	4.35	Very good
7.	Ceiling effect: % of maximum extreme scores	32.7%	Poor
8.	Floor effect: % of minimum extreme scores	0%	Excellent
9.	Variance in data explained by measures	77.3%	Very good
10.	Unexplained variance in contrasts 1-5 of PCA residuals	6.3%	Good

2.3.8.1 Targeting

The targeting of the rating scale generally reflects the difference between person mean measure and item mean measure (JM Linacre, personal communication, 22 February 2011). It measures the average person distance from the centre of item calibrations. As a rough guide, the rating scale is on target when the distance is less than one error of measurement (logit) from the centre of item hierarchy (Fisher, 2007). In this study, the person mean measure was 3.11 logits and the item mean measure was –0.01 (Appendix 9-6). So, the distance between the two was 3.12. The large error of measurement showed the poor targeting of the rating scale. However given that the survey was designed to ascertain the core infection control skills endorsed by infection control professionals, such high endorsements from the persons could be expected; i.e., the infection control nurses found it easy to endorse the bulk of these items as representing important core competencies for infection control nurses in Hong Kong. The Wright map tabulated on Figure 9-4 shows graphically on the gap between the rating scale and the items.

2.3.8.2 Item Model Fit Mean Square Range Extremes

Infit is more sensitive to the response pattern of items of the targeted persons and is considered as inlier sensitive (Linacre, 2002). The item infit mean squares range from 0.48 to 1.39 in this study that are considered as "good" performance (Fisher, 2007; Linacre, 2003). The lower extreme value (0.48) indicates the item is too predictable/ overfitting while value greater than 1.0 indicates the item is unpredictable (Linacre, 2002). There are no hard-and-fast rules to diagnose the mean square fit value. In a general comment, mean square value less than 0.5 is less productive, but it is not degrading the measurement (Wright & Linacre, 1994). It may misleadingly generate good reliabilities and separation coefficients (Linacre, 2002). Wright and Linacre (1994) suggested that a rating scale in survey with a range of 0.6-1.4 is considered as reasonable. In the case of judged (agreement encouraged), like this study, the acceptable range is 0.4-1.2 (Wright & Linacre, 1994).

2.3.8.3 Person and Item Reliability

Winsteps running Rasch measurement provides person measure reliability (person reliability) and item measure reliability (item reliability) in its summary statistics outputs automatically by the computation based on the standard errors of measure estimates (Linacre, 2006), and these reliabilities are useful to examine the quality of the rating scale. Person reliability (0.98 logit) and item reliability (0.90-0.91 logit) were found to be "excellent" and "very good" respectively in this survey (Fisher, 2007).

2.3.8.4 Person and Item Strata Separated

Strata analysis was used instead of separation for examining the person and item separations in this survey, since the outliers of the person and item are heavy-tailed (from the Wright map) (Wright & Masters, 2002). The calculation of strata (for both person and item) is (4 x Separation + 1) then divided by 3. The person strata was 9.08 and item strata was 4.35 considered as excellent and good quality in the rating scale (Fisher, 2007). This means that there were approximate 9 groups of persons and 4 groups of items in the data set.

2.3.8.5 Ceiling and Floor Effects

The floor and ceiling effects were examined to check the quality of the rating scale. The minimum extreme category "very not important" accounted no responses, and this exhibited the excellent floor effect. At the other end, the maximum extreme category "very important" accounting for a mere 32.7% of total responses informed a poor ceiling effect (Fisher, 2007). A poor ceiling effect seemingly indicates a limitation on the scale structure. The ceiling effect informed that many more than 5% of the responses, 32.7% in this study, chose the item as very important. A finer measurement on the side of importance could be used to collect the information on the side of importance. However, as the purpose of the survey is to elicit endorsements of importance, this is not a practical problem.

2.3.8.6 Variance

The principal component analysis of residuals revealed 77.3% variance could be explained by the measures. The unexplained variance in the remaining contrasts of accounted for only 6.3%. This information shows the "very good" and "good" features of the rating scale respectively in this study (Fisher, 2007) and confirms the presence of one strong underlying dimension in the data set.

2.3.8.7 Conclusion on the Rating Scale

The indicators on the quality of rating scale show its quality ranging from poor to excellent. However, the two criteria with poor results, targeting and ceiling effect, help to underline the appropriate content validity of the questionnaire. The gap between mean locations of persons and items shows that the persons readily endorse the items as important items. This is because the target is developing the core competency while the proposed content is drafted by the relevant experts. The high ceiling effect (32.7%) shows that the participants, i.e. infection control nurses, agree most of the items as important items that are proposed by the experts. This means that the proposed content is true in the working field that reinforces the content validity in this study. The present rating scale is shown as functional as each rating category has its distinct position on the scale. If more rating categories are added in the survey to explore the participants' finer perception on the important side, the risk of measurement error may be anticipated as the participants may not reliably differentiate these adjacent categories as expected (Adelson & McCoach, 2010). Most of the quality indicators show the rating scale of this survey is good. Two indictors with poor results endorse the valid content of this survey.

2.3.9 The Core Competency Scale

The core competency scale consists of 76 items was established by Rasch measurement after removing the misfitting persons and misfitting items stepwise. Each item contains an item measure (in logit). Each item measure refers to the perceived importance of that skill in the core competency scale. The order is decided by the given responses in 5 category-importance levels by the 76 participants. In this core competency scale, 76 item measures range from 1.96 to –2.36 logits, from the least important core competency item (Item 78: Demonstrate knowledge of biostatistics) to the most important core competency item (Item 74: Demonstrate knowledge of infectious diseases) respectively (Appendix 9-22). The important levels of core competency items are inversely related. For person measures on this core competency scale, a smaller value means that the participant tends to endorse the items as important items in the survey.

2.3.9.1 Strata Separation

In Phase Two, a survey was conducted to collect the opinion of local infection control nurses on the 83 proposed core competency items drafted by the local infection control experts in Phase One. By using Rasch analysis to analyze these survey data, a reliable and valid competency scale with 76 core competency items was established. The importance level (i.e. values of the item measures), of the 76 core competency items as perceived by the 76 participants (infection control nurses) is shown on an interval scale in logits. When discussing the person and item strata separation in this chapter (point 2.2.7.4), item strata were 4.35. This means that there are approximately four groups of items in view of their importance levels on the scale. To work out the strata separation locations for these four groups, Rasch measurement standard error (RMSE) for items was examined. The statistics for RMSE can be referred to summary statistics for 76 persons and 76 items tabulated in Appendix 9-6. The real RMSE was 0.28 while the model RMSE was 0.27. Either RMSE may be used for strata computation. However, the larger one is usually used to be on the safe side (JM Linacre, personal communication, 30 April 2011). So, I used the value of 0.28 (real RMSE) for strata computation. The strata are located 3 RMSEs apart. In this study, three locations for four strata separation are found. The item mean measure located at –0.01 logit. 3 RMSEs apart located at 0.83 (-0.01 + 3x0.28) logit and –0.85 (-0.01 – 3x0.28) logit respectively. The strata boundaries are tabulated in Table 9-12. Strata 1 got 13 core competency items, strata 2 had 26 items, strata 3 contained 24 items and strata 4 got 13 items. Strata 1 contains the least important items while strata 4 consists of the most important items

Table 9- 12: Boundaries for item strata separation

Importance level	Strata	Boundary (in logit)	No. of core competency items
Least important	Strata 1	> 0.83	13
↑	Strata 2	> (-0.01) - 0.83	26
↓	Strata 3	> (-0.85) – (-0.01)	24
Most important	Strata 4	≤ (-0.85)	13

The 76 core competency items are still under the 10 competency categories, and none of the initially drafted categories were removed in Phase Two. These

76 core competency items represent a comprehensive list of core competencies of Hong Kong infection control nurses. Let us look into the most and least important core competency items located in the two extreme strata.

2.3.9.2 The Most Important Core Competency Items (Strata 4) in the Scale

Table 9-13 lists the 13 most important competency items in strata 4. Five of them are "outbreak investigation and control" category. This reflects that local infection control nurses perceived managing infection outbreaks an important element in their practice. The most important core competency item is item 74 "demonstrate knowledge of infectious diseases". It is the key knowledge required by infection control nurses to detect infectious cases based on surveillance and reporting, and control the disease spread through advice and education. It belongs to "expert knowledge" category. Other items falling into "expert knowledge" category include items 71 "demonstrate knowledge of decontamination" and 70 "demonstrate knowledge of asepsis". These two items involve daily safe patient care practices. Item 68 "demonstrate knowledge in areas of patient care practices" is critical for infection control nurses when investigating infection incidents and outbreaks, communicating and educating the healthcare workers. Item 75 "demonstrate knowledge of communication skills" is another item from "expert knowledge" category. When the first infection control nurse was appointed in the United Kingdom, she was responsible for promoting a new line of communication (Gardner, Stamp, Bowgen & Moore, 1962) and it was not surprising that this core competency item is one of the important items for Hong Kong infection control nurses. Item 20 "communicate the necessary resources to administration/

management" also involves the communication activities in infection control nurses' job. Surveillance is the core activity in infection control as it helps to identify unusual situations, and item 2 "use standardized definitions to conduct surveillance" describes the major technique of infection control nurses in infection surveillance.

Table 9- 13: The 13 most important core competency items (Strata 4)

Logit	Item	Category	Description
-2.36	74	Expert knowledge	Demonstrate knowledge of infectious diseases
-2.28	57	Outbreak investigation and control	Collect the appropriate data during infection outbreak investigation
-2.04	60	Outbreak investigation and control	Evaluate the effectiveness of the control measures during outbreak situations
-1.73	2	Surveillance	Use standardized definitions to conduct surveillance
-1.65	58	Outbreak investigation and control	Advise the control measures to the involved parties during outbreak situations
-1.20	55	Outbreak investigation and control	Assess the extent of outbreak situation
-1.12	54	Outbreak investigation and control	Recognize an outbreak through surveillance information and reporting channels
-1.12	71	Expert knowledge	Demonstrate knowledge of decontamination
-1.05	70	Expert knowledge	Demonstrate knowledge of asepsis
-0.97	20	Programme management and evaluation	Communicate the necessary resources to administration/ management
0.90	75	Expert knowledge	Demonstrate knowledge of communication skills
-0.90	43	Team and service management	Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures
-0.86	68	Expert knowledge	Demonstrate knowledge in areas of patient care practices

2.3.9.3 The Least Important Core Competency Items (Strata 1) in the Scale

At the other end of the comprehensive competency list, strata 1 contained 13 least important items from eight different categories (Table 8-14). The categories include “expert knowledge”, “research and development”, “programme management and evaluation”, “education”, “surveillance”, “Collaboration and partnership”, “Continuing education and professional development” and “Team and service management”. The least important items come from diversified categories implying that all the ten competency categories are of equal importance. Only some of the items inside the categories were rated as less important than others. Three items under “expert knowledge” category were item 78 “demonstrate knowledge of biostatistics”, item 73 “demonstrate knowledge of educational methodologies”, and item 76 “demonstrate knowledge of programme administration”. Both item 62 “critically review the related research” and item 67 “publish or present the participated research findings to contribute in advancing the field of infection prevention and control” belong to “Research and development” category. In Hong Kong, most infection control nurses seldom review research papers habitually and they usually read them casually (item 62). Even few of them participate in research so that publishing and presenting their research work is not a common activity (item 67). Advancing the field by participating related research (item 83) is even unlikely. Only a few of the infection control nurses apply biostatistics in their daily work (item 78). Some experts even promote the idea of hiring statisticians to perform statistical analyses related to infection control, so the biostatistics in the daily work of infection control nurse remain at a rather basic level. Hence, infection control nurses are usually not aware of database selection for surveillance if it matches the internal or external data structure as stated in item 5 (under “surveillance” category). Nowadays, the surveillance programmes from overseas countries are easily accessible. Adopting others' surveillance programmes from overseas is common. That was the reason why infection control nurses endorsed item 1 "design a surveillance plan for the served populations(s) using epidemiological principles" as one of the least important items. Another item in "expert knowledge" category, item 73 "demonstrate knowledge of educational methodologies" was considered as one of the least important item. This is not surprising as educational methodologies are not covered in the curriculum for local infection control nurses or general nurses. As infection control training for healthcare workers in Hong Kong is mandatory with standardized packages are usually established in the service, item 31 "periodically assess the educational needs of clients" under "education" category become less important. These results reflect the situation of infection control nurses' practices in Hong Kong.

Although communication work is important for infection control nurses (Gardner et al., 1962), item 19 "communicate with clients on the value of the programme" under "programme management and evaluation" category, is more likely to be performed by a colleague in a more senior role, such as team in-charge or even an infection control officer (a medical doctor). Item 52 "recruit other relevant parties to involve in the infection prevention and control programmes if necessary" and item 76 "demonstrate knowledge of programme administration" were not the concern of an infection control nurse unless he or she was in the position of in-charge. The resources handling duties include in item 17 "recommend appropriate resources for the proposed programme plan" and item 48 “integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes” were also considered as less important because the in-charge usually takes up the role. The infection control nurses in specialist level were perceived as a professional role rather than a managerial role.

Table 9- 14: The 13 least important items (Strata 1) in the scale

Logit	Item	Category	Description
1.90	78	Expert knowledge	Demonstrate knowledge of biostatistics.
1.47	62	Research and development	Critically review the related research.
1.47	19	Programme management and evaluation	Communicate with clients on the value of the programme.
1.47	31	Education	Periodically assess the educational needs of clients.
1.34	5	Surveillance	Select a database(s) that matches internal/ external data structure of surveillance.
1.34	73	Expert knowledge	Demonstrate knowledge of educational methodologies.
1.28	76	Expert knowledge	Demonstrate knowledge of programme administration
1.08	52	Collaboration and partnership	Recruit other relevant parties to involve in the infection control prevention and control programme if necessary
1.08	67	Research and development	Publish or present the participated research findings to contribute in advancing the field of infection prevention and control
1.01	83	Continuing education and professional development	Advance the field of infection prevention and control through the involvement of related research
1.01	48	Team and service management	Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes
1.01	17	Programme management and evaluation	Recommend appropriate resources for the proposed programme plan
0.87	1	Surveillance	Design a surveillance plan for the served population(s) using epidemiological principles

3 Competency for Infection Control Nurses from Overseas Countries

The 83 proposed core competency items developed in Phase One were transformed into an 83 item-questions of core competencies for survey in Phase Two. Besides input from expert, the information for the drafting of competency categories and core competency items was mainly from two documents, the core competencies for infection prevention and control in the United Kingdom (Infection Control Nurses Association, 2004) and the APIC/ CHICA-Canada infection control and epidemiology: professional and practice standards of the North America. The latter one (APIC/ CHICA-Canada standards) was developed by the combined efforts of The Association for Professionals in Infection Control and Epidemiology, Inc. (APIC) and the Community and Hospital Infection Control Association of Canada (CHICA-Canada) (Horan-Murphy et al., 1999). During this research period, the APIC and CHICA-Canada revised their professional and practice standards in 2008 (Friedman et al., 2008). One category, “occupational health”, was added in the revised standards. The content of each category was slightly adjusted. These two major documents developed by the infection control leading countries (the United Kingdom and North America) were used to compare with the result of this study.

This study established a comprehensive list of core competency items for Hong Kong infection control nurses. It contains 76 items under 10 categories. Each core competency item is an action/ behavioural statement, which starts with a verb. Both the APIC/ CHICA-Canada standards and core competencies of the

United Kingdom use the same format as Hong Kong version to describe their standard items. I examined their contents and made comparisons in the following sections.

3.1 Comparison of Competencies between Hong Kong and the United Kingdom

The core competencies of the United Kingdom consist of four domains, namely specialist knowledge, healthcare governance, learning and teaching, and leadership and management (Infection Control Nurses Association, 2004). Fifteen competency areas are listed under these four domains (Appendix 3-1). A total of 146 key criteria outcomes are further listed according to the fifteen categories. By studying the content of core competencies of the United Kingdom, I tried to group them into the competency categories of Hong Kong. Apart comparing the categories, items were also compared. The common areas of competency for infection control nurses between Hong Kong and the United Kingdom are in all the categories:

1) Surveillance,
2) Programme evaluation,
3) Evidence-based practice,
4) Education,
5) Team and service management,
6) Collaboration and partnership,
7) Outbreak investigation and control,
8) Research and development,

9) Expert knowledge, and

10) Continuing education and professional development.

Within the common areas, “occupational health” activities are not grouped in a specific category. Activities of immunization and supporting occupational health department related to staff infection issues are documented. In Hong Kong, “occupational health” is developed under the principles of evidence-based practice. Details of content are omitted in the “evidence-based practice” category. The term “leadership and management” is used in the competency area of United Kingdom. This area is similar to the two competency categories of infection control nurses of Hong Kong: “team and service management” and “collaboration and partnership”. Although most of the core competencies are similar between the two, “use of link person systems” as the resource of infection and managing the system is not mentioned in the version of United Kingdom. Principles of “quality management” were agreed underpinning in “team and service management” by our experts in Phase One. Details of quality management activities are not necessarily listed. The area of “quality management” is mentioned under “clinical effectiveness” of the core competencies of United Kingdom.

After matching, two components (items under the category) are existed in Hong Kong version but not core competencies of United Kingdom (Table 9-15). They are “data management” and “use of link person systems”. However, “patient and public involvement”, which involves in clinical governance, belongs to competency areas of United Kingdom only. The details of matching between the two competency lists are tabulated in Appendix 9-23.

Table 9- 15: Comparison of competency categories between Hong Kong and the United Kingdom

10 Hong Kong categories	Omitting competency items in UK practice	Omitting competency items in Hong Kong practice
Surveillance	"data management" items	
Team and service management	"Use of link person systems" items	
"un-classified"		Patient and public involvement

The whole core competencies of United Kingdom can almost be fed into 10 Hong Kong categories, except "patient and public involvement" item (Table 9-15). This "patient and public involvement" appears to be distinctly identifiable in the practice of the United Kingdom. Although the core competencies of United Kingdom seemingly covers all infection control practice under the 10 Hong Kong categories, it does not fit in some categories nicely, particularly, the "Surveillance" category and the "Team and service management" category. The practice of the United Kingdom lacks competency items relating to data management, such as "Select a database(s) that matches internal/ external data structure of surveillance" and "Select a database(s) that ensures accurate data management for surveillance" in the" Surveillance" category.

Relating to the “Team and service management” category, the core competencies of United Kingdom tend to omit the competency items related to “the use of link person systems”.

Infection control involves patient safety. Many countries, as well as the World Health Organization have recently promoted patient and public engagement or empowerment in patient safety (Leonhardt, 2010; Pronovost & Faden 2009; World Health Organization [WHO], 2009). Implementing the patient involvement strategies is affected by the factors of patient and healthcare workers. Patients need to understand their roles and have sufficient knowledge and skills to give voices to their opinion/ needs, while healthcare workers are prepared to accept patients’ suggestions and requests. The mutual support and respect between the two parties are key components in making the strategies work (Davis, Jacklin, Sevdalis & Vincent, 2007). Unfortunately, in practice, unfavorable patient factors, such as unwillingness to voice their needs, were commonly reported (Lent et al., 2009; Longtin, Sax, Allegranzi, Hugonnet & Pittet, 2009). This situation is even worse in a Chinese community like Hong Kong, where people are often too shy to express their views and to articulate their needs. Also, the elderly, who form the majority of healthcare service users in Hong Kong, usually possess insufficient healthcare knowledge to participate in the patient empowerment programme. On the other hand, healthcare workers in Hong Kong, because of their knowledge and skills, are usually perceived by patients and healthcare workers themselves to be in a superior position, when interacting with patients (Cole & Lacefield, 1978). In view of this situation in

Hong Kong, it is not easy at present for the local healthcare workers to accept the advice from patients. It clearly explained why the specific practice of the United Kingdom to "involve patients and the public in clinical governance" fit in no place of the 10 Hong Kong categories.

3.2 Comparison of Core Competency/ Standard for infection control practice between Hong Kong and North America

During drafting the core competency for infection control nurses of Hong Kong, one of the major references is the professional and practice standards of infection control and epidemiology published by the APIC/ CHICA-Canada in 1999 (Horan-Murphy et al., 1999). After the core competency drafted in this research (Phase One), the APIC/ CHICA-Canada revised their professional and practice standards in 2008. Apart from the addition of "occupational health", all the areas in previous publication are basically covered in the new practice standards (Friedman et al., 2008). The major differences between the two versions are listed in Appendix 9-24.

According to the Hong Kong competency categories, the 2008 APIC/ CHICA-Canada standards covers 9 categories, and surprisingly its written practices/ standards relating to the outbreak investigation and control category is completely absent. Some practice items relating to "financial management" in APIC/ CHICA-Canada standards fit into none of the 10 Hong Kong categories. Table 9-16 looks into categories by their content details one by one.

Table 9- 16: Comparison of the 2008 APIC/CHICA standards and the Hong Kong version

Hong Kong categories	Omitting competency items in North American practice	Omitting competency items in Hong Kong practice
Surveillance		'Make recommendation for improvement based on surveillance findings'
Evidence based practice		"occupational health" items
Education	Evaluate the educational programmes/ tools that related to infection prevention and control.	
Team and service management	"use of link person system" items	"quality management" items "seek opportunities to influence and educate the public" "integrate relevant local national and global public health issues into practice" (public health relation)
Collaboration and partnership		Collaborate with community health organizations
(Outbreak investigation and control)	"outbreak investigation and control" items	
Research and development		"incorporate with other professional organizations and academic entities to further the prevention of infection" 'Incorporate cost analysis into infection prevention and control research when possible'
Expert knowledge	"demonstrate knowledge of biostatistics"	Demonstrate knowledge of facility planning/ construction, occupational health, emergency preparedness, product evaluation, information technology, legislative issues/ policy making, research
"un-classified"		Financial management

As compared to the core competencies of United Kingdom, the APIC/CHICA-Canada standards give a better coverage in items of "data management" in the Surveillance category. In the Team and service management category, the APIC/CHICA-Canada standards apparently lack the practice of “use of link person systems”, while they specifically focus on practices relating to “quality management”. Under the Expert knowledge category, the APIC/CHICA-Canada standards indicate a wide spectrum of knowledge demonstration from facility planning/ construction, information technology, even to legislative issues/ policymaking, which are absent in Hong Kong version. In contrast, the standards do not specifically require the infection control practice demonstrating knowledge of biostatistics under the Expert knowledge category.

In summary, the practice of “financial management” has been missed out in the practice of Hong Kong, but it is specific to the APIC/CHICA-Canada practice according to its written standards. In Hong Kong, an infection control team in hospital is generally not a department, but rather a team composed by members of different departments, such as infection control nurses from the nursing services division and the infection control officer from the Department of Microbiology or Medicine. In this situation, the hospital infection control team in Hong Kong does not usually have its own budget. Financial resources are often managed by individual departments or made available by the relevant hospital committee as required on a project basis. Therefore, financial management is not applicable in the local situation in most of the time. Instead, the skill of preparing proposals of budgets is more relevant to Hong Kong’s daily practice, and this has been covered in the Hong Kong version under "programme management and evaluation" category, item 20 "communicate the necessary resources to administration/ management".

The core competency for infection control nurses of Hong Kong has two special areas that APIC/CHICA-Canada standards do not exist. They are the practices in relation to "use of link person systems" and "outbreak investigation and control". Use of link nurse and link doctor systems was initiated from the United Kingdom (Ayliffe, Fraise, Geddes & Mitchell, 2000). The use of this is not certain in North American. At least, it has not been explicitly written on its standards. The absence of "outbreak investigation and control" category in the APIC/CHICA-Canada standards were unexpectedly recognized in this comparison exercise. In fact, the APIC/CHICA-Canada standards have documented "Demonstrate knowledge of outbreak management and emergency preparedness", which is classified under "expert knowledge" category. Besides, there is no other explicit description on the desired practice in this area in the practice standards. Apparently, Hong Kong version lists out the core competency items of this category in details from recognizing the outbreak till management and evaluation.

Some statements in APIC/CHICA-Canada standards involve parties outside the hospital, such as "seek opportunities to influence and educate the public" of the Team and service management and "incorporate with other professional organizations and academic entities to further the prevention of infection" classified as the Research and development category. Similar practices that having the linkage with external parties beyond the hospital environment cannot be identified in Hong Kong core competency list.

Regarding to the public health relation, the APIC/CHICA-Canada standards suggest, “Integrate relevant local national and global public health issues into practice” classified under the Team and service category. Originally, a similar competency item read as “integrate relevant public health issues into practice when applicable” was included in the survey questionnaire, but it was removed during the Rasch analysis (Phase Two) due to the misfit to the model. A detailed comparison of Hong Kong competency and the APIC/CHICA-Canada standards (2008) can be found in Appendix 9-25.

To summarize, by comparing the results of this study with the core competencies of the United Kingdom (Infection Control Nurses Association, 2004) and the APIC/CHICA professional and practice standards (2008) together, both common and different infection control practices are identified. The graphic presentation is depicted in Figure 9-7.

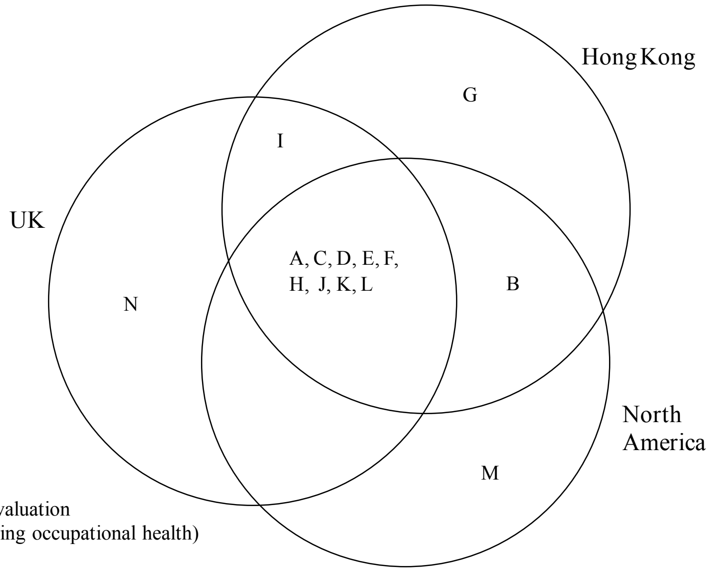

Figure 9- 7: Competency components of infection control practice for Hong Kong, the United Kingdom (UK) and North America

4 Conclusion

Through the role delineation concept by D'Costa (1986), this research went through the processes of inputs from literature and experts in Phase One. This phase (Phase Two) demonstrated the process of input from the field practitioners and finalized the 76-item core competency of Hong Kong infection control nurses in the order of their perceived importance levels.

Professional competency is influenced by local political, social and economic situations, health needs, resources availability and structure of the healthcare system (McGaphie, Miller, Sajid & Telder, 1978). This study showed that the core competency for infection control nurses of Hong Kong is different from other countries and has its own characteristics.

Absent from the core competencies of the United Kingdom and APIC/CHICA-Canada standards, “using infection control link person systems” is emphasized in Hong Kong. The Infection Control Link Nurse system is actually adopted in the United Kingdom, Netherlands and Portugal (Dawson, 2003). The Infection Control Link Doctor system is also a programme in the United Kingdom and Portugal (Ayliffe et al., 2000; Melo-Cristino, Marques-Lito & Pina, 2002). In the Hong Kong setting, infection control team even extends these resources and practices to allied health professionals and administration departments to spread the infection control culture more extensively. It shows that the infection control link system is considered more important in Hong Kong than in other countries (Centre for Health Protection, Scientific Committee on Infection Control, 2005).

CHAPTER 10

PHASE THREE — RESULTS AND DISCUSSION

1 Introduction

The Hong Kong infection control nurses' (ICNs) core competency list containing 76 core competency items, with perceived importance levels to individual competency items, was developed through Phase One and Phase Two based on the role delineation concept of D'Costa (1986). In this chapter, findings of Phase Three will be reported.

2 Findings

The findings in this phase divided into three sections, namely, expert-defined critical competency, the true critical competency and the content blueprint for certification.

2.1 The Expert-defined Critical Competency

With the core competency items of infection control nurses were identified with their respective importance levels, this phase (Phase Three) identified the most important core competency items (critical competency items) using qualitative expert consensus technique. Six infection control experts were requested to answer a questionnaire survey. Based on a list of core competency items (identified in Phase Two) with ranks in importance, they had to make a decision to cut the list into the most essential items and preferred items and provide a justification for the decision. When all experts' replies were received, their suggested cut-off points, justifications and comments were listed on a table for examination (Appendix 10-1).

Table 10- 1: Proposed cut-off by six experts

Expert	Cut-off rank	No. of most essential items
ICO_A	Rank 17/ 18	25 items
ICO_B	Rank 16/ 17	23 items
ICO_C	Rank 11/ 12	13 items
ICN_D	Rank 29/ 30	57 items
ICN_E	-	-
ICN_F	-	-

Table 10-1 summarises the proposed cut-off ranks of the experts. All six experts had some comments on the 76 core competency items. Only four gave their decisions on the position of cut-off lines together with justifications as instructed. Individual justifications and cut-off points were analyzed qualitatively in pairs (Appendix 10-1).

ICO_A replied promptly on the same day of sending out the questionnaire. He recommended to remove items of rank 18 and below, and to keep 25 items in the most essential list. He noticed and accepted that core competency items of same categories scattering over various ranks, and he knew why he was asked to make a cut on the list for certification purposes. He justified his recommendation that "items ranked below 17 are, in my opinion, mostly team competency, rather than individual ability markers". Having made a cut, he stressed those items in ranks 18 to 42 were "desirable elements" for infection control nurse specialists. I appreciate his prompt response and strong justification, and I conclude that ICO_A was confident to handle this task.

ICO_B also responded quickly on the next day of sending out the questionnaire. Initially, he suggested including rank 1 to rank 8 (9 items) to the essential competency list, because he believed that infection control nurse specialists referred to only the infection control nurse in-charges. After clarification of the definition of infection control nurse specialists, that included all clinical specialists, and not necessarily the infection control nurse in-charges only, ICO_B finally suggested the cut-off point to be placed between rank 16 and rank 17. From rank 1 to rank 16, there were 23 essential competency items. This cut-off point was close to that of ICO_A (rank 17/18) with only 2 items fewer in the essential list. ICO_B also noticed that some core competency items of same categories go to different ranks. He further opined that it was because the items are "too specific". He found that this scattering situation make his task to draw a cut-off line very difficult. In spite of the difficulty, ICO_B gave his quick and sound response after clarification. I have no doubt in his confidence to complete this task.

ICO_C made the cut-off at rank 11/12 to include 13 essential core competency items. He specifically commented that some items of rank 40 and rank 41 (critically review the related research and application of biostatistics) relating to outbreak management should be ranked in greater importance. He emphasized that "scientific basis of research and application of biostatistics is also important in managing the outbreak". He referred to the daily practice that "when we measure the incidence of Methicillin resistant *Staphylococcus aureus* or Multiple resistant *Acinetobacter baumannii* in the clinical unit, basic knowledge of biostatistics is required to compare if there is any significant change over time". ICO_C made a comparatively short list for certification purposes. And there was no justification of his decision. He did not agree the ranking of some core competency items and did not accept items of same categories going to different ranks. In conclusion, he was not satisfied with the order of 76-item core competency list.

ICN_D, in her first reply, provided the decision of cut-off at rank 29/30 including 57 competency items only without any textual explanation. It was a long essential list. She only provided her justification in one sentence, saying "I consider operational and knowledge competency is more important" after my request. This brief justification was not sufficiently clear but there was no further clarification upon requested.

ICN_E in her first reply did not provide her suggested cut-off point, and she commented that many core competency items in the questionnaire were not for infection control nurse specialists, but was for general nurses instead. When I discussed with her, she had query about the formulation and scoring of the list. I reassured her that the list was developed from the views of infection control nurses in Hong Kong and experts of infection control field including ICN_E herself. Based on her comment “Many are basic knowledge that a general nurse should know”, I then requested ICN_E to identify those items that were not considered ‘general’ and only specific for infection control nurses. No further response was received.

ICN_F shared similar view to that of ICO_C. He was not satisfied with the ranking of the core competency items on the questionnaire. He specifically pointed out that items of the less importance in ranks 38 to 41 should be included in essential list. Without making any cut-off point, ICN_F suggested picking items from different portions of the core competency list. I further explained about the purpose of this study and the task of experts through email. Unfortunately, he failed to accomplish his task.

After examined all the replies and comments, the following summary was made:

> Four experts (ICO_B, ICO_C, ICN_E and ICN_F) found that determining the position of the cut-off line was not easy. Two experts (ICN_E and ICN_F) failed to provide the cut-off line. Four cut-off lines proposed at rank 11/12 (ICO_C), rank 16/17 (ICO_B), rank 17/18 (ICO_A) and rank 29/30 (ICN_D). These cut-off lines referred to include 13, 23, 25 and 57 items respectively. ICO_C commented the shortest list without good justification and this might miss some important items for certification purpose. ICN_D recommended the longest list of 57 items without satisfactory justification. Thus, both ICO_C and ICN_D's recommendations were not considered. The other two cut-off points recommended by ICO_B and ICO_A were close (ICO_B, rank 16/17; ICO_A, rank 17/18), and their suggested essential lists were similar with two items difference only (ICO_B, 23 items; ICO_A, 25 items). Both ICO_A and ICO_B provided their practical and sensible justifications, and that they both had good experience in the field of infection control, contributing a lot in corporate-wide issues. Thus, their critical competency recommendation well accepted for consideration. To be safe and not missing any essential items in the certification programme, I decided without difficulty to include 25 items from rank 1 to rank 17 (the ICO_A's cut-off).

At this stage, the expert-defined critical competency with 25 items was established. These 25 items and their importance levels in logits are tabulated in Table 10-2. At the bottom of Table 10-2, the logit of the cut-off at rank 17/18 is –0.37. There are two items at –0.37 logit (rank 17), the least important items of the expert-defined critical competency. They are: "item 32, Develop educational objectives and strategies to meet the client needs" and "item 80, Act as expert resource in infection prevention and control in clinical and organizational level". The most important item "item 74, demonstrate knowledge of infectious diseases" (rank 1) is at –2.36 logits. All in all, the 25 items of expert-defined critical competency for infection control nurses in Hong Kong were lying between –2.36 and –0.37 logits of the core competency scale.

Table 10- 2: 25-item expert-defined critical competency for infection control nurses of Hong Kong

Rank	Item	Description	Importance level (logit)
1	74	Demonstrate knowledge of infectious diseases.	-2.36
2	57	Collect the appropriate data during infection outbreak investigation.	-2.28
3	60	Evaluate the effectiveness of the control measures during outbreak situations.	-2.04
4	2	Use standardized definitions to conduct surveillance.	-1.73
5	58	Advise the control measures to the involved parties during outbreak situations.	-1.65
6	55	Assess the extent of outbreak situation.	-1.20
7	71	Demonstrate knowledge of decontamination.	-1.12
7	54	Recognize an outbreak through surveillance information and reporting channels.	-1.12
8	70	Demonstrate knowledge of asepsis.	-1.05
9	20	Communicate the necessary resources to administration/ management.	-0.97
10	43	Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	-0.90
10	75	Demonstrate knowledge of communication skills.	-0.90
11	68	Demonstrate knowledge in areas of patient care practices.	-0.86
12	61	Share the findings of outbreak investigation to the relevant parties.	-0.82
13	15	Assess the client needs on the infection prevention and control programme during planning.	-0.67
13	59	Advise the investigation to the involved parties during outbreak situations.	-0.67
14	27	Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	-0.60
14	50	Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.	-0.60
14	29	Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	-0.60
15	56	Use epidemiological knowledge to identify the risk factors during outbreak situations.	-0.52
16	77	Demonstrate knowledge of epidemiology.	-0.45
16	38	Disseminate the policies of the infection prevention and control programmes to concerned clients.	-0.45
16	72	Demonstrate knowledge of educational skills and tactics.	-0.45
17	32	Develop educational objectives and strategies to meet the client needs.	-0.37
17	80	Act as expert resource in infection prevention and control in clinical and organizational level.	-0.37

2.2 The True Critical Competency

By using expert consensus method, the core competency items for ICNs certification programme and their importance levels in logits had been identified (Table 10-2). Each of the 25 importance levels in logits to expert-defined critical competency items is a measure estimate locating along the core competency scale. All measurement may have errors. The 25 importance levels in logits established in Table 10-2 are not necessarily their true value, only measure estimates. By the same token, the expert-defined cut-off point of -0.37 logit is a measure estimate on the core competency scale. With measurement errors of importance levels in logits, some essential core competency items may be excluded unintentionally. In statistic language, the safety margin is the error portion of the measurement. The critical competency for certification programme should not miss any essential competency items. Thus, Rasch model was used as a framework to work out the safety margin of the expert-defined critical competency cut-off point.

In Rasch model, the standard error is the standard deviation of the measurement error. It is the safety margin of the cut-off point (in logits) on the core competency scale. The standard error provides the estimate along with its precision for the accumulation of measure estimates in Rasch model (Linacre, 2005; Rasch, 1980). Therefore, the estimate of accumulation of observations consists of the measure estimate plus or minus the standard error of the estimate. The standard errors of importance levels in logits on the core competency scale (item measure estimates) had already been calculated by the

Winsteps when it yielded the final 76-item core competency list in Phase Two (Appendix 9-7). The expert-defined cut-off is at -0.37 logit (rank 17, including item 32 and item 80). By looking up the record in Winsteps, its standard error is 0.27 logit, the safety margin of the expert-defined cut-off. By adding this safety margin (0.27 logit), the true cut-off location on the competency scale can be identified as -0.10 logit (-0.37 + 0.27 logit).

As per the above calculation, the revised and final critical competency items for the certification programme are those lying between –2.36 and –0.10 logits on the Rasch measuring competency scale. By looking up the record in Winsteps, the competency items rank 1 (at -2.36 logits) to rank 20 (at -0.17 logit) were included, where items of next rank 21 locating at -0.07 logit and beyond are outside the boundary. The true critical competency increases to 35 items, 10 more than those of the expert-defined critical competency. Table 10-3 summarises the 35-item critical competency. The details of individual critical competency items with corresponding importance levels are listed in Appendix 10-3.

Table 10- 3: Summary of 35-item critical competency

Rank	Components of critical competency	Importance level (logit)	No. of items
1-17	Expert-defined	(-2.36) – (-0.37)	25
18-20	Safety margin (standard error)	>(-0.37) – (-0.10)	10
1-20	Overall	(-2.36) – (-0.10)	35

2.3 Content Blueprint of Certification for Infection Control Nurses

The content blueprint of certification consists of two components. First, the content, which was the critical competency for infection control nurses. Second was the content weight of individual critical competency items within the content boundary.

2.3.1 Critical Competency of Infection Control Nurses in Hong Kong

The expert-defined critical competency with safety margin added was the content of certification for infection control nurses of Hong Kong. There were 35 items, falling into seven categories, namely 1) Surveillance; 2) Programme management and evaluation; 3) Evidence based practice; 4) Education; 5) Team and service management; 6) Outbreak investigation and control; and 7) Expert knowledge. The description of 35 critical competency items in categories for certification programme for Hong Kong infection control nurses can be found in Appendix 10-4.

2.3.2 Content Weights of Critical Competency Items

2.3.2.1 Rescale the Item Measures

Of the 76 core competency item measures, the values were between 1.90 and -2.36 (the least important and the most important) and these were converted into positive values between 5 and 100 arbitrarily by Winsteps programme. The rescaled item measures lay between 4.79 and 99.68 logits on the new scale, with the most important competency item (Item 74: Demonstrate knowledge of infectious diseases) located at 99.68 logits and the least important item (Item

78: Demonstrate knowledge of biostatistics) located at 4.79 logits. These scaled item measures for 76 competency items can be found in Appendix 10-2.

2.3.2.2 Weights Calculation

From the 76 rescaled item measures (Appendix 10-2), 35 critical competency items were identified and extracted for weight calculation. Their rescaled locations ranged from the most important at 99.68 logits (Item 74: Demonstrate knowledge of infectious diseases) to the least important at 50.80 logits (Item 34: Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control). They are listed in Appendix 10-5 in the most-to-least-importance order. To calculate the weight of the 35 critical competency items, first, add all 35 rescaled item measures, which yield the sum of 2251.07 logits as shown in the last row of Appendix 10-5. Next, divide rescaled item measures by 2251.07 logits, converting this proportion to percentage. The weights of 35 critical competency items are listed in Appendix 10-5, showing the more important critical competency items in the greater weights (positive values in percentage).

2.3.3 Content Blueprint of Certification Programme for Infection Control Nurses of Hong Kong

The 35 critical competency items with their content weights form the content blueprint of the certification programme are listed on Appendix 10-6. For easy reference, the critical competency items are grouped into categories systematically. Recalled that all core competency items were derived from their categories at the early stage of the drafting process. The order of the items in the content blueprint was re-arranged according to the weights of their competency categories, called critical competency categories. The weight of individual critical competency categories is the sum of item weights of individual categories. Seven critical competency categories are found in the content blueprint. They are:

1) Outbreak investigation and control (27.0%);
2) Expert knowledge (24.2%);
3) Team and service management (12.8%);
4) Programme management and evaluation (10.5%);
5) Education (9.6%);
6) Surveillance (8.3%); and
7) Evidence based practice (7.7%).

The category "outbreak investigation and control" holds the greatest content weight of 27.0%, and "expert knowledge" holds the second place of 24.2%. They have accounted for more than 50% content weight in this blueprint, and hence the certification programme for the Hong Kong infection control nurses.

3 Certification Content Blueprint for Infection Control Nurses from Overseas Countries

After developing the content blueprint of certification programme for infection control nurses of Hong Kong, with individual content weights of competency items, it is compared with other certification content blueprints relating to infection control practice in other countries. The content blueprints of certification examinations/ programmes may not be readily available, but their content outlines for the test or the programme are usually available for candidates/ applicants' reference. Content outlines are not as detailed as blueprints, and only gross weight and categories will be shown. Based on the newly developed content blueprint for Hong Kong infection control nurses, content outlines of the certification programme as shown in Table 10-4 was prepared for candidates' reference.

Table 10- 4: Content outline for Hong Kong infection control nurses certification programme

Content of certification programme	Weight
Outbreak investigation and control	27.0%
Expert knowledge	24.2%
Team and service management	12.8%
Programme management and evaluation	10.5%
Education	9.6%
Surveillance	8.3%
Evidence based practice	7.7%
Overall	100.0%

At present, there are two certification/ credentialing packages for infection control nurses or infection control practitioners in the world, which the content outlines, are available. The Australian Infection Control Association (AICA) credentialing package, which is organized by the AICA, is for their members only. The other is a certification programme offered by Certification Board of Infection Control and Epidemiology, Inc. (CBIC) of the United States. It is open to all infection control practitioners all over the world, but most candidates are from North American. With their content outlines, their categories and their category weights were compared to the newly prepared Hong Kong blueprint.

3.1 AICA Credentialing Application Package

The AICA credentialing process is a portfolio review. Applicants are required to fulfill the criteria to earn points for successful applications. Under the review, educational criteria and other criteria are examined (Australian Infection Control Association, 2009a). Depending on the educational attainment, from bachelor to PhD degree, applicants may earn 20 to 90 points.

The classification of the portfolio package content of AICA is different from that of the new blueprint of Hong Kong. To facilitate comparison between the two, the content and weight of AICA package are "translated" to match the category of the new Hong Kong blueprint. As majority (94.5%) of infection control nurses in Hong Kong got a bachelor's degree (result of Phase Two), this academic qualification is taken to work out the calculation. The result of the translation is listed in Table 10-5.

Table 10- 5: Translating the AICA content to Hong Kong ICN certification content blueprint categories

AICA Credentialing Package			**Translated to Hong Kong blueprint for Hong Kong ICNs**	
Content	Marks (points)	Weight	Weight	Category
Educational qualification	20	16.7%	25.0%	
Curriculum vitae	10	8.3%		
1) Portfolio submission (outbreak management/ quality management/ IC policy development and implementation	25	20.8%	20.8%	Outbreak investigation and control (Option 1)/ Team and service management (Option 2 or 3)
2) Education project	25	20.8%	20.8%	Education
3) Peer review on participation in multidisciplinary committees	5	4.2%	4.2%	
3) Peer review on management of staff health issues	5	4.2%	4.2%	Evidence based practice
3) Peer review on ethical issues	5	4.2%	4.2%	
3) Peer review on management of a specific infection control project	5	4.2%	4.2%	Programme management and evaluation
4) Personal statement/ critical review	20	16.7%	16.7%	

Categories not included in the certification blueprint for Hong Kong infection control nurses

There are 50.1% content from AICA with no match in Hong Kong blueprint equivalent categories (shaded areas in Table 10-5). This share is largely made up by the “qualification and curriculum vitae” (25.0%). Others related to collaboration and partnership, ethical issues and continuing education and professional development. There are four equivalent Hong Kong blueprint categories (unshaded areas in Table 10-5), namely the outbreak investigation and control or the team and service management (depends on the option of submission), the education, the evidence based practice, and the programme management and evaluation, and their category weights are compared with AICA package and of Hong Kong blueprint (Figure 10-1). “Outbreak investigation and control” has greatest weight of 27.0% signifying its importance in Hong Kong certification blueprint as well as local infection control practice. In the AICA package, the “outbreak investigation and control” is covered under the optional portfolio submission (option 1), whereas the other options (option 2 or 3) for portfolio submissions relate to the “team and service management”. Optional portfolio submission means that content under the “outbreak investigation and control” may not be covered in the AICA package. If the applicants opts the “outbreak investigation and control” for portfolio submission (option 1 in Figure 10-1), it only accounts for 20.8% content weight of the whole package, less than that of Hong Kong blueprint (27.0%). If applicants pick the topics relating to the Team and service management (option 2 or 3 in Figure 10-1), the AICA package gives 20.8%, higher proportion than that of Hong Kong blueprint (12.8%). For “programme management and evaluation”, there is a great difference in content weights (Hong Kong vs. AICA; 10.5% vs. 4.2%) For “Education”, Hong Kong blueprint gives 9.6% weight, and the AICA package gives 20.8%. For “Evidence based practice”, Hong Kong blueprint and the AICA package give 7.7% and 4.2% weight respectively. AICA credentialing does not cover the content in “expert knowledge” and “surveillance”.

From the above comparison, the assessment activities (credentialing processes or certification programmes) for infection control nurse specialists organized by Hong Kong can be very different to that of Australia. Individual credentialing/ certification activities feature their local important infection control practices.

3.2 CBIC Certification Blueprint

Next the CBIC certification blueprint of the United States is compared to that of Hong Kong newly developed blueprint. In actual fact, the content of CBIC certification programme, and hence its certification blueprint for candidates' reference is not derived directly from the professional and practice standards proposed by APIC and CHICA-Canada (Horan-Murphy et al, 1999). Instead, the practice analysis, an independent procedure dedicated for CBIC certification blueprint, is held periodically by Applied Measurement Professionals, Inc. and CBIC to revise the certification content. At the time of writing, the most updated practice analysis was conducted in 2009 (Feltovich & Fabrey, 2010). The content outline of the certification examination based on this practice analysis was published for candidate's reference (Applied Measurement Professionals, Inc. & Certification Board of Infection Control and Epidemiology, Inc., 2010). There are six areas in the content outline, namely:

1) identification of infectious disease processes;
2) surveillance and epidemiologic investigation;

3) preventing/ controlling the transmission of infectious agents;

4) employee/ occupational health;

5) management and communication (leadership); and

6) education and research.

Different tasks are under areas or sub-areas. Because of different classification of categories, CBIC tasks were “translated” into equivalent Hong Kong blueprint categories for comparison as shown in Table 10-6 and Figure 10-2. Except three tasks that have no match equivalent in Hong Kong blueprint, all the other tasks can be matched into seven equivalents Hong Kong blueprint categories:

1) surveillance;

2) programme management and evaluation;

3) evidence based practice;

4) education;

5) team and service management;

6) outbreak investigation and control; and

7) expert knowledge.

Three tasks in CBIC requesting performance on “collaboration and partnership” and the “research and development” are not included in Hong Kong blueprint.

In matching, the content weight of CBIC certification programme are estimation only as there are insufficient details in CBIC content outline. The

CBIC certification examination includes 135 examination questions. Its blueprint only provides number of examination questions to be tested under individual areas or sub-areas without individual tasks information. In order to estimate the content weight of tasks, the number of tasks of an area or sub-area, was divided by the total number of examination questions of that area or sub-area, to obtain an average. By doing so, individual task weights of an area or sub-area share are the same. The category weight is the sum of all task weights under this category.

The three tasks of CBIC certification programme with no match in Hong Kong blueprint account for 13.1% content weight of its total weight. The content weight of the whole programme of Hong Kong certification and CBIC certification are comparable. By comparing the content weights of individual common categories of Hong Kong blueprint and of CBIC certification programme, four categories are similar. They are 1) Expert knowledge (24.2% vs. 27.1%), 2) Team and service management (12.8% vs. 15.4%), 3) Evidence based practice (7.7% vs. 10.2%) and 4) Education (9.6% vs. 6.9%). For the other three common categories, namely Outbreak investigation and control (27.0% vs. 7.0%), Programme management and evaluation (10.5% vs. 2.4%) and Surveillance (8.3% vs. 18.5%), the content weights of Hong Kong blueprint and CBIC programme of individual categories show great discrepancies (20%, 7.1%, 10.2%). Furthermore, “surveillance” contributes the heaviest content weight in the CBIC certification programme (18.5%), while

“Outbreak investigation and control” is the most important in Hong Kong blueprint (27.0%).

Apart from quantitative comparison in category weight, analysis was done by comparing the items/ tasks under the categories (Appendix 10-7). When comparing the equivalent categories of the two programmes, some items/ tasks may be specific to one programme but not the other, or have different content weight. The “surveillance” is the most important category in the CBIC programme. It accounts for 27.0% content weight of the CBIC programme, 20.0% more than that of Hong Kong blueprint. The CBIC Surveillance category largely consists of the tasks of “design of surveillance systems” and “interpretation of surveillance data”, while the Hong Kong blueprint covers minimum on these. The “team and service management” category of Hong Kong blueprint and of CBIC programme has similar content weights, but the item of “use of infection control link system” is unique to Hong Kong blueprint. These imply that infection control practice and main concern is different in different countries.

Table 10- 6: Translation of CBIC certification content outline to Hong Kong ICN certification content blueprint categories

CBIC certification content outline		**Translated to Certification blueprint for Hong Kong ICNs**	
Content	Task weight	Weight	Category
2A) Design of surveillance system	7.0%	18.5%	Surveillance
2B) Collection and compilation of surveillance data	7.0%		
2C) Interpretation of surveillance data (1-4,7)	4.4%		
1) Identification of infection disease processes	13.3%	27.1%	Expert knowledge
2C) Interpretation of surveillance data (5-6)	1.8%		
3C) Preventing/ controlling the transmission of infectious agents	4.8%		
4) Employee/ occupational health (2,4)	3.7%		
5B) communication and feedback	2.0%		
6A) Education (2)	1.5%		
2C) Interpretation of surveillance data (8)	0.9%	10.2%	Evidence based practice
3C) Preventing/ controlling the transmission of infectious agents	4.8%		
4) Employee/ occupational health (1,3)	3.7%		
5A) Planning (5)	0.8%		
2D) Outbreak investigation	7.0%	7.0%	Outbreak investigation and control
3A) Preventing/ controlling the transmission of infectious agents	9.6%	15.4%	Team and service management
5B) communication and feedback (2,4)	1.0%		
5C) Quality/ performance improvement and patient safety	4.0%		
5A) planning (4)	0.8%		
5B) communication and feedback (1)	0.5%	6.4%	Education
6A) Education (1,3-5)	5.9%		
5A) Planning (1-3)	2.4%	2.4%	Programme management and evaluation
3B) Preventing/ controlling the transmission of infectious agents	9.6%	10.1%	
5B) communication and feedback (3)	0.5%		
6B) Research	3.0%	3.0%	

	Categories not included in the certification blueprint for Hong Kong infection control nurses

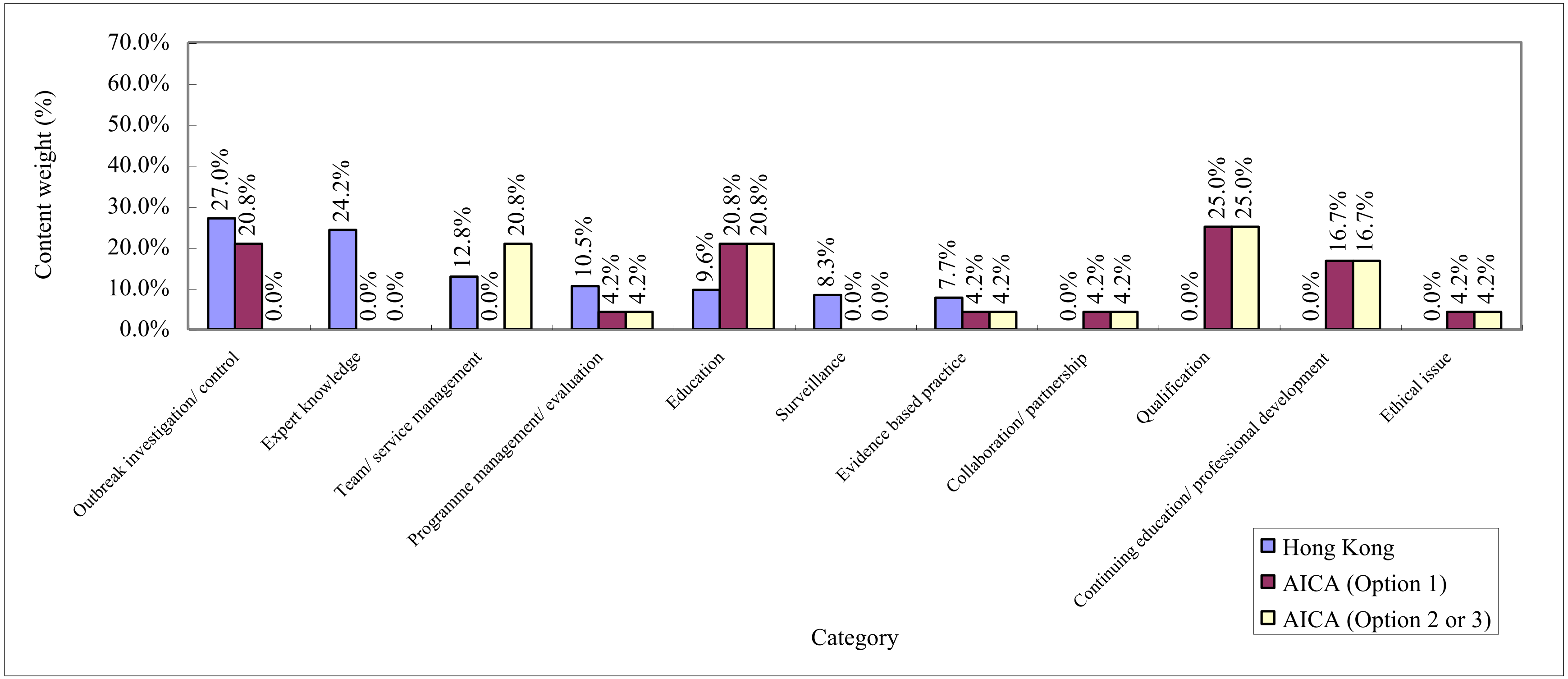

Figure 10- 1: Comparison of content proportions between the certification blueprint of Hong Kong infection control nurses and AICA (Australia) credentialing package

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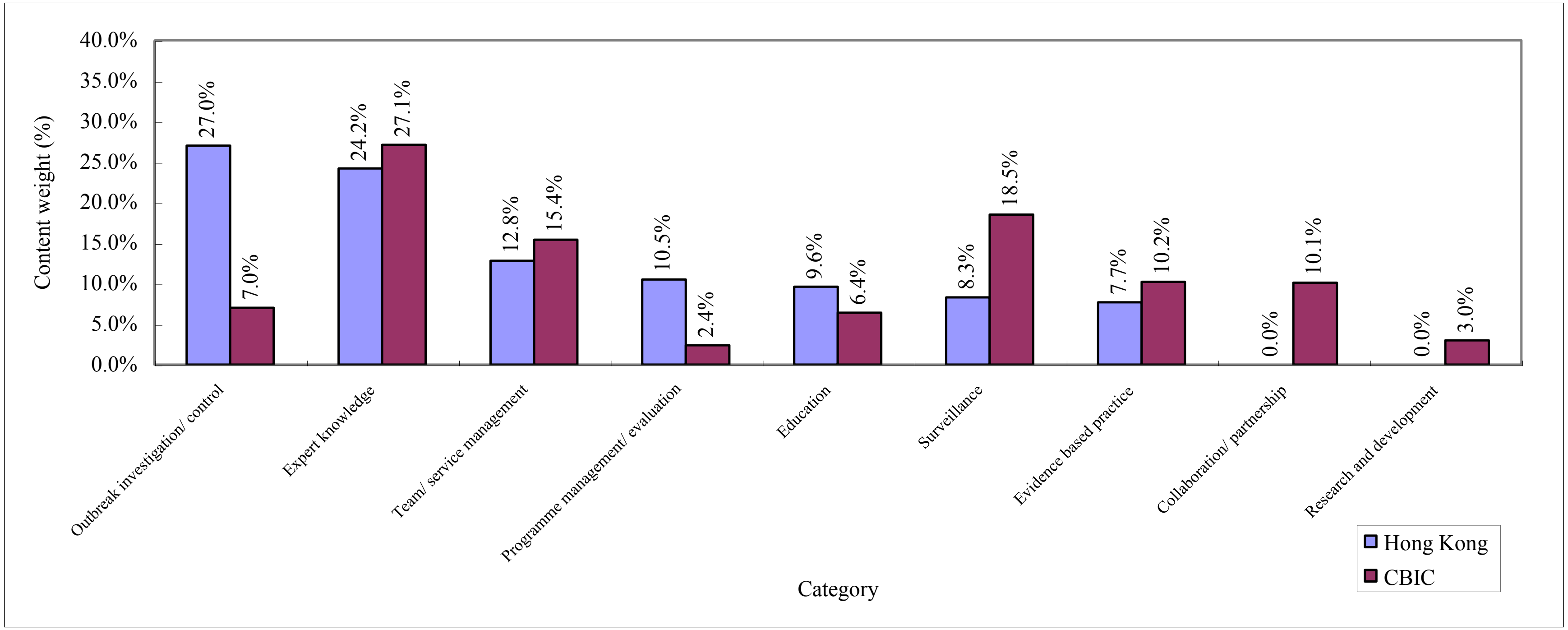


Figure 10- 2: Comparison of content proportions between the certification blueprint of Hong Kong infection control nurses and CBIC (USA) certification content outline

3.3 Comparison of Certification Blueprint for Hong Kong infection control nurses, AICA (Australia) Credentialing Package Content Outline and CBIC (US) Certification Content Outline

The three certification programmes, Hong Kong, Australia (AICA) and the United States (CBIC), are compared and depicted in Figure 10-3. Three circles are made to present each blueprint/ content outline. Individual circles include several letters indicating their competency components of individual blueprint/ content outlines. It is noted that the AICA credentialing package allows optional portfolio submissions of two competency components, the Outbreak investigation and control (Option 1) or the Team and service management (Option 2 and 3). Thus, two comparisons of the three programmes are made accordingly.

First see the comparison of the AICA – Option 1 (Outbreak management) content outline (Figure 10-4). The three circles partially overlap. Three blueprint/ content outlines have common components as shown in the centre of three partial-overlapping circles. The common components are “programme management and evaluation”, “evidence-based practice”, “education” and “outbreak investigation and control”. For the comparison of the AICA – Option 2 or 3 (Team and Service management) content outlines (Figure 10-5), the common components of three blueprint/ content outlines are “programme management and evaluation”, “evidence-based practice”, “education” and “Team and service management”, with the last common component replacing “outbreak investigation and control”.

In the three-circle diagram, the components specifically own by individual blueprint/ content outlines can be clearly shown. The AICA content outline (both optional contents) has specific components (qualification, continuing education and professional development and ethical issue). The CBIC content outline has one specific component of "research and development". Our newly developed Hong Kong blueprint has also one specific component of "Use of link person systems". During drafting the core competency items (Phase One), the "use of link person systems" was put under the category of "team and service management".

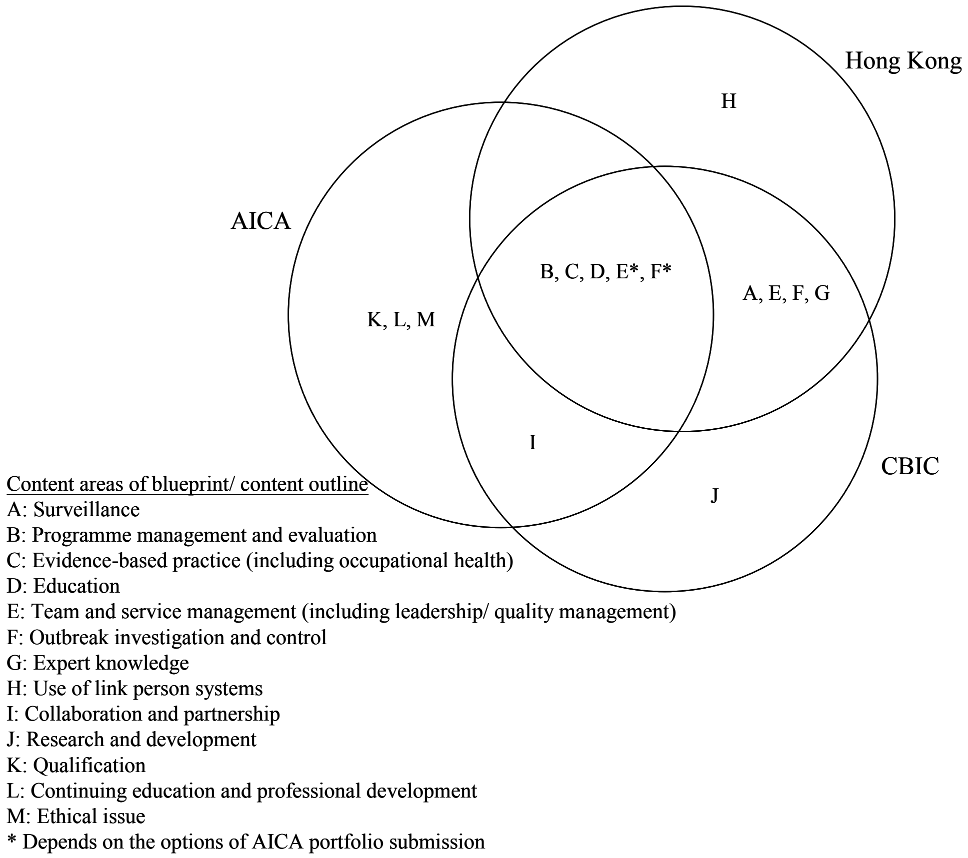
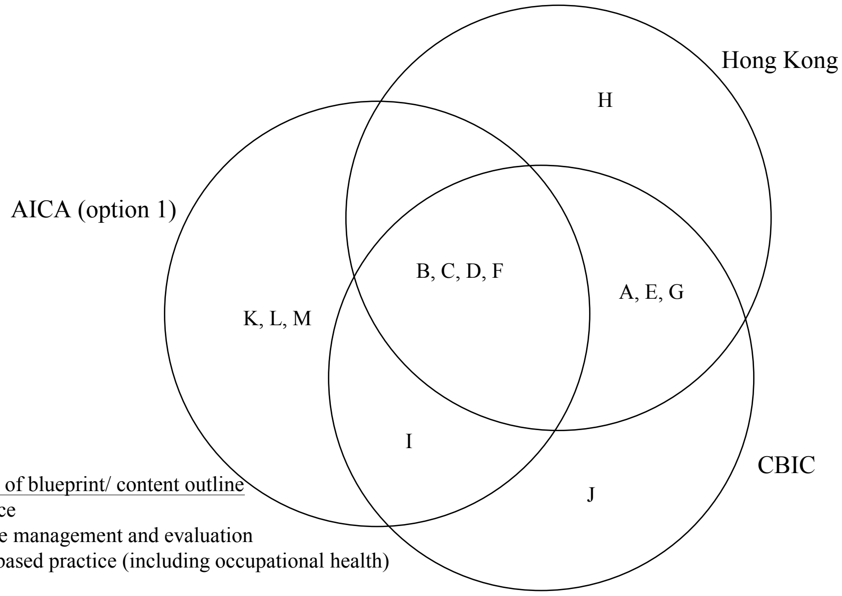
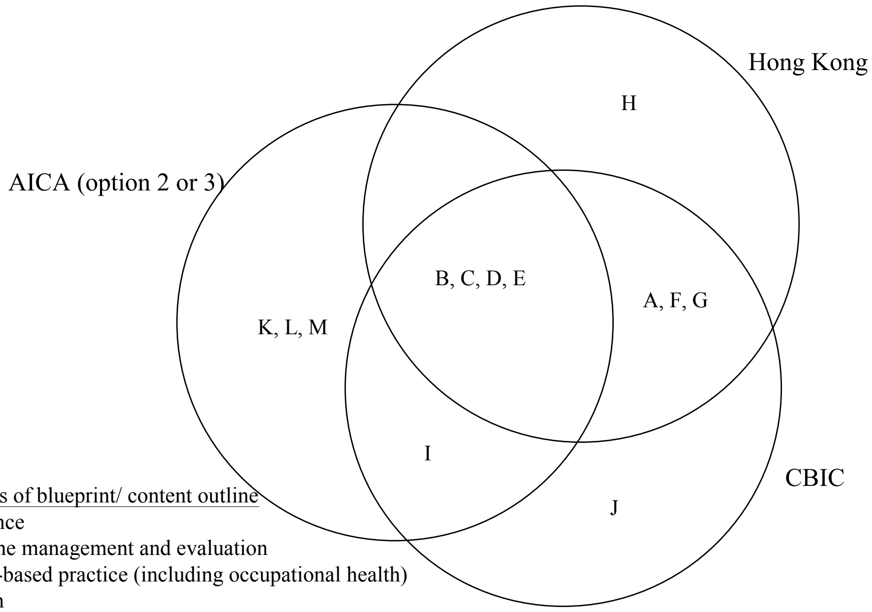


Figure 10- 3: Content areas of the certification blueprint for Hong Kong infection control nurses, AICA (Australia) credentialing package and CBIC (US) certification outline



Content areas of blueprint/ content outline
A: Surveillance
B: Programme management and evaluation
C: Evidence-based practice (including occupational health)
D: Education
E: Team and service management (including leadership/ quality management)
F: Outbreak investigation and control
G: Expert knowledge
H: Use of link person systems
I: Collaboration and partnership
J: Research and development
K: Qualification
L: Continuing education and professional development
M: Ethical issue

Figure 10- 4: Content areas between the certification blueprint for Hong Kong infection control nurses, AICA-Option 1 (Australia) credentialing package and CBIC (US) certification content outline



Content areas of blueprint/ content outline
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F: Outbreak investigation and control
G: Expert knowledge
H: Use of link person systems
I: Collaboration and partnership
J: Research and development
K: Qualification
L: Continuing education and professional development
M: Ethical issue

Figure 10- 5: Content areas between the certification blueprint for Hong Kong infection control nurses, AICA-Option 2 or 3 (Australia) and CBIC (US) certification content outline

4 Conclusion

Phase Three identified the critical competency (the most important core competency items) through expert consensus for building the certification content blueprint. The expert-defined critical competency contained 25 competency items. To avoid missing essential items, safety margin was added, by using Rasch linear scale analysis, and finally 35 items were identified as the critical competency list. After rescaling and proportioning, a certification content blueprint for infection control nurses of Hong Kong with weighted critical competency items was prepared. Unlike the blueprint development process in other common certification examinations (Feltovich & Fabrey, 2010), this research adopted Rasch measurement to analyse the data of opinion survey and interpreting the importance levels of the core competency items accurately. With the linear feature of the resultant importance levels of critical competency items can be easily transferred to content weight of the certification content blueprint (Spray & Huang, 2000; Wang, 2009).

Comparisons were made between the certification/ credentialing blueprint/ content outlines of Hong Kong, CBIC (United States) and AICA (Australia). Each of the three programmes has their own specific design in terms of content and weight. This indicates that different countries have different infection control nurse specialist training and practice of infection control. It is unwise to directly use the certification blueprint/ programme of other countries to Hong Kong. At the same time, acquiring overseas certification in infection control, e.g. CBIC, does not mean that specific local Hong Kong infection control nurses' requirement can be satisfied. In view of the urge for specialization in infection control in Hong Kong, it is necessary to develop our local certification programme. The establishment of certification content blueprint in Phase Three is the first step to develop the local certification programme for infection control nurses of Hong Kong.

CHAPTER 11

CONCLUSION, IMPLICATIONS AND RECOMMENDATIONS

1 Introduction

This research established the core competency for infection control nurses of Hong Kong and identified its most important element, known as critical competency. The results have important implications and can make substantial contributions to the areas of professional training and governance in the field of infection control. It serves as the foundation for specialist training to prepare infection control nurses. With the identification of the most important portion of core competency (critical competency), the results of this research can also be translated into a content blueprint for a programme to certify infection control nurse specialists. The concept of this research process is based on the role delineation framework proposed by D'Costa (1986). A wide range of resource inputs ensure the validity and ownership of the research outputs for the field practitioners that will facilitate implementation in the professional field in future. This concept is the core element in model establishment presented here.

In Phase One, based on the competency framework for registered nurses of Hong Kong, literature review and Delphi survey, I drafted a list of items that proposed to be representative of core competency (proposed core competency) for infection control nurses in Hong Kong. In Phase Two, I conducted an opinion survey with infection control nurses (field practitioners) on importance levels of the proposed core competency items. The survey data were analysed by Rasch measurement and resulted in the core competency of infection control nurses. In Phase Three, I defined the critical competency items and adjusted them with Rasch-based concepts to establish the certification content blueprint. The results demonstrated that using the competency framework of registered nurses of Hong Kong (The Nursing Council of Hong Kong, 2004) and role delineation model by D'Costa (1986) to establish the professional core competency for nurse specialists were feasible in this context.

The next section begins with briefing the findings of this research phase by phase and how they can answer the three research questions satisfactorily. It also examines the identified core competency and describes a process model to develop the content of certification, which is created according to the study results. Then, the implications of this research, limitations and suggestions for further research are discussed.

2 Summary of Research Findings

The summary of research outputs is tabulated in Table 11-1. Phase One proposed a list of items by which the core competency of infection control nurses in Hong Kong can be judged (83 items in 10 categories). I derived the preliminary content based on the competency framework of Hong Kong registered nurses, literature review and then the Delphi survey to collect the input from the experts to draft the content. A draft of core competency categories was developed first. Then, individual items were drafted by repeating the drafting cycle. After validity and reliability tests were performed with satisfactory results, the core competency items and the rating scale of the questionnaire were proposed for use in Phase Two.

Phase Two identified 76 core competency items in 10 categories based on input from field practitioners collected through an opinion survey. The survey data were analysed by the Rasch measurement. The analysis converted the ordinal data to a linear importance scale and each item was assigned an importance level.

In Phase Three, using expert consensus, the expert-defined critical competency of infection control nurses of Hong Kong was defined in terms of 25 items. After adding a safety margin based on the Rasch measurement concept, the final critical competency item list for infection control nurses of Hong Kong was fixed as 35 items in 7 categories. The importance levels of the critical competency items were translated into the content weight of individual items.

This list constituted the content blueprint of a certification programme for infection control nurses in Hong Kong.

Table 11- 1: Summary of research outputs

Phase	Objective	Procedure	Output	
			Major output	**Other output**
One	Establish proposed core competency	Reviewed literature to develop the preliminary core competency categories	13 preliminary core competency categories	
		Delphi survey on the draft core competency categories	11 draft core competency categories	
		Reviewed literature to develop preliminary core competency items	58 preliminary core competency items	
		Delphi survey on the draft core competency items	51 draft core competency items (in 10 categories)	
		Split double-barrel items	64 draft core competency items	
		Validated the content of the draft core competency by experts		Content validity indicators
		Tested the reliability of the draft core competency and the rating scale	64 proposed core competency items	Reliability indicators; Scale of questionnaire
		Split double-barrel items	83 proposed core competency items (in 10 categories)	
Two	Identify core competency with perceived importance levels	Developed the questionnaire for infection control nurses	83 proposed core competency items in questionnaire format	
		Administered questionnaire to infection control nurses followed by Rasch analysis	76 core competency items (in 10 categories)	Each item has an importance level
Three	Defining critical competency and building certification content blueprint	Defined the critical competency by expert consensus	25 expert-defined critical competency items	
		Added Rasch-based safety margin to expert-defined critical competency	35 critical competency items (in 7 categories)	
		Rescaled and calculated item weights of critical competency	Certification content blueprint (35 critical competency items with weights in 7 categories)	

3 Answering the Research Questions

Below are the answers given for each of the research questions.

3.1 Research Question 1

What is the critical competency for infection control nurses of Hong Kong?

Critical competency is the most important portion of the core competency of infection control nurses of Hong Kong. Phase Two identified the core competency for Hong Kong infection control nurses. The critical competency items were defined in Phase Three. There were 35 items (Appendix 10-3). They included 25 expert-defined critical competency items and 10-items for providing a safety margin. A certification content blueprint for infection control nurses was organized using the 35-critical competency items and their respective importance levels. The item content weights were translated by rescaling and proportioning of the respective importance levels. They ranged from 4.4% to 2.3% (Appendix 10-5).

3.2 Research Question 2

To what extent are the perceptions of importance of infection control nurses influenced by the nurses' background characteristics? The perceptions of importance of infection control nurses on the core competency items were analysed in Phase Two. The background of infection control nurses, including academic qualifications (having a master degree or not), position rank (junior vs. senior), work modality (part-time vs. full-time) and funding of the hospitals (public vs. private) were found to influence the perceptions on the core competency items. A summary of the background factors found to have an influence on the opinions of infection control nurses are shown in Table 11-2.

Table 11- 2: Influential background of infection control nurses (ICNs)

Background of ICNs	No. of items affected	Locations (logit) of affected items	Range of DIF contrast
Academic qualification	7	-0.60 – 0.66	0.54 - 1.34
Work modality	3	-1.05 – 0.87	0.60 – 1.72
Position rank	1	0.37	0.83
Hospital funding	5	-1.73 – 0.45	0.68 – 2.44
All	14	-1.73 – 0.87	0.54 – 2.44

Fourteen (18.4%) core competency items were influenced by the background of infection control nurses. Two items were affected by two influential factors. Eight (57.1%) of the 14 items lay within the boundary of critical competency (between -2.36 and -0.17 logits). These are tabulated in Table 11-3. Among the four influential factors, position rank did not influence the perception of critical competency items. One item “item 70: Demonstrate knowledge of asepsis” was influenced by two factors, hospital funding and work modality. “Academic qualification” remained the most influential factor of the perceptions of infection control nurses on the critical competency items; this factor was followed by “hospital funding”

Table 11- 3: Critical competency items influenced by background of Hong Kong infection control nurses

Critical competency items	Influential group
(2) Use standardized definitions to conduct surveillance.	Hospital funding
(22) Periodically evaluate the effectiveness of the infection prevention and control programme.	Hospital funding
(28) Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	Academic qualification
(29) Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	Academic qualification
(32) Develop educational objectives and strategies to meet the client needs.	Academic qualification
(49) Identify opportunities for service improvement.	Academic qualification
(70) Demonstrate knowledge of asepsis.	Hospital funding
	Work modality
(72) Demonstrate knowledge of educational skills and tactics.	Academic qualification
	Hospital funding

3.3 Research Question 3

To what extent can perceptions of importance be used to identify the critical competency (the most important portion of core competency) for infection control nurses? Phase Two identified the perceptions of importance of individual core competency items. The locations lie between -2.36 and 1.9 logits. These locations give the importance levels of individual core competency items for further assessment. First, it helps to generate a core competency list from the most important to the least important for experts' consideration to suggest a cut-off point for the most important portion, which is known as expert-defined critical competency (between -2.36 and -0.37 logits). Second, the standard error of the last expert-defined critical competency item serves as the safety margin of the expert-defined critical competency, resulting in the true-critical competency for infection control nurses (between -2.36 and -0.17 logits) after additional of this margin. Third, the linear relationship of this set of logit locations can be directly transcribed into the content weights of individual critical competency items based on the mathematic proportioning of its boundary.

The research work successfully answered the research questions. The findings contribute to the field of infection control in Hong Kong. With the publication of such research outputs, the research processes can be used to establish a model for developing the content blueprint of certification for healthcare professionals.

4 Core Competency of Infection Control Nurses of Hong Kong

The core competency of infection control nurses of Hong Kong is the core output of this research.

4.1 Conceptual Framework

The conceptual framework for identifying the core competency for Hong Kong infection control nurses is the competency framework of Hong Kong registered nurses (The Nursing Council of Hong Kong, 2004). The framework consists of five competency areas, namely 1) professional, legal and ethical practice; 2) health promotion and health education; 3) management and leadership; 4) research; and 5) personal effectiveness and professional development. After going through the inputs from literature, experts and field practitioners, the core competency of infection control nurses results in a 10-category structure, including 1) surveillance; 2) programme management and evaluation; 3) evidence based practice; 4) education; 5) team and service management; 6) collaboration and partnership; 7) outbreak investigation and control; 8) Research and development; 9) expert knowledge; and 10) continuing education and professional development. The 10 categories fit into the five competency areas of the conceptual framework. Table 11-4 shows their relationships.

Table 11- 4: Conceptual framework of core competency of infection control nurses of Hong Kong

Competency areas of conceptual framework	**Competency categories of infection control nurses**
Professional, legal and ethical practice	Surveillance
	Evidence based practice
Health promotion and health education	Education
Management and leadership	Programme management and evaluation
	Team and service management
	Collaboration and partnership
	Outbreak investigation and control
Research	Research and development
Personal effectiveness and professional development	Expert knowledge
	Continuing education and professional development

In this connection, the core competency framework of infection control nurses includes five areas. The "Professional, legal and ethical practice" area demonstrates that the infection control nurses are proficient in applying epidemiological principles, evidence-based knowledge and other problem solving skills to perform specialist duties safely, legally, ethically and effectively. The "Health promotion and health education" area shows that the infection control nurses are able to work with other partners, such as other healthcare providers, clients, families and the community, in preventing infections and infectious diseases, promoting and protecting the health of the individual and society. The "Management and leadership" area illustrates that the infection control nurses are able to execute effective managerial and leadership skills when providing quality infection control services. They are also able to initiate and implement change conducive to the improvement of healthcare provision; contribute to infection prevention and control policy formulation when working with other healthcare team members and community sectors. On the other hand, they are able to assess and manage infection risks and crises. The “Research” area demonstrates the infection control nurses can apply the knowledge and skills in infection control related research and collect, analyse, interpret and use the research data to improve infection prevention and control practices. The “Personal effectiveness and professional development” area shows that the infection control nurses are able to develop and maintain infection prevention and control as a profession and maintain the individual’s status as a professional infection control nurse specialist. The core competency framework for infection control nurses of Hong Kong is depicted in Figure 11-1.

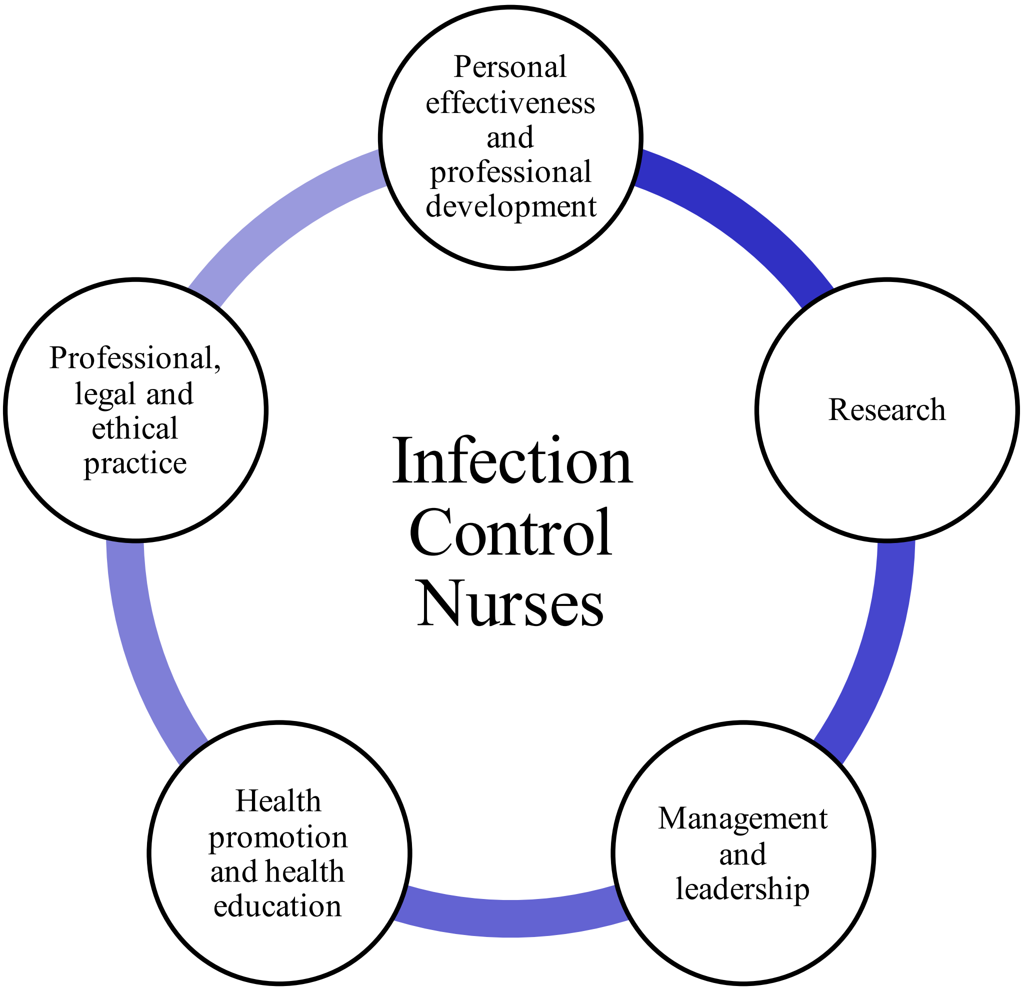
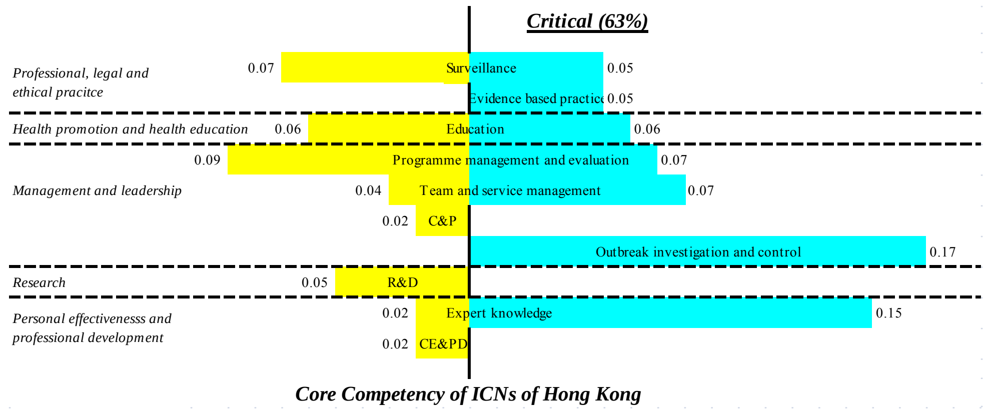


Figure 11- 1: Core competency framework for infection control nurses of Hong Kong

The core competency of infection control nurses is a comprehensive requirement for infection control nurses. Phase Three identified the most important portion of this core competency, known as critical competency, to serve as the content of certification. Thirty-five core competency items consisted of 63% weight of core competency were considered as critical competency. Figure 11-2 depicts the core competency of infection control nurses of Hong Kong. The diagram outlines the framework in five competency areas from top to bottom and each area is demarcated by dotted lines. Each competency area may contain more than one competency category. There are 10 competency categories in the five areas. Each competency category is represented by one coloured bar, running from right to left. The vertical line may divide the competency categories into core competency in yellow and critical competency in blue, showing on the left-side and the right-side respectively. The irrespective content weights in numeric forms are described next to the bars. Among 10 categories of core competency, three of them are out of the scope of critical competency; they are “collaboration and partnership”, “research and development” and “continuing education and professional development”. When looking into the core competency framework for infection control nurses (Figure 11-1), the “research” area is the only component that is excluded from the critical competency.



C&P = Collaboration and partnership
R&D = Research and development
CE&PD = Continuing education and professional development
ICN = Infection control nurse
Core competency
Critical competency

Figure 11- 2: A diagram on core competency for infection control nurses of Hong Kong

Figure 11-3 depicts the core competency model of infection control nurses of Hong Kong, which shows the relationship between core competency and critical competency within the competency framework. The yellow oval, containing five competency areas, is the core competency of infection control nurses. The blue circle is the critical competency of infection control nurses, which is the most important part of the core competency. However, it only covers four competency areas in the comprehensive core competency where the "research" area is omitted. The findings inform the infection control practitioners, their employers and the public about the required proficiency of an infection control nurse of Hong Kong. On the other hand, the critical competency, which is embedded within the core competency, is recognized as the most important element in the core competency, which infection control nurses must be accomplished and it should be covered in the content of certification programme.

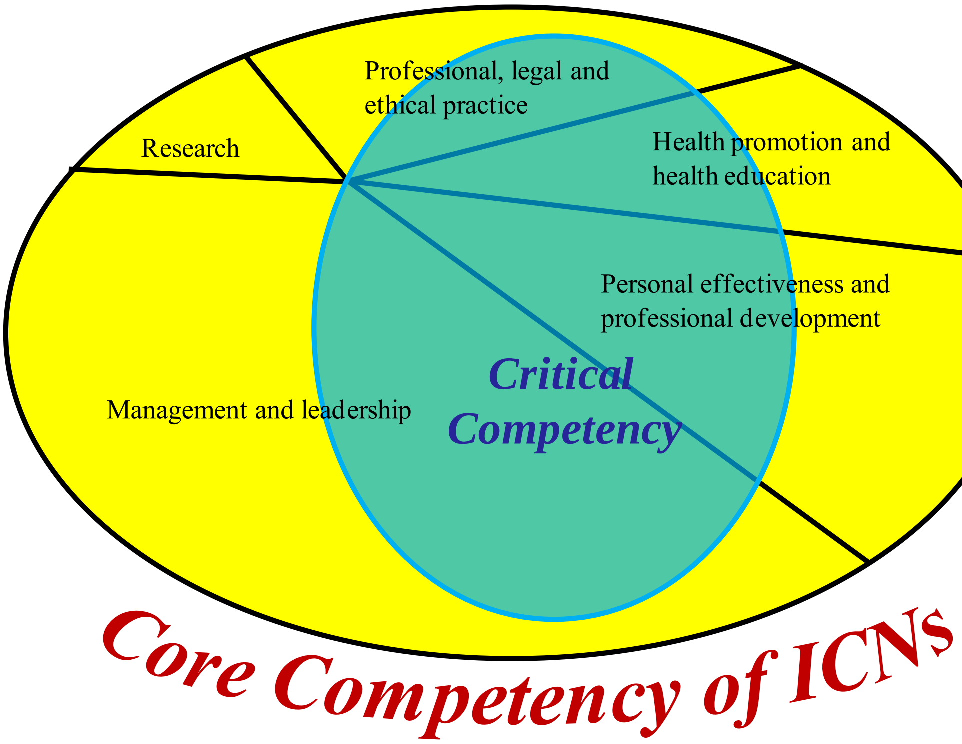


Figure 11- 3: Core competency model for infection control nurses of Hong Kong
(ICN = Infection Control Nurse)

4.2 Construct Validity

Construct validity is the heart of the validity issue, representing the central principle in educational and psychological measurement (Messick, 1981). It measures whether the items are representative enough to show the underlying conceptual structure in the questionnaires or scale (Rattray & Jones, 2007). The assumption of Rasch measurement is unidimensional. The core competency scale developed in this research fits into the Rasch model showing the unidimensionality of the core competency scale. This was supported by majority (77.3%) of the variances explained by the model and only a small level among the residuals of unexplained variance was identified in the first contrast (Baylor, Yorkston, Eadie, Miller & Amtmann, 2009). The Rasch analysis illustrated explicit evidence of the construct validity of the core competency scale during analysis of variances.

There are two threats in construct validity. The first is "construct under-representation" and the other is "surplus construct irrelevancy" (Messick, 1993). Construct under-representation can be overcome if a comprehensive domain specification is used during construction of the test. In this research, a conceptual framework of registered nurses was used. The proposed work (proposed core competency) went through a comprehensive competency identification procedure. It was initially prepared through literature review by an experienced (more than 10 years) infection control nurse (the investigator). The work then went through a consensus process by a group of field experts. The proposed product was further validated by the content experts, who were the field experts. After collecting the input from the field practitioners, the final 76-item core competency was constructed by Rasch analysis. Through these stringent processes, the possibility of missing construct in the core competency scale was not likely, or was only limited. During Rasch analysis, the final output (76-item core competency) illustrated in the Wright map (Figure 9-4) shows the items lay evenly along the scale in a bell-shape without gaps inside. This illustrates that nothing of importance was left out, although the targeting of the map is not perfect, and this will be discussed in later sections (Baphaei, 2008).

The principles of the Rasch measurement are based on Messickian construct-validity issues. The misfitting items represent examples that lie outside of the single dimension. This indicates irrelevant test variance (Baghaei, 2008). Removing these misfitting items ensures the construct validity of the core competency scale in this research (Wright & Masters, 1982). The surplus construct irrelevancy is not likely.

In the opinion survey conducted in Phase Two of this research, the participants, the on-job infection control nurses of hospitals in Hong Kong, were requested to rate the importance (in 5-option Likert scale) of the individual proposed core competency items (83 items). The options were:

(1) Not very important
(2) Not important
(3) Neutral
(4) Important
(5) Very important

Appendix 11-1 displays the probabilities of response categories on each core competency item. No rating fell in the category of "not very important". For the most important item (Item 74: Demonstrate knowledge of infectious diseases), all the ratings fell in either "important" or "very important" categories. For the least important item (Item 78: Demonstrate knowledge of biostatistics), no rating fell in the "not important" category while the probability of rating in the “neutral” category was 0.29. Although it was the least important item, probabilities of being rated as “important” and “very important” were 0.55 and 0.16 respectively. As a whole, the participants endorsed all the items in the core competency scale as important items but with different levels of importance.

4.3 Content Validity

To discuss the content validity of the newly identified core competency of infection control nurses of Hong Kong, two aspects are considered, namely content relevance and how representative the content was (Messick, 1993).

4.3.1 Content Relevance

The total body of information of core competency of infection control nurses identified in this research was guided by the core competency framework originally used in core competency of registered nurses of Hong Kong (The Nursing Council of Hong Kong, 2004), though little experience on its use was evident. The core competency identification in this research is adopting the concept of role delineation for healthcare professionals from D’Costa (1986). Three sources of input, namely literature, experts and field practitioners are used. The wide range of input ensures the content validity of the core competency. Although the content validity indices shown in Phase One contradictorily ranged between 0.75 and 0.90, the majority ratings (91%) in the opinion survey of field practitioners, fell into the options of “important” and “very important” illustrating that the field practitioners agreed with the most of the core competency items proposed by the experts. This is evident of the validity of the content of core competency for the practitioners.

During drafting of the core competency items (Phase One), a group mixed with medical and nursing experts was employed. The drafted product (51 core competency items) showed excellent agreement between the experts with 0.84 free-marginal multi-rater Kappa (Cicchetti, 1984). In the content validation process, three experts (all were infection control officers) also showed good level of agreement and a 0.67 free-marginal multi-rater Kappa was noted. These quantifying indices together with the validity indices support the content relevance of core competency of infection control nurses of Hong Kong.

4.3.2 Content Representativeness

Content representativeness refers to the content proportion of individual core competency items, which is critical and legally required (Thompson & Thompson, 1982). The content weights of individual core competency items are critical as some of them are defined as critical competency to ultimately serve the content blueprint of certification programme. Ordinal ratings of the importance level were collected in the opinion survey (Phase Two). Rasch analysis converted the ordinal ratings to a linear scale where the locations of individual items were identified. These locations in logits are directly translated into the content weights of individual items (Spray & Huang, 2000; Wang, 2009). When the critical competency items are defined, the importance levels of individual items remain the same. The content weights are only adjusted (proportioning) based on the boundary of competency items.

Most of the research on competency identification or certification content blueprint development used traditional statistics, such as mean ratings of participants to develop the content weights of the competency items (Feltovich & Fabrey, 2010; Lin, Hsu, Li, Mathers & Huang, 2010; Willens, DePascale & Penny, 2010). The linear data assumption applied on non-linear data structure of an ordinal scale distorted the data proportion, resulting in inaccurate data analysis. In this research, use of the Rasch analysis ensured accurate representativeness of importance levels of individual competency items.

5 The Process Model

A valid core competency for infection control nurses has been successfully identified in this research showing that the proposed competency framework and identification process are feasible. Based on the results of this research, a model for developing the content blueprint for certification for healthcare specialists is derived as shown in Figure 11-4.

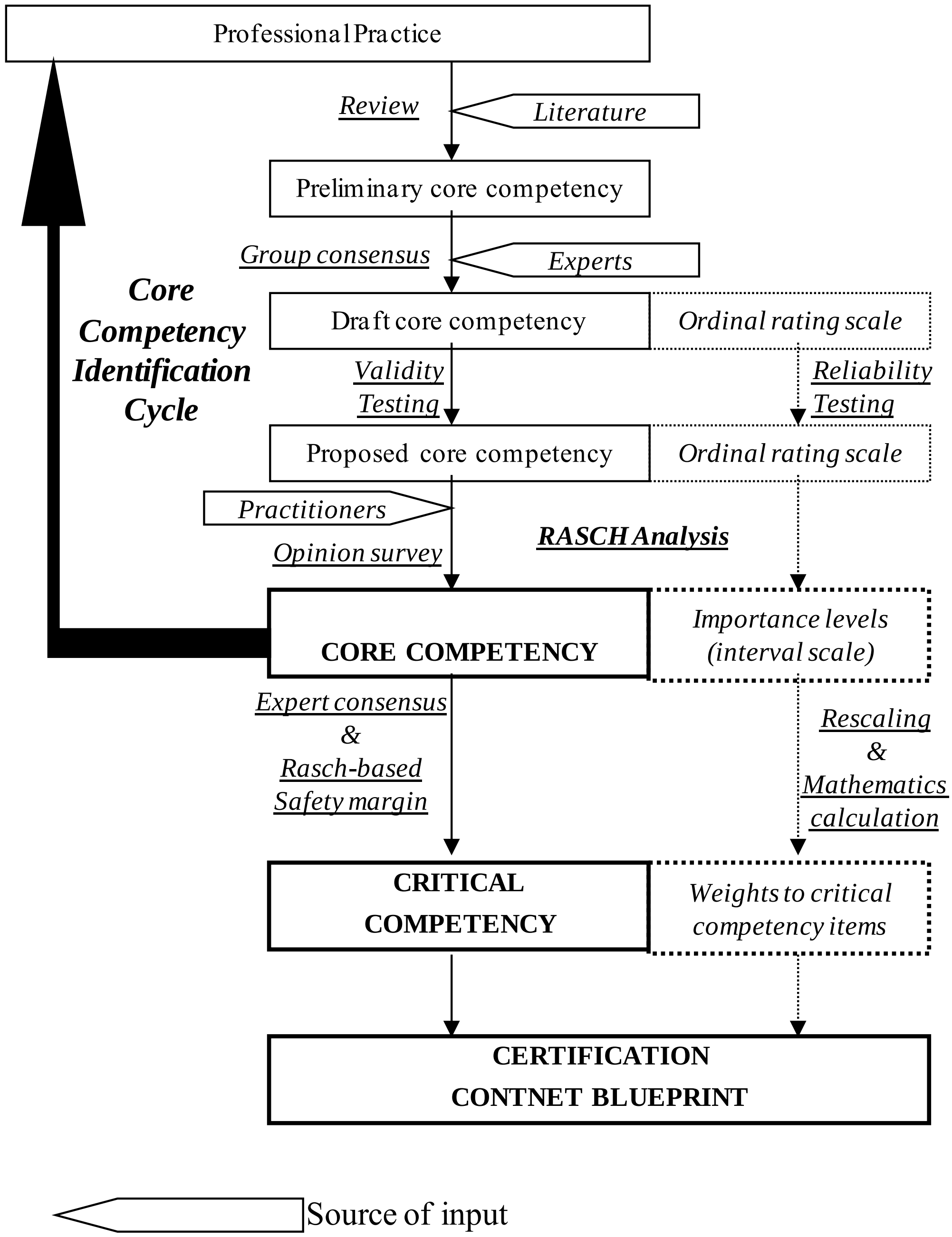


Figure 11- 4: A model of developing content blueprint for certification programmes

The model in Figure 11-4 shows how the certification content blueprint for healthcare specialists is developed in accordance with professional practice. The core competency identification cycle is the core component of this model.

With the critical competency identified, core content of the certification (critical competency) is defined and then the content blueprint is created. These three components of the model, namely, the core competency identification cycle, the critical competency and certification content blueprint are discussed in details in the following sections.

5.1 Core Competency Identification Cycle

A certification programme is only valid when its content is derived from professional practice (D'Costa, 1986; Larson, Elsenberg & Soule, 1988). Core competency is the capability of a practitioner to perform his or her duties. However, core competency of a profession is dynamic. It relates to professional development; ideally, it evolves as the duties of practice change. When the practice changes, a professional needs to be trained appropriately in order to maintain his or her level of the core competency. Certification is used to ensure the professional is competent to carry out the duties. This is the validity issue of the certification programme. Therefore, competency assessment must be continuous; it is not a one-off process. .

The process of core competency identification in this model adheres to the proposal of D'Costa (1986). It describes the role delineating process for healthcare professionals. Three resources of input are literature, experts and practitioners.

5.1.1 Input from Literature

To start the core competency identification process, professional practice is reviewed in the literature (Calhoun, Davidson, Sinioris, Vincent & Griffith, 2002). This is the literature input stated by D'Costa (1986). I call the output from the literature review "preliminary core competency".

5.1.2 Input from Experts

Standards set by the practitioners themselves may not be the most desirable standards from their clients' point of view. Field experts, senior practitioners and infection control officers, should also be invited to give feedback on the preliminary core competency content, both the category and item levels (Bonner & Stewart, 2001; Calhoun et al., 2002; Powell, 2003). To collate the wisdom from the experts, a group consensus method using experts as the participants is proposed to draft the core competency. The expert group in this research consisted of distinguished infection control officers and infection control nurses in Hong Kong. This is the "expert input" as proposed by D'Costa (1986).

5.1.2.1 Group Consensus

No specific group consensus method is recommended in the model. Different group consensus methods have their strengths and limitations. The model suggests that each researcher employs a group consensus method that fits his/her particular situation.

The most common group consensus methods are consensus development conference, Delphi method, nominal group technique and RAND/ UCLA appropriate technique (Halcomb, Davidson & Hardaker, 2008). The consensus development conference is a face-to-face debate on the current scientific evidence related to the policy and practices. The result of the method is relatively implicit. The nominal group technique results in more explicit outcomes. Panel members give their individual comments before sharing with others. The idea is then discussed face-to-face and voted upon. RAND/ UCLA appropriate technique is similar with nominal group technique but the individual comments are collected through a survey. The ideas from the survey are then shared with another panel. A face-to-face discussion is held and then vote upon. The major difference of the Delphi method from the three mentioned previously is that it does not involve any face-to-face discussion. However, interaction still occurs through a coordinator (the investigator) as all the ideas from the panel members are summarized and shared in the survey questionnaire. Members have the privacy to express their original ideas. In this research, the expert panels are composed of mixed healthcare disciplines, including doctors and nurses. Doctors are usually in a higher hierarchical position than nurses in Hong Kong. This phenomenon suppresses the intention of nurses to voice out their ideas. In view of this, the Delphi method was used in the research to encourage the participation of nursing experts in the expert group.

Based on the preliminary core competency content, the group consensus method is used to draft the core competency of the specialists to prepare for the content of the questionnaire to collect the input from the field practitioners to identify the core competency. Validity and reliability tests are required to ensure the content and scale of questionnaire are appropriate. The draft core competency with validity and reliability tested is known as "proposed core competency".

5.1.2.2 From Competency Categories to Competency Items

The core competency drafting process includes the inputs from literature and experts. The competency categories are drafted first. Based on the draft competency categories, the competency items are drafted according to the procedure of literature review and group consensus. In this research, the competency categories of the nurse specialists are derived based on the generic competency areas of nurse generalists of Hong Kong and literature review on the specialist practice. The draft competency categories provide the scope for drafting the core competency items. This drafting approach, from macro to micro perspective, assists the literature review and expert input in a more systematic way of competency identification (Griffin, Cuc, Gillis & Thanh, 2006). It guides the experts to achieve the consensus step by step. Of course, competency categories are allowed to be added, removed or combined during the core competency item drafting process. However, this did not happen in this study.

5.1.3 Input from Field Practitioners

An opinion survey is used to collect the input from the field practitioners to create the buy-in effect (Calhoun et al., 2002). After the input from the literature and experts, the proposed core competency is transcribed into a questionnaire using the confirmed rating scale. The rating scale used in the questionnaire to collect the opinion on proposed core competency items in the practitioners' view is an ordinal scale, whether the question is about the importance or significance of the items. In the feature of inconsistent distances between the scale options of the ordinal scale, traditional statistics under classical test theory, such as assessing the mean values, is inappropriate for the data analysis (Bond & Fox, 2007). Use of the Rasch measurement is powerful in this area in that the ordinal raw scores will be converted to linear interval scale (Granger, 2007). The locations of the core competency items represent their importance or significance levels. These locations, or importance levels of core competency items, are translated to the content weights directly in the later stage of the research work. The analysis facilitates objectively identifying the noisy items for consideration of exclusion. Finally, a professional core competency with importance level in each core competency item results.

5.1.4 Importance of the Cycle

As stated at the beginning of core competency identification cycle, the professional core competency should be revised when the professional practice is changed. Therefore, the core competency identification cycle is repeated regularly or irregularly to reflect the up-to-date professional practice of the practitioners.

5.2 Critical Competency

The professional core competency identified in the core competency identification cycle in the model is a comprehensive list of core competency items for the practitioners. The list is too long or too impractical to make into a certification programme. In fact, only the most important core competency items should be tested for the certification in views of practicability and economy (D'Costa, 1986). The most important core competency items are named as "critical competency items" in this study. As the core competency identified from the core competency identification cycle is having the importance levels attached to individual items, it is not difficult to find which items are more important and which are less important. However, when the core competency items are listed from the most important to least important, making a cut-off on the core competency list to define the critical competency items is really a difficult task. This hard job is then left to the field experts. The expert consensus with private decision and justification results in the expert-defined critical competency. The process of defining the critical competency does not end at this point. Due to the imprecision of the Rasch item estimation, a safety margin is needed to be added to ensure the true critical competency items are included in the content blueprint. Standard error of the cut-off item is the safety margin. Using the concept of the Rasch measurement, the safety margin (standard error in logit) is added at the cut-off location (in logit) on the linear core competency scale to identify the cut-off location of the true critical competency level. The competency items in the defined range of importance levels contribute to the critical competency for the specialist group.

5.3 Certification Content Blueprint

After the Rasch analysis, the importance levels of the items are ready for transferring to the content weights directly when the locations (importance levels) of all the items are in positive values and in a form that the more important item has higher logit and less important item gets a lower logit. The fact is the Rasch measurement is in a reverse situation where a more important item has a lower logit while a less important item gets a higher logit based on the scale used in the questionnaire of this research. Moreover, some items have negative values. Utilizing the Winsteps software programme (Rasch analysing programme), the items are rescaled to positive values with reversed locations. Then, the content weights of individual items are calculated based on their proportions of the total weights in the critical competency. The boundary of the critical competency items with item content weights is the content blueprint of certification programme.

When the practice is changed, the professional core competency is revised. After revising the professional core competency, the certification content blueprint is adjusted. This model of developing the certification content blueprint describes the core competency identification cycle followed by critical competency defining and weights transferring procedures, thus resulting in a certification content blueprint.

A good credentialing examination should be valid for the users, who are the practitioners (D’Costa, 1986). Valid refers to both the content and its proportion. It is suggested that the validity issues is documented throughout the whole process of examination development. This model of certification explicitly describes the process of developing the content blueprint of the certification programme, and contributes to the major concern of the validity issues.

6 Implications of this Research

6.1 Core Competency Framework of Nursing Profession

By sharing the same conceptual framework for registered nurses and infection control nurses in this research, underpinning the differentiated practice model, the core competency concept for infection control nurses proposed in Figure 6-7 has been confirmed. Under the same conceptual framework, registered nurses serve as the first practice level and infection control nurses serve as the second practice level. This concept can be generalized from infection control nurses to the nursing profession and is depicted in Figure 11-5.

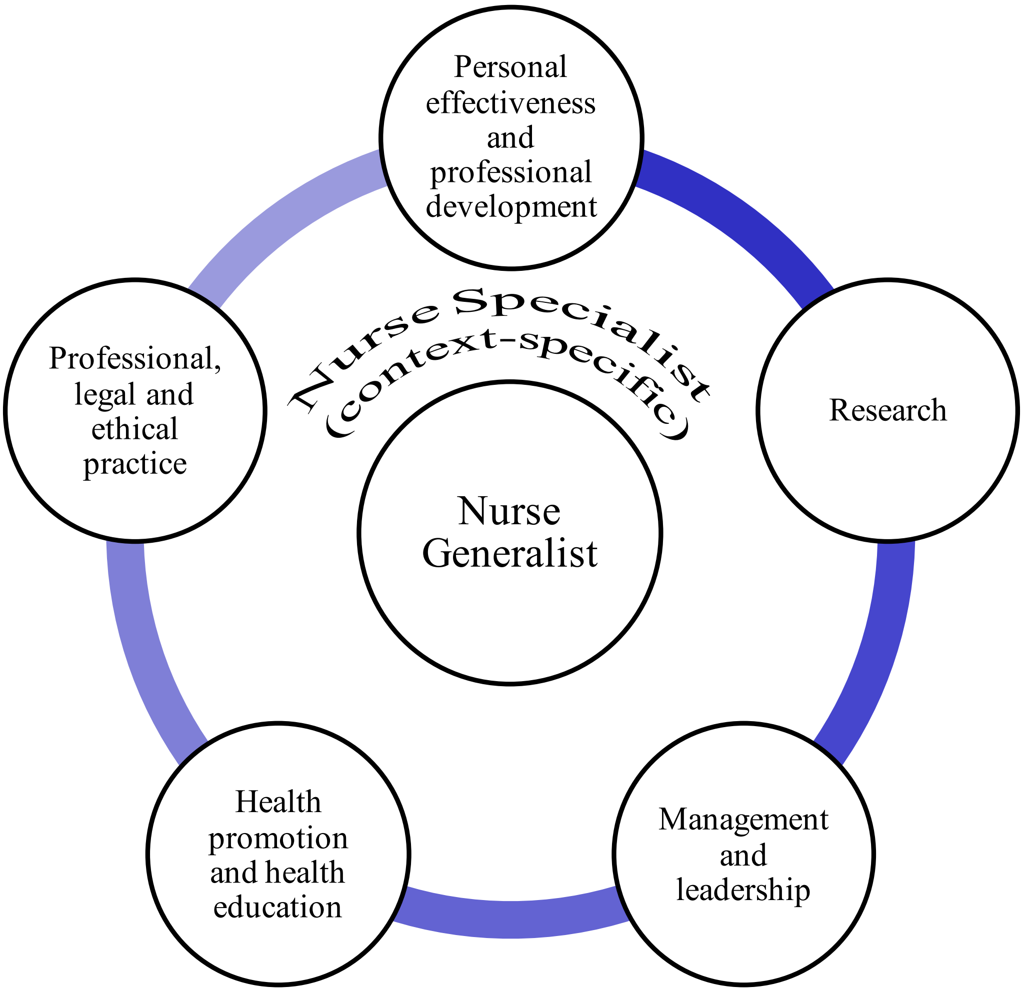


Figure 11- 5: Core competency model for nursing profession (context-specific)

The core competency framework for the nursing profession is described in the outer most circle to serve the boundary of core competency. The five competency areas of framework are professional, legal and ethical practice, health promotion and health education, management and leadership, research, and personal effectiveness and professional development. The first area "professional, legal and ethical practice" has been modified from "professional, legal and ethical nursing practice" as not all the practice of nurses is "nursing practice", such as infection control nurses. Under this core competency framework, nurse generalist is the first practice level and its core competency is generic. The second practice level is nurse specialist but its core competency is context-specific to individual specialties. This precise core competency for nurse specialists is ready-to-use once identified, such as for training and assessment.

6.2 Professional Training for Specialists

The process model built in this research is not only a tool or guide to develop the content blueprint for a certification programme. It also influences the whole system of professional development activities within that specific group of specialists. The implication of the model is presented in Figure 11-6. The left side of the figure describes the process model of developing the content blueprint for certification programme that have been explained in point 5 of this chapter. The shaded circle on right side of the figure is the certification cycle. The implication of this model involves the practitioners in the healthcare field when they advance from generalists, specialists and then certified. The areas of concern include the training and certification for specialists.

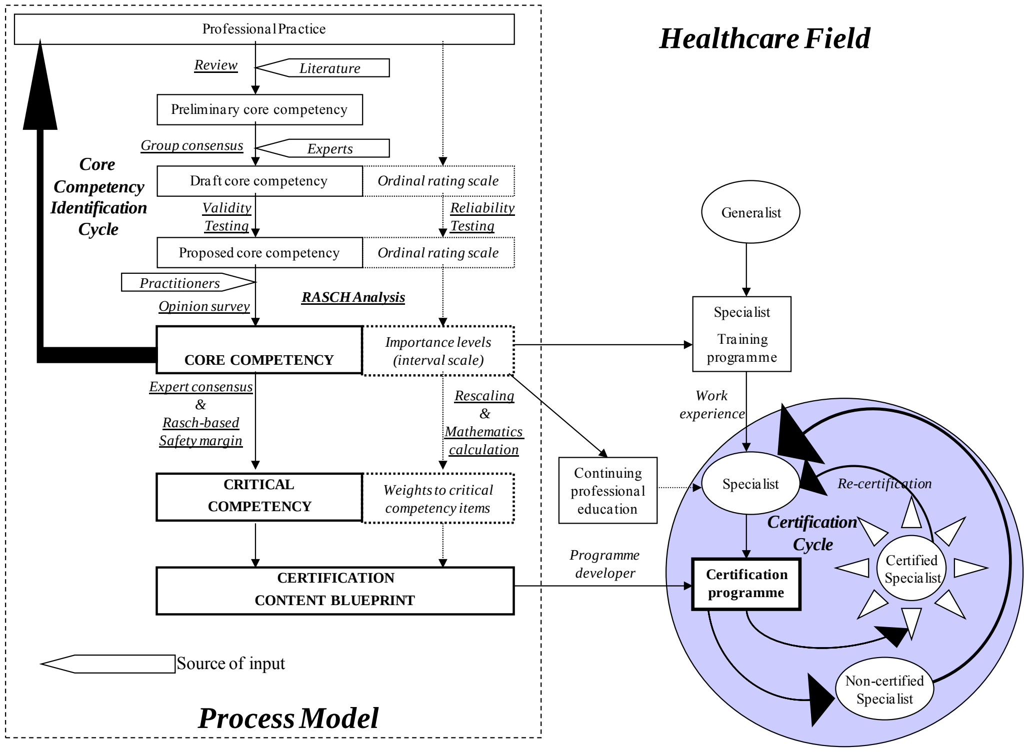


Figure 11- 6: Implications of the process model

A generalist receives the training and then becomes a specialist after experience gained. In addition to training, experience is linked to knowing what to do and knowing how to do it (Kucera, Higgins & McMillan, 2010). When this process model of developing certification content blueprint is absent, the basis of a training programme is unknown. The validity of the training programme comes into question. The problem of the practice gap is created as pointed out by Lenberg (1999) because training and the promoted practice are independent. In the process model developed in this research, professional core competency is identified to be not the sole purpose for the certification. It can be used to develop the training programme for the generalists to prepare them to be the specialists. Other continuing professional educational activities are also derived for the specialists as the professional practice is dynamic. The model does not end with the core competency identified. The further defining critical competency and content weight calculation finally build the certification content blueprint. Based on this blueprint, the test/ programme developers develop the certification programme. The term “certification programme” instead of “certification examination” is used in this research.

6.3 Certification Cycle

The ultimate goal for competency identification is for competency assessment (Axley, 2008). With the certification programme available, the specialists participate in the programme and become certified after passing the programme. As the practice is evolving, the certification is valid for a period of time instead of life long. When the certification has expired or nearly expired, the specialist participates in the certification programme again for re-certification. Unsuccessful candidates in the certification/ re-certification process may re-join the programme for certification/ re-certification. This is the certification cycle at the right side (shaded) in Figure 11-6.

When the practice is changed, the core competency identification cycle is triggered. Once the core competency is updated, the certification content blueprints are revised. The updated core competency also leads the revision of training programmes and continuing professional educational activities. This is how the process model leads the specialist training and certification in the field.

7 Recommendations

This research established a process model to develop the content of professional certification. Its feasibility was demonstrated by identifying the core competency for infection control nurses of Hong Kong. With this theory in mind, the core competency for infection control nurses in fact serves as a core competency model for specialists in context. It describes the differentiated practice levels within the specialist profession, which is supported by a single core competency framework throughout all the practice levels. With this characteristic, the model serves as a guide of career ladder for the practitioners to achieve the higher practice level in the model. Based on the fruitful results found in this research, a few recommendations are proposed to contribute in the professional development in the field of infection control.

7.1 Promote Certification in Infection Control

There is no certification system to qualify the infection control nurse specialists in Hong Kong. Participating in the certification examination overseas does not solve the problem as professional practice is local-context specific, thus the certification programme should also be local-context specific to serve the needs. To safeguard the patient safety and professional development, a local-context specific certification programme to recognise the local infection control nurse specialists is urgently called-for.

Being the only infection control professional organization in Hong Kong, Hong Kong Infection Control Nurses' Association supports the voluntary and periodic certification for infection control nurses. The association also suggests that a professional body should be authorized to set up the certification process for the field practitioners (Hong Kong Infection Control Nurses' Association, 2011). With the association's position statement, the Hong Kong Infection Control Nurses' Association should take a more proactive role to promote the culture of certification for infection control nurses in Hong Kong.

7.2 Review the Training Programme for Infection Control Nurses

A generalist has to receive training in order to become an infection control nurse who is a specialist. Partnering with the university, Asia Pacific Society of Infection Control has been organising training programmes for infection control nurses in Hong Kong as well as in Asia Pacific region since 1980s. With the core competency of infection control nurses in Hong Kong identified in this research, it should be served as the foundation to train the local infection control nurses. The proposed competency-based training will therefore be in line with the responsibilities of infection control nurses and close the gap between the training and practice (Lenburg, 1999). Being the training organizer, Asia Pacific Society of Infection Control should review their existing training programme to ensure it matches with the newly identified core competency for infection control nurses.

7.3 Establish the Certification Board for Infection Control in Hong Kong

The professional organizations of infection control, such as Hong Kong Infection Control Nurses' Association and Asia Pacific Society of Infection

Control, are involved in the training activities for infection control nurses. The professional body to certify the infection control nurses should be independent from such training activities to avoid conflict of interest. Therefore, the Certification Board for Infection Control in Hong Kong should be established for the sole purpose of certification. This shall be a collaboration with an independent professional group and university, which has expertise in test development. With the newly identified content blueprint for the certification programme for infection control nurses of Hong Kong in this research, the Certification Board for Infection Control shall develop the valid certification programme and the details of related certification process. The newly developed process model for developing the certification programme in the research serves as the guide for the Certification Board to revise the programme periodically. All these works can be merged with the upcoming College in The Hong Kong Academy of Nursing when it is established in the future (Hong Kong Academy of Nursing Preparatory Committee, 2010).

7.4 Certification Programme for Hong Kong Infection Control Nurses

Certification represents the attainment of expertise, skills and attributes that are essential to competent practice (Pugliese, Larson, Foote, Jackson & Hierhoizer, 1986). In the United States, a multiple-choice question examination is adopted to assess the attainment of expertise, skills and attributes of practitioners, including infection control practitioners (Certification Board of Infection Control and Epidemiology, Inc., 2011). This is a convenient and efficient method of assessment.

Giving up the traditional testing method, Australian Infection Control Association (AICA) of Australia adopts a portfolio reviewing method for granting accreditation to infection control practitioners. Although a portfolio may track the experience and other attributes of the practitioners, dishonesty of the submitter or submitter's writing skills may influence the rating of reviewers (Redfern, Norman, Calman, Watson & Murrells, 2002).

Research confirms that no single assessment method is the best for evaluating personal and professional competency in healthcare professionals. Thus, a multi-method approach for assessing competency is recommended to overcome the strengths and weakness of different evaluation methods and give a realistic, balanced assessment of competency (Casey & Egan, 2010; Connally, Jorgensen, Gillis & Griffin, 2003; Griffin & Gillis, 2001; Hager & Gillis, 1995; Leach, 2008; Norman, Watson, Murrells, Calman & Redfern, 2002). This is the recommended approach for the certification programme for infection control nurses of Hong Kong. The term "certification programme" used in this research means that the competency evaluation method used in the certification is a multi-method approach. Traditional paper testing methods, clinical assessments, portfolio evaluation and others as appropriate should be adopted to ensure the certification programme is valid, reliable and fair.

7.5 Continuing Education and Re-certification

With the establishment of certification activities for infection control, continuing education for certified infection control nurses is still needed for updating their new knowledge and practice from the dynamic environment. All education should be based on the most updated and research-based core competency, which is identified from the revised practice. The continuing educational activities may be provided by the hospitals, professional organizations and universities that are independent from the Certification Board of Infection Control in Hong Kong. On the other hand, the revised core competency triggers the revision of a certification programme. As discussed in Figure 11-6, once the certification process is launched, it is a cyclic process that re-certification is necessary. The cycle maintains the certified infection control nurses to be up-to-date with the related knowledge and skills. After receiving the relevant continuing education, the infection control nurses are prepared to be re-certified. They continue to be professionally recognised if re-certified before the certification status has expired.

8 Limitations of this Research

Several limitations of this research must be acknowledged. First, inexperience in writing and examining the competency statements resulted in multiple-barrelled statements that conveyed unclear message in Phase One. Both the investigator and the panel of experts are the field practitioners with limited exposure to the educational issues. After the core competency items were drafted/ proposed, they were split twice from 51 to 64 and then from 64 to 83 in Phase One.

Second, the use of the Rasch measurement in analysing the opinion survey data was critical in this research. The core competency items were included or excluded based on the Rasch results objectively in the study. However, the grouping of core competency items into categories by a scientific means was not available. The competency items were the most critical elements in this research while the competency categories were less important. Categories did not influence the validity and reliability of the core competency identified. The categories simply helped to organize the core competency items in a more structural way. In the end, I decided to adhere to the experts' advice in grouping the competency items based on their drafting procedure in Phase One.

Third, the drop-out rate of the experts in the consensus exercise in Phase Three was high (33.3%, two out of six). The two experts who dropped-out were both the infection control nurses. They intended to reply initially. After some enquiries, the first one dropped out. The other infection control nurse responded but did not return the required answer. After some conversation about the requirement, the second one dropped out. In fact, the only infection control nurse who responded did not provide a real "justified answer". Among the six experts, all the infection control nurses (three) did not complete the task satisfactorily, and appeared unable to complete the task. This may be related to the training background of the profession. Apart from their high status, being the leading and most experienced infection control nurses in Hong Kong, another reason of inviting them was their track records in Phase One of the Delphi survey. They performed very well with other experts of infection control officers and the inter-rater statistics showed their good consensus. Phase Three was a qualitative study that validity refers to the reader being able to track and verify the process from the research report. The ideal situation in this study would be if the practitioners who are infection control nurses could have been involved. However, the performance of the infection control nurse experts was disappointing.

Despite these limitations in this research, the current study has demonstrated the development process of a certification content blueprint for local infection control nurses. A model for content blueprint development for healthcare specialists has been created. This is an initial step for healthcare specialists, especially for the nursing profession, to be certified for their professional post-basic specialization.

9 Further Research

This research identifies the core competency of infection control nurses of Hong Kong using a role delineation model by D'Costa (1986). The further defined critical competency serves as the content blueprint of a certification programme. Ultimately, a process model of developing the content blueprint for certification was established. Although the results of this research have values in professional development, further research is necessary to explore and clarify the following issues.

9.1 Core Competency Model for Nursing Profession

I discussed the context-specific core competency model for the nursing profession in point 6.1 of this chapter (Figure 11-5). Employing the concept of differentiated practice model, the core competencies of different practice levels of nurses share the same core competency framework. Nurse generalists are the first practice level with generic core competency described. Nurse specialists are the second practice level with context-specific core competency documented. The context-specific core competency of nurse specialists speeds up the professional development activities as it is ready-for-use once identified. The experience of identifying the context-specific core competency for nurse specialists using the core competency framework of The Nursing Council of Hong Kong is limited. Apart from the brief work of the council on paediatric and adolescent nurses (The Nursing Council of Hong Kong, 2010b), this research serves to further identify the context-specific core competency for nurse specialists who are the infection control nurses of Hong Kong. Mature practices have been established in different groups of nurse specialists. Identifying the core competencies of these nurse specialist groups is essential to the direction of post-basic nursing specialization. Further research on this aspect should be continued if the proposed core competency framework can be applied in other groups of nurse specialists.

On the other hand, after implementing nurse specialist scheme in Hospital Authority of Hong Kong in 1993, a pilot scheme of senior nurse specialists were launched in 1997 to explore the role and scope of service for senior nurse specialists. The review of the scheme found that the prominent roles of a senior nurse specialist were a clinical leader and an engineer of client service. The career development of nurse specialists with clear roles and expectations demonstrated values in healthcare service (Wong, 2001). Based on this support, nurse consultants of five clinical specialties, namely community psychiatric, continence, diabetic, renal, and wound and stoma care, were in posts for practice in Hospital Authority (Hospital Authority, 2010a). These new posts were evaluated after three to six months of launching. The report found that there were significant reductions in hospital admission, length of hospital stay and visits of Accident and Emergency Department for patients who were under the care of nurse consultants. Specialty-specific indicators were significantly improved, patients were facilitated to access the timely specialty care, practices were improved and standardized, cross-speciality collaboration was strengthened and patient satisfaction and empowerment were enhanced. Also, educational programmes to prepare nurse specialists to nurse consultant level were requested. If nurse consultant belongs to one practice level in the nursing profession instead of only in Hospital Authority, the extension of the previous proposed core competency model for nursing profession (Figure 11-5) should be further extended to nurse consultant practice level (Figure 11-7).

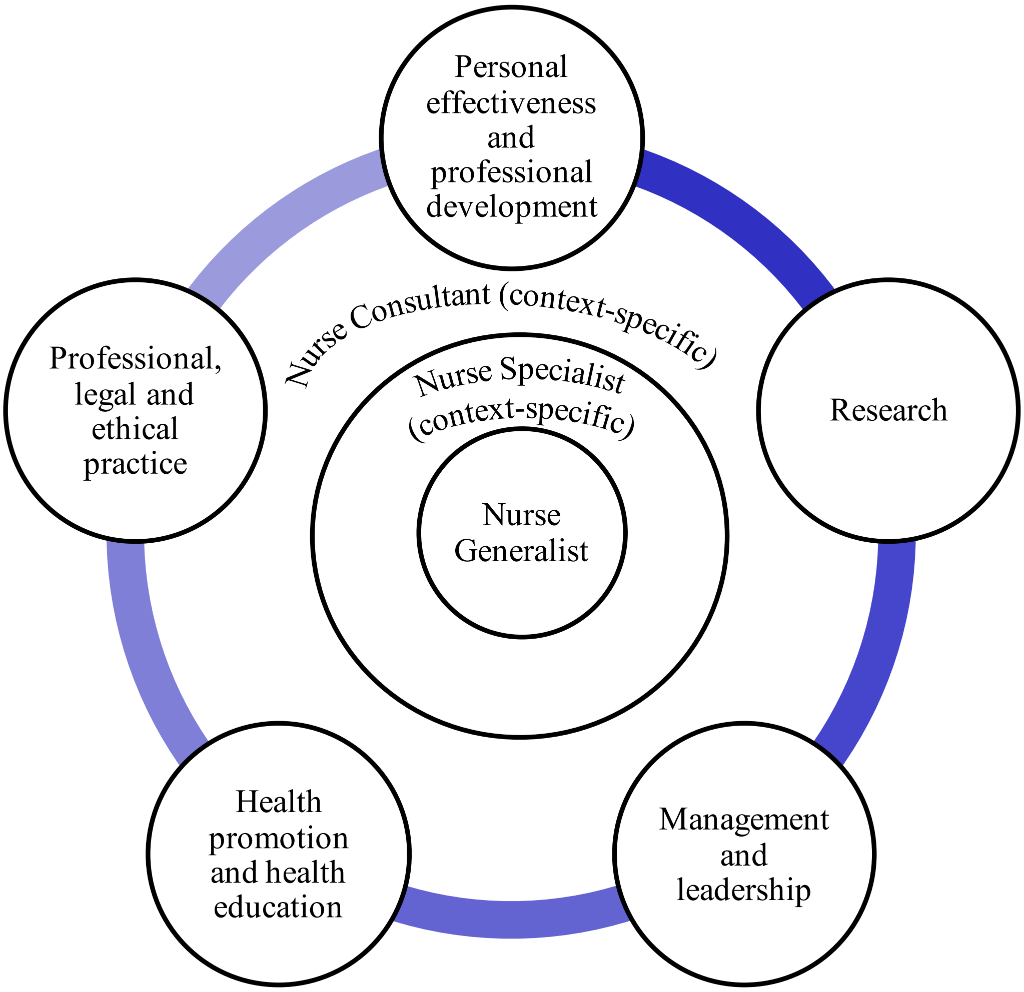


Figure 11- 7: Extended core competency model for nursing profession

Figure 11-7 depicts the proposed three practice levels of nursing profession, from nurse generalist, nurse specialist to nurse consultant. The core competencies for all practice levels are under the same competency framework from The Nursing Council of Hong Kong, which are described in five areas in the outermost circle. The core competency for nurse generalist is generic while core competencies for nurse specialist and nurse consultant are context-specific. With the same core competency framework, the core competencies of practice levels for nurses can be differentiated based on its complexity of practices with the context specified. The core competency of the higher levels of practice documents the additional core competencies required in that particular level, suggesting that the core competencies required in the lower level(s) of practice are also needed. The stepping up core competencies requirement informs the nursing professionals about what to be prepared for at the next, higher level of practice. It also serves as the foundation for assessing the competencies of each practice levels for nurses. All these are valuable to the professional nursing development. Similar core competency models can be adopted for other healthcare professionals when practice levels can be differentiated. However, identifying a universal competency framework, which is suitable for that particular profession, is critical. The extended core competency model for the nursing profession (Figure 11-7) and the competency framework for different healthcare professions are worth consideration to be included into the research agenda for contributing to further professional development in the healthcare field.

9.2 Rating Scale of Opinion Survey

The response categories of the rating scale used in the opinion survey on importance levels of core competency items (Phase Two) included:

(1) Not very important
(2) Very important
(3) Neutral
(4) Important
(5) Very important

This is a basic rating scale for attitude survey which consists of an equal number of positive and negative categories with a neural point (Wrights & Masters, 1982). However, when examining the targeting of this rating scale (Chapter 9), the difference between the means of person location and item location was 3.12 logits. The gap of these means is graphically shown in the Wright map of 76-item core competency scale (Figure 9-4). Besides the targeting, the minimum extreme category “not very important” had not been used by participants in the survey, but the maximum extreme category “very important” accounted for 32.7% of total responses. In spite of these unsatisfactory results in targeting and floor effect of the rating scale in this survey, a Rasch expert supported that this was sufficient to establish the core competency scale in this study for infection control nurses of Hong Kong. The argument was that adjusting or shifting the rating scale categories to the “important” side made zero difference for this study result (T Bond, personal communication, 17 October 2011).

Targeting of the rating scale can be improved by adding items at the unused end of the rating scale (Fisher, 2006). This can be exercised for an ordinary test design, but not the case in this survey as the items are in the core competency section. These core competency items are identified through literature review and expert consensus and adding or deleting every item should be carefully assessed. Therefore, the alternative option for improving the targeting of this kind of study is to adjust the rating scale. Despite the comment from the Rasch expert, an attempt at using a revised rating scale is worthwhile if further research is conducted using the proposed model when the proposed core competency items are drafted and validated by the subject matter experts. The revision may involve removing the non-used category (not very important) and adding a category on the important side (extremely important). The proposed categories for the revised rating scale therefore are:

(1) Not important
(2) Neutral
(3) Important
(4) Very important
(5) Extremely important

This skewed rating scale are similar with the rating scale used in the recent CBIC practice analysis survey when participants were asked to rate the significance of performing the tasks in a safe and effective manner (Curchoe, Fabrey & LeBlanc, 2008). The shifted rating scale will facilitate the spread of response categories and maximize the variation, which is important to obtain high reliability of the instrument (Fisher, 2006).

9.3 Influences on Item Locations: Backgrounds of Infection Control Nurses

It was reported in the opinion survey in Phase Two that 14 (18.4%) items showed differential item functioning. This involved eight critical competency items ultimately identified in Phase Three. The person sub-group pairs involved included work modality (part-time vs. full-time), funding of hospital (public vs. private), rank (senior vs. junior) and whether the participant had a master's degree. The work modality was also found as an influential factor in participants' ratings in the recent CBIC practice analysis survey although the data analysis method used was different (Curchoe, Fabrey & LeBlanc, 2008). However, the factors on hospital funding and ranks of infection control practitioners were not explored in their survey.

Although this research aimed at identifying one set of core competency that was prepared for the content of certification programme, the findings of differential item functioning should be treated carefully as the sample size was small in this survey (less than 100 participants). In view of a portion of items with differential item functioning has been found, further investigating the influence of infection control nurses' background on the item locations and their effects on different data analysis methods are called-for in future studies.

9.4 Levels of Difficulty or Complexity of Core Competency Items

This research identified the content and proportion of the core competency items that contributed to the content blueprint of the certification programme for infection control nurses of Hong Kong. A useful certification programme is to differentiate the abilities of the participants. The test items are derived from the core competency items. Can we utilize the perceived importance levels of core competency items to decide the difficulty levels or range of difficulty levels of the derived test items? It will be useful in test development if this relationship can be established in future research.

9.5 Core Competency Statements

From the literature review to competency identified in this research, different resources give input on the preliminary, draft and proposed content. Clearly conveying the content of the core competency items to all parties involved is important. The parties involved in this research include the investigator, the field experts and field practitioners. Educators may also be involved, but not in this study. The mutual understanding of competency statements between the investigator and the research participants throughout the whole research process is important to ensure the message is clearly conveyed thus resulting in accurate responses (Wright, 2002).

As discussed in the approaches of competency in Chapter 5, behaviourist approach makes the competency simple but ignoring the required knowledge and skills during observation of performance (Gonczi, 1994). The generic skill approach ignores the context that is not specific to the professional (Hager, 1993). This approach does not facilitate identifying the context specific core competency for the specialists in this research. The practices of healthcare practitioners are complex. Generic skills approach is not appropriate to describe their practices while behaviourist approach is too simplistic. As an initial research for certification in Hong Kong, this research uses the integrated approach for core competency identification that action descriptions are employed to describe the intended actions (Campbell, 1989; Raymond, 2001). The statement starts from a verb to describe the action where the structure is the same as the behavioural statement. These statements are straightforward for the field experts and practitioners that can be used in the training, assessment and practices to convey the clear message among different parties. With the characteristics of easy understanding, Lenburg (1999) supports the use of this structure of competency statements to close the gap between training, assessment and practices. Core competency developed by Infection Prevention Society and Competency Steering Group (2011) and Competency and Practice Standards developed by APIC and CHICA-Canada (Friedman, Curchoe, Foster, Hirji, Krystofiak, Lark & et al., 2008) also adopt this format of competency statements.

Using the integrated approach, action statements are adopted for core competency identification, like this research. In the subsequent test development, the one easily links the core competency in action statements to the related knowledge, skills and attitudes for further test construction (Larson, Elsenberg & Soule, 1988). Although this is the usual practice in test development, the effectiveness of communication of different formats of core competency may be further explored.

<u>10 Conclusions</u>

This is the first research work on identifying a context-specific core competency of nurse specialists and then establishing a model for developing the content for professional certification for healthcare specialists in Hong Kong. The products are prepared at the right time as colleges for nursing specialties are being established. The direction of building nursing specialty colleges is to promote the nursing professionalism under the structure of Hong Kong Academy of Nursing. The issue of kitemark for the nurse specialists is floating by the demand of the profession itself, employers and the public. Certification of professionals, which is local-context specific, is the answer to solve their concerns in the dynamic healthcare environment.

10.1 Evolution of Infection Control Practice

Infection control practices are dynamic; they have been evolving since their establishment. The recent evolution highlights emergency response and preparedness after the epidemic and pandemic of infectious diseases. In the United States, the role of infection control practitioners was published for emergency management (Rebmann & The 2008 APIC Emergency Preparedness Committee, 2009). Nine domains of the role were elaborated, namely:

1) Knowledge of disasters and emergency management;
2) Assessing readiness and emergency management plans;
3) Infection prevention coverage;
4) Participation in disaster response and recovery;
5) Healthcare policy development;
6) Surveillance;
7) Patient management;
8) Physical plant issues; and
9) Infection Preventionist as educator.

The Infection Prevention Society (previously named Infection Control Nurses Association) of the United Kingdom revised their core competency in February 2011 (Infection Prevention Society & Competency Steering Group, 2011). The revised core competency is prepared for the advanced level practice of infection prevention and control. There are 17 competencies grouped into four domains (Appendix 11-2). More detailed performance indicators, such as knowledge and skills, are listed under each competency item. Compared with the 2004 version, the outbreak management has been expanded to include emergency responses. This is in line with the developments in the United States, another leader in infection control. It also shows that the infection control practice all over the world, including Hong Kong, is dynamic and that review of core competency for infection control nurses is a non-stop cycle.

10.2 The Way Forward

The practice of infection control in Hong Kong is important because it impacts life and death during epidemic and pandemic crises. The core competency of infection control nurses has aroused the concerns of the practitioners, employers and the public. Certification of infection control nurses in Hong Kong is urged to ensure ongoing competent practice of infection control nurses.

The certification for healthcare professionals is common in North America. The first certification examination for infection control practitioners in the United States was offered in 1983 (Goldrick, 2005). It is now opened to all infection control practitioners worldwide although the validity issue of the test for outside North American region was wondered (Chan, 2005). The credentialing process for infection control practitioners in Australia was started in December 2000 (Hunt & Hellsten, 2006). Instead of using a testing method, the Australian Infection Control Association employs the portfolio review in the process. Being the leading infection control country, the United Kingdom does not have any certification or similar activities for the infection control practitioners at the moment. However, Burnett et al. (2009) expressed that The Infection Prevention Society recognized the need for provision of accreditation for the achievement of set competences and the society began to investigate the related systems and processes on it.

In Hong Kong, a process model for developing the certification content for healthcare specialists has been built in this research using infection control nurses to demonstrate the feasibility. With this model, the development of certification programme for infection control nurses is not difficult to undertake in the local setting. This model is applicable to the other healthcare specialists because the foundation, the process of competency identification, in the model, is based on role delineation for healthcare professionals (D'Costa, 1986). The investigator is sharing the research process to promote the professional development in healthcare professions. This is the initial step in developing a certification programme. The development of a certification programme will be a continuous process (regular revision is needed) once the certification is adopted by the profession.

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APPENDICES

LIST OF APPENDICES

Appendix 3- 1: Summary of core competencies of Infection Control Nurses Association of the United Kingdom (Second Edition)

Area of competency
1. Specialist knowledge 1.1. Infection prevention and control practice 1.2. Decontamination 1.3. Microbiology 1.4. Immunology 1.5. Epidemiology 1.6. Emergency planning 1.7. Demographics in health
2. Healthcare governance 2.1. Research and development 2.2. Clinical effectiveness 2.3. Patient and public involvement 2.4. Risk management
3. Learning and teaching 3.1. Personal and professional development 3.2. Facilitating learning in others
4. Leadership and management 4.1. Leads the development of a proactive infection prevention and control service 4.2. Managing an infection prevention and control service

Reference:

Infection Control Nurses Association. (2004). Core Competencies for Practitioners in Infection Prevention and Control (2nd Edition). Retrieved 4 September 2011 at http://www.ips.uk.net/icna/Admin/uploads/Competencies2ndeditionpdf.pdf

Appendix 3- 2: Summary of APIC/ CHICA-Canada professional and practice standards for infection control and epidemiology (1999)

Professional standards

1) Professional accountability
2) Qualifications
3) Professional development
4) Leadership
5) Ethics

Practice standards

6) Infection prevention and control practice
7) Epidemiology
8) Surveillance
9) Education
10) Consultation
11) Performance improvement
12) Programme management and evaluation
13) Fiscal responsibility
14) Research

Reference:

Horan-Murphy E, Barnard B, Chenoweth C, Friedman C, Hazuka B, Russell B, Foster M, Goldman C, Bullock P, Docken L & McDonald L. (1999). APIC/CHICA-Canada infection control and epidemiology: Professional and practice standards. American Journal of Infection Control, 27(1), 47-51.

Appendix 7- 1: Literature review for drafting the preliminary competency categories

Preliminary competency category	References
1. Surveillance	CHP-SCIC, 2005b; CHP-SCIC, 2006a; CHP-SCIC, 2006b; Hambræus, 1995; Hobbs, 2007;Horan-Murphy et al, 1999; ICNA, 2004; Murphy & McLaws, 1999; VSIGM, 1982; Worsley, 1988;
2. Program management and evaluation	CHP-SCIC, 2005b; Hambræus, 1995; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy & McLaws, 1999
3. Consultation	Hambræus, 1995; Hobbs, 2007; Horan-Murphy et al, 1999; McLaws, 1999; Murphy & VSIGM, 1982
4. Occupational health	CHP-SCIC, 2005b; Hambræus, 1995; Hobbs, 2007; Murphy & McLaws, 1999
5. Infection prevention and control practice	CHP-SCIC, 2005b; Hambræus, 1995; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy & McLaws, 1999; VSIGM, 1982; Worsley, 1988
6. Education	CHP-SCIC, 2005b; Hambræus, 1995; Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; Murphy & McLaws, 1999; VSIGM, 1982; Worsley, 1988
7. Team and service management	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; VSIGM, 1982
8. Partnership	CHP-SCIC, 2005b; ICNA, 2004; Murphy & McLaws, 1999; Worsley, 1988
9. Outbreak investigation and control	CHP-SCIC, 2005a; CHP-SCIC, 2005c; CHP-SCIC, 2005d; Hambræus, 1995; Hobbs, 2007; ICNA, 2004
10. Research and development	Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; Worsley, 1988
11. Qualification	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999
12. Continuing education and development	Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; Murphy & McLaws, 1999
13. Professional development	Horan-Murphy et al, 1999; ICNA, 2004

References:

Centre for Health Protection, Scientific Committee on Infection Control [CHP-SCIC]. (2005a). Recommendations on delineating roles of participating HCWs in outbreak control in a hospital setting. Retrieved on 24 April 2011 at http://www.chp.gov.hk/files/pdf/grp_scic_recommend_2005042802.pdf

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Centre for Health Protection, Scientific Committee on Infection Control [CHP-SCIC]. (2005c). Recommendations on infection control among incapacitated patients requiring long term care. Retrieved on 24 April 2011 at http://www.chp.gov.hk/files/pdf/grp_scic_recommend_2005042803.pdf

Centre for Health Protection, Scientific Committee on Infection Control [CHP-SCIC]. (2005d). Recommendations on laboratory testing in outbreak investigation. Retrieved on 24 April 2011 at http://www.chp.gov.hk/files/pdf/grp_scic_recommend_2005042801.pdf

Centre for Health Protection, Scientific Committee on Infection Control [CHP-SCIC]. (2006a).Recommendations on prevalence survey of hospital acquired infections. Retrieved on 24 April 2011 at http://www.chp.gov.hk/files/pdf/grp_scic_recommend_20061106_02.pdf

Centre for Health Protection, Scientific Committee on Infection Control [CHP-SCIC]. (2006b). Recommendations on surgical site infection surveillance. Retrieved on 24 April 2011 at http://www.chp.gov.hk/files/pdf/grp_scic_recommend_20061106_01.pdf

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Appendix 7- 2: Literature review for drafting the preliminary core competency items based on the drafted competency categories

Draft competency categories/ preliminary competency items	**References**
Surveillance	
1. Design a surveillance plan for the served population(s) using epidemiological principles.	CHP-SCIC, 2005b; CHP-SCIC, 2006a; CHP-SCIC, 2006b; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
2. Use standardized definitions to conduct surveillance.	CHP-SCIC, 2005b; CHP-SCIC, 2006a; CHP-SCIC, 2006b; Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004
3. Select appropriate indicators to monitor internal trend and benchmark externally.	CHP-SCIC, 2005b; CHP-SCIC, 2006a; CHP-SCIC, 2006b; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
4. Select a database(s) that matches internal/ external data.	Hobbs, 2007; Law, 1993; Murphy CL & McLaws, 2000; Staggers et al, 2002
5. Ensure the data management is accurate and minimize the repeated data entry.	Hobbs, 2007; Law, 1993; Murphy CL & McLaws, 2000; Staggers et al, 2002
6. Analyze surveillance data by appropriate statistical techniques.	CHP-SCIC, 2005b; CHP-SCIC, 2006a; CHP-SCIC, 2006b; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; Law, 1993;
7. Critically evaluate significance of findings.	Ayliffe et al, 2000; CHP-SCIC, 2005b; CHP-SCIC, 2006a; Gail et al, 2004; Hobbs, 2007; ICNA, 2004; Murphy DM, 2002
8. Report the findings to appropriate clients and give recommendations accordingly.	CHP-SCIC, 2005b; CHP-SCIC, 2006b; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
9. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.	CHP-SCIC, 2005b; CHP-SCIC, 2006b; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
Program management and evaluation	

Draft competency categories/ preliminary competency items	**References**
10. Develop and annually review a programme plan with measurable outcomes.	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
11. Assess and incorporate the client needs into the programme plan.	CHP-SCIC, 2005b; Horan-Murphy et al, 1999; Masterton & Teare, 2001; Murphy DM, 2002
12. Recommend appropriate resources for the proposed plan.	Hobbs, 2007; Horan-Murphy et al, 1999
13. Communicate the necessary resources to administration/ management and modify programme plan if needed.	Hobbs, 2007; Horan-Murphy et al, 1999
14. Periodically evaluate the effectiveness of the infection surveillance, prevention and control programme and integrate the findings during modification.	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999; Masterton & Teare, 2001; Murphy DM, 2002
15. Evaluate client needs and satisfaction and modify the infection surveillance, prevention and control programmes accordingly.	CHP-SCIC, 2005b; Horan-Murphy et al, 1999; Murphy DM, 2002
Consultation	
16. Maintain access to update information on infection prevention and control.	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999
17. Communicate with clients on the function, role and value of the programme.	Horan-Murphy et al, 1999
18. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
19. Disseminate the findings, recommendations and policies of the infection surveillance, prevention and control programmes to appropriate clients.	Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy DM, 2002
20. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.	Ayliffe et al, 2000; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Law, 1993;
Evidenced based practice on infection prevention and control (includes occupational health)	

Draft competency categories/ preliminary competency items	References
21. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	CHP-SCIC, 2005b; Horan-Murphy et al, 1999; Murphy DM, 2002
22. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications.	CHP-SCIC, 2005b; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Murphy CL & McLaws, 2000; Murphy DM, 2002
23. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	CHP-SCIC, 2005b; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; Law, 1993; Murphy DM, 2002
24. Integrate relevant public health issues into practice when applicable.	Horan-Murphy et al, 1999
Education	
25. Periodically assess the educational needs of clients	CHP-SCIC, 2005b; Horan-Murphy et al, 1999; Murphy DM, 2002
26. Develop educational objectives and strategies to meet the client needs.	CHP-SCIC, 2005b; Horan-Murphy et al, 1999; Murphy DM, 2002
27. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.	Ayliffe et al, 2000; Gail et al, 2004; Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; Law, 1993; Murphy DM, 2002
28. Continuously evaluate the effectiveness of educational programmes and learner outcomes.	CHP-SCIC, 2005b; Horan-Murphy et al, 1999; Murphy DM, 2002
Team and service management	
29. Share knowledge and skills with other team members and clients if appropriate.	CHP-SCIC, 2005b; Horan-Murphy et al, 1999, Law, 1993
30. Support and promote the importance of research in shaping the practice of infection prevention and control.	Horan-Murphy et al, 1999; Law, 1993
31. Emphasize the value of scientific basis of infection prevention and control.	Horan-Murphy et al, 1999
32. Initiate creativity and innovation to practice.	Horan-Murphy et al, 1999

Draft competency categories/ preliminary competency items	References
33. Seek opportunities to influence policymakers.	Horan-Murphy et al, 1999; Law, 1993; Murphy CL & McLaws, 2000
34. Consider both clinical outcomes and financial implications when initiating changes in practice.	Horan-Murphy et al, 1999
35. Evaluate the use of technology or products to achieve cost-effective purpose.	Hobbs, 2007; Horan-Murphy et al, 1999
36. Integrate relevant cost information into the analysis of findings and recommendations.	Horan-Murphy et al, 1999
37. Document cost saving in the organization through infection surveillance, prevention and control programme activities.	Horan-Murphy et al, 1999
38. Identify opportunities for service improvement.	Horan-Murphy et al, 1999
39. Contribute epidemiologic skills to improvement process.	Horan-Murphy et al, 1999
40. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems	Ayliffe et al, 2000; Dawson, 2003; Ching & Seto, 1990; CHP-SCIC, 2005b
Team work and partnership	
41. Identify the needs of involvement of the other parties in the infection prevention and control programmes.	CHP-SCIC, 2005b
42. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.	Ayliffe et al, 2000; CHP-SCIC; 2005b; Horan-Murphy et al, 1999; ICNA, 2004
Outbreak investigation and control	
43. Recognize an outbreak through surveillance information and reporting channels.	Ayliffe et al, 2000; CHP-SCIC, 2005a; CHP-SCIC, 2005b; CHP-SCIC, 2005c; ICNA, 2004
44. Assess the extent of outbreak situation.	Ayliffe et al, 2000; CHP-SCIC, 2005a; CHP-SCIC, 2005b; CHP-SCIC, 2005c; Hobbs, 2007; ICNA, 2004
45. Identify the risk factors and collect the appropriate data.	Ayliffe et al, 2000; CHP-SCIC, 2005c; Hobbs, 2007

Draft competency categories/ preliminary competency items	References
46. Advise the control measures and investigations to the involved parties and evaluate the effectiveness.	Ayliffe et al, 2000; CHP-SCIC, 2005b; CHP-SCIC, 2005c; CHP-SCIC, 2005d; Hobbs, 2007; ICNA, 2004
47. Share the findings of outbreak investigation to the relevant parties.	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999
Research and development	
48. Critically review the research.	Horan-Murphy et al, 1999; ICNA, 2004; Law, 1993; Murphy CL & McLaws, 2000
49. Incorporate the relevant published research findings into practice, education or consultation.	Horan-Murphy et al, 1999; Law, 1993
50. Organize and share findings from surveillance and other infection prevention and control activities.	Horan-Murphy et al, 1999
51. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control...	Hobbs, 2007; Horan-Murphy et al, 1999; ICNA, 2004; Law, 1993; Murphy CL & McLaws, 2000
Qualification	
52. Demonstrate knowledge in areas of patient care practices, microbiology, asepsis, disinfection/ sterilization, adult education, infectious diseases, communication, programme administration, epidemiology and biostatistics.	Gail et al, 2004; Horan-Murphy et al, 1999; ICNA, 2004
53. Has at least two years of experience in infection control practice.	CHP-SCIC, 2005b
54. Completed at least a certificate-level of infection control training for infection control practitioners organized by university, university collaborated programme or equivalent.	Horan-Murphy et al, 1999
Continuing education and professional development	
55. Advance the knowledge and skills through continuing education	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999; Law, 1993; Murphy CL & McLaws, 2000;

Draft competency categories/ preliminary competency items	References
56. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings.	CHP-SCIC, 2005b; Hobbs, 2007; Horan-Murphy et al, 1999; Law, 1993; Murphy CL & McLaws, 2000;
57. Advance the field of infection prevention and control through the support of related research.	Horan-Murphy et al, 1999; Murphy CL & McLaws, 2000
58. Participate in or support the professional organizations.	Horan-Murphy et al, 1999

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Appendix 7- 3: Questionnaire of Delphi survey (Round 1) to draft the competency categories of infection control nurses in Phase One

Drafting the Core Competency of Infection Control Nurses

Round 1

Please keep this information confidential and do not share with others (including panel members or infection control practitioners)

We are drafting the core competency of hospital infection control nurse specialists of Hong Kong. They are the core competencies of specialist level in additional to the general nurses. The followings are the preliminary core competency categories. Please indicate if you agree or disagree with each of them.

Infection Control category	Please "✓"		Remarks
	Agree	Disagree	
1. Surveillance			
2. Program management and evaluation			
3. Consultation			
4. Occupational health			
5. Infection prevention and control practice			
6. Education			
7. Team and service management			
8. Partnership			
9. Outbreak investigation and control			
10. Research and development			
11. Qualification			
12. Continuing education and development			
13. Professional development			
Additional infection control category:			

Appendix 7- 4: Questionnaire of Delphi survey (Round 2) to draft the competency categories of infection control nurses in Phase One

Drafting the Core Competency of Infection Control Nurses

Round 2

Please keep this information confidential and do not share with others (including panel members or infection control practitioners)

We are drafting the core competency of hospital infection control nurse specialists of Hong Kong. They are the core competencies of specialist level in additional to the general nurses. After the round 1 survey, the first eight core competency categories have been confirmed. The last four categories with further elaboration are listed for your comment again. Please indicate if you agree or disagree with each of them.

Infection Control Category	Please "✓"		**Remarks**
	Agree	Disagree	
1. Surveillance (include data management)			Confirmed (100% agreement)
2. Program management and evaluation			Confirmed (100% agreement)
3. Consultation			Confirmed (83.3% agreement)
4. Evidence based practice on infection prevention and control (include occupational health)			Confirmed (100% agreement)
5. Education (include coaching)			Confirmed (100% agreement)
6. Outbreak investigation and control			Confirmed (83.3% agreement)
7. Research and development			Confirmed (83.3% agreement)
8. Team and service management (include leadership, resource and quality management)			Confirmed (83.3% agreement)
9. Partnership (with other teams and disciplines)			50% agreement

Infection Control Category	Please "✓"		**Remarks**
	Agree	Disagree	
10. Qualification (mainly infection control training)			50% agreement
11. Continuing education and development (self development)			66.7% agreement
12. Professional development (for infection control profession instead of self development)			50% agreement
Additional infection control category:			

Appendix 7- 5: Questionnaire of Delphi survey (Round 3) to draft the core competency items of infection Control Nurses in Phase One

Drafting the Core Competency of Infection Control Nurses

Round 3

Please keep this information confidential and do not share with others (including panel members or infection control practitioners)

We are drafting the core competency of hospital infection control nurse specialists of Hong Kong. They are the core competencies of **specialist level** in additional to the general nurses. The core competency categories of infection control nurse specialists have been confirmed through rounds 1 and 2. In this round, more specific core competency items are proposed under each category. Please indicate if you agree or disagree with each of them.

Competency items under each category	Please "✓"		**Remarks**
	Agree	Disagree	
Surveillance			
1. Design a surveillance plan for the served population(s) using epidemiological principles.			
2. Use standardized definitions to conduct surveillance.			
3. Select appropriate indicators to monitor internal trend and benchmark externally.			
4. Select a database(s) that matches internal/ external data.			
5. Ensure the data management is accurate and minimize the repeated data entry.			
6. Analyze surveillance data by appropriate statistical techniques.			
7. Critically evaluate significance of findings.			
8. Report the findings to appropriate clients and give recommendations accordingly.			
9. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.			
Program management and evaluation			
10. Develop and annually review a programme plan with measurable outcomes.			
11. Assess and incorporate the client needs into the programme plan.			
12. Recommend appropriate resources for the proposed plan.			

Competency items under each category	Please "✓"		**Remarks**
	Agree	Disagree	
13. Communicate the necessary resources to administration/ management and modify programme plan if needed.			
14. Periodically evaluate the effectiveness of the infection surveillance, prevention and control programme and integrate the findings during modification.			
15. Evaluate client needs and satisfaction and modify the infection surveillance, prevention and control programmes accordingly.			
Consultation			
16. Maintain access to update information on infection prevention and control.			
17. Communicate with clients on the function, role and value of the programme.			
18. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.			
19. Disseminate the findings, recommendations and policies of the infection surveillance, prevention and control programmes to appropriate clients.			
20. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.			
Evidence based practice on infection prevention and control practice (includes occupational health)			
21. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.			
22. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications.			
23. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.			
24. Integrate relevant public health issues into practice when applicable.			
Education			

Competency items under each category	Please "✓"		Remarks
	Agree	Disagree	
25. Periodically assess the educational needs of clients			
26. Develop educational objectives and strategies to meet the client needs.			
27. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.			
28. Continuously evaluate the effectiveness of educational programmes and learner outcomes.			
Team and service management			
29. Share knowledge and skills with other team members and clients if appropriate.			
30. Support and promote the importance of research in shaping the practice of infection prevention and control.			
31. Emphasize the value of scientific basis of infection prevention and control.			
32. Initiate creativity and innovation to practice.			
33. Seek opportunities to influence policymakers.			
34. Consider both clinical outcomes and financial implications when initiating changes in practice.			
35. Evaluate the use of technology or products to achieve cost-effective purpose.			
36. Integrate relevant cost information into the analysis of findings and recommendations.			
37. Document cost saving in the organization through infection surveillance, prevention and control programme activities.			
38. Identify opportunities for service improvement.			
39. Contribute epidemiologic skills to improvement process.			
40. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems			
Team work/ Partnership			
41. Identify the needs of involvement of the other parties in the infection prevention and control programmes.			
42. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.			

Competency items under each category	Please "✓"		**Remarks**
	Agree	Disagree	
Outbreak investigation and control			
43. Recognize an outbreak through surveillance information and reporting channels.			
44. Assess the extent of outbreak situation.			
45. Identify the risk factors and collect the appropriate data.			
46. Advise the control measures and investigations to the involved parties and evaluate the effectiveness.			
47. Share the findings of outbreak investigation to the relevant parties.			
Research and development			
48. Critically review the research.			
49. Incorporate the relevant published research findings into practice, education or consultation.			
50. Organize and share findings from surveillance and other infection prevention and control activities.			
51. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control...			
Qualification			
52. Demonstrate knowledge in areas of patient care practices, microbiology, asepsis, disinfection/ sterilization, adult education, infectious diseases, communication, programme administration, epidemiology and biostatistics.			
53. Has at least two years of experience in infection control practice.			
54. Completed at least a certificate-level of infection control training for infection control practitioners organized by university, university collaborated programme or equivalent.			
Continuing education and professional development			
55. Advance the knowledge and skills through continuing education			
56. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings.			

Competency items under each category	Please "✓"		**Remarks**
	Agree	Disagree	
57. Advance the field of infection prevention and control through the support of related research.			
58. Participate in or support the professional organizations.			

Additional core competency items under corresponding category:	
Core competency items	Category
1.	
2.	
3.	
4.	
5.	
6.	

Appendix 7- 6: Questionnaire of Delphi survey (Round 4) to draft the core competency items of infection control nurses in Phase One

Drafting the Core Competency of Infection Control Nurses

Round 4

Please keep this information confidential and do not share with others (including panel members or infection control practitioners)

We are drafting the core competency of hospital infection control nurse specialists of Hong Kong. They are the core competencies of specialist level in additional to the general nurses. After going through the previous three rounds, most of the core competency items of infection control nurse specialists have been confirmed. Please give your further comment on items 27 and 47. Elaboration on these items has been described in the respective "remarks" column. You are also welcome to give further suggestions on the agreed elements.

Competency items under each category	Please "✓"		**Remarks**
	Agree	Disagree	
Surveillance			
1. Design a surveillance plan for the served population(s) using epidemiological principles.			
2. Use standardized definitions to conduct surveillance.			
3. Select appropriate indicators to monitor internal trend and benchmark externally.			
4. Select a database(s) that matches internal/ external data to ensure efficient and accurate data management.			
5. Analyze surveillance data by appropriate statistical techniques.			
6. Critically evaluate significance of findings.			
7. Report the findings to appropriate clients and give recommendations accordingly.			
8. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.			

Competency items under each category	Please "✓"		Remarks
	Agree	Disagree	
Program management and evaluation			
9. Develop and annually review a programme plan with measurable outcomes.			
10. Assess and incorporate the client needs into the programme plan.			
11. Recommend appropriate resources for the proposed plan.			
12. Communicate with clients on the objectives, function, role and value of the programme.			
13. Communicate the necessary resources to administration/ management and modify programme plan if needed.			
14. Periodically evaluate the effectiveness of the infection surveillance, prevention and control programme and integrate the findings during modification.			
15. Evaluate client needs and satisfaction and modify the infection surveillance, prevention and control programmes accordingly.			
Consultation			
16. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.			
Evidence based practice on infection prevention and control practice (includes occupational health)			
17. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.			
18. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications.			
19. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.			
20. Integrate relevant public health issues into practice when applicable.			
Education			
21. Periodically assess the educational needs of clients.			

Competency items under each category	Please "✓"		**Remarks**
	Agree	Disagree	
22. Develop educational objectives and strategies to meet the client needs.			
23. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.			
24. Disseminate the findings, recommendations and policies of the infection surveillance, prevention and control programmes to concerned clients.			
25. Continuously evaluate the effectiveness of educational programmes and learner outcomes.			
Team and service management			
26. Share knowledge and skills with other team members and clients.			
27. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.			R1
28. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.			
29. Seek opportunities to influence policymakers.			
30. Consider both clinical outcomes and financial implications when initiating changes in practice.			
31. Evaluate the use of technology or products to achieve cost-effective purpose.			
32. Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection surveillance, prevention and control programme activities, if any.			
33. Identify opportunities for service improvement.			
34. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems			
Team work/ Partnership			
35. Identify the needs of involvement of the other parties in the infection prevention and control programmes.			
36. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.			

Competency items under each category	Please "✓"		Remarks
	Agree	Disagree	
Outbreak investigation and control			
37. Recognize an outbreak through surveillance information and reporting channels.			
38. Assess the extent of outbreak situation.			
39. Identify the risk factors and collect the appropriate data.			
40. Advise the control measures and investigations to the involved parties and evaluate the effectiveness.			
41. Share the findings of outbreak investigation to the relevant parties.			
Research and development			
42. Critically review the related research.			
43. Incorporate the relevant published research findings into practice, education or consultation.			
44. Organize and share findings from surveillance and other infection prevention and control activities.			
45. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.			
Qualification			
46. Demonstrate knowledge in areas of patient care practices, microbiology, asepsis, decontamination, adult education, infectious diseases, communication, programme administration, epidemiology and biostatistics.			
47. Have **at least two years** of experience in infection control practice.			R2
48. Completed at least a certificate-level of infection control training for infection control practitioners organized by university, university collaborated programme or equivalent.			
Continuing education and professional development			
49. Advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control.			
50. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings.			

Competency items under each category	Please "✓"		Remarks
	Agree	Disagree	
51. Advance the field of infection prevention and control through the support of related research.			

R1: Rephrased as suggested. (for core competency item 27)

R2: Some members suggested increase the years of experience to be a specialist ICN. Please indicate if you agree with the element 47 again. If you disagree with it, please propose the minimum years of experience. (for competency item 47)

Appendix 7- 7: Questionnaire for content validity survey in Phase One

Content Review of the Draft Core Competency for Infection Control Nurses

Questionnaire

Please keep this information confidential.

Introduction:
I am developing the core competency for hospital infection control nurse specialists of Hong Kong. This core competency of infection control nurses is the specialist competency in addition to general nurses. The attributes of core competency of infection control nurse specialists are prepared in terms of behaviours.

Instruction:
Please fill in the questionnaire according to the following steps:
1. Judge how representative of items 1 to 64 are the attributes of competency of infection control nurses by rating 1 to 4. If you rate the items as 1, 2 or 3, please write down your comments on the "comment column" on the right hand side of the "rating column".
2. Judge the clarity of the items 1 to 64, if they are well-written and distinct. Give your input in the "comment column" if wording adjustment is necessary.
3. After rated items 1 to 64, please check the comprehensiveness of the questionnaire by answering question 65.

After completing the questionnaire, please return it to Ms. Chan Wai Fong by email (chanwf3@ha.org.hk) or fax (Fax no. 22346466) on or before
8 June 2007. For further enquiry, please contact the investigator, Ms. Chan Wai Fong at 21626104/ 61723004. Thank you very much.

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is <u>not representative</u> of core competency of ICN (specialist) 2 = The item needs <u>major revisions</u> to be representative of core competency of ICN (specialist) 3 = The item needs <u>minor revisions</u> to be representative of core competency of ICN (specialist) 4 = The item <u>is representative</u> of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
Surveillance					
1. Design a surveillance plan for the served population(s) using epidemiological principles.					
2. Use standardized definitions to conduct surveillance.					
3. Select appropriate indicators to monitor internal trend of infection.					
4. Select appropriate indicators to benchmark externally.					
5. Select a database(s) that matches internal/ external data of surveillance.					
6. Select a database(s) that ensures efficient and accurate data management.					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is <u>not representative</u> of core competency of ICN (specialist) 2 = The item needs <u>major revisions</u> to be representative of core competency of ICN (specialist) 3 = The item needs <u>minor revisions</u> to be representative of core competency of ICN (specialist) 4 = The item <u>is representative</u> of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
7. Analyze surveillance data by appropriate statistical techniques.					
8. Critically evaluate significance of findings of surveillance.					
9. Report the surveillance findings to appropriate clients.					
10. Give recommendations to clients during reporting the surveillance findings.					
11. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.					
Programme management and evaluation					
12. Develop and annually review a programme plan with measurable outcomes.					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
13. Assess and incorporate the client needs into the programme plan.					
14. Recommend appropriate resources for the proposed plan.					
15. Communicate with clients on the objectives, function, role and value of the programme.					
16. Communicate the necessary resources to administration/ management and modify programme plan if needed.					
17. Periodically evaluate the effectiveness of the infection prevention and control programme and integrate the findings during modification of the programme.					
18. Evaluate client needs and satisfaction and modify the infection prevention and control programmes accordingly.					
Consultation					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
19. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.					
Evidence based practice on infection prevention and control practice					
20. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.					
21. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications.					
22. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.					
23. Integrate relevant public health issues into practice when applicable.					

<table>
<tr><th rowspan="4">Attributes of core competency of ICN (specialist) in hospitals</th><th colspan="4">Representativeness
1 = The item is <u>not representative</u> of core competency of ICN (specialist)
2 = The item needs <u>major revisions</u> to be representative of core competency of ICN (specialist)
3 = The item needs <u>minor revisions</u> to be representative of core competency of ICN (specialist)
4 = The item <u>is representative</u> of core competency of ICN (specialist)</th><th rowspan="4">Comment</th></tr>
<tr><th colspan="4">Please ✓ as appropriate</th></tr>
<tr><th>1</th><th>2</th><th>3</th><th>4</th></tr>
<tr></tr>
<tr><td colspan="6">Education</td></tr>
<tr><td>24. Periodically assess the educational needs of clients.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>25. Develop educational objectives and strategies to meet the client needs.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>26. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>27. Disseminate the findings, recommendations and policies of the infection prevention and control programmes to concerned clients.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>28. Continuously evaluate the effectiveness of educational programmes and learner outcomes.</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="6">Team and service management</td></tr>
<tr><td>29. Share knowledge and skills with other team members and clients.</td><td></td><td></td><td></td><td></td><td></td></tr>
</table>

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is <u>not representative</u> of core competency of ICN (specialist) 2 = The item needs <u>major revisions</u> to be representative of core competency of ICN (specialist) 3 = The item needs <u>minor revisions</u> to be representative of core competency of ICN (specialist) 4 = The item <u>is representative</u> of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
30. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.					
31. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.					
32. Seek opportunities to influence policymakers.					
33. Consider clinical outcomes when initiating changes in practice.					
34. Consider financial implications when initiating changes in practice.					
35. Evaluate the use of technology or products to achieve cost-effective purpose.					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
36. Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.					
37. Identify opportunities for service improvement.					
38. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems.					
Collaboration and Partnership					
39. Identify the needs of involvement of the other parties in the infection prevention and control programmes.					
40. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.					
Outbreak investigation and control					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
41. Recognize an outbreak through surveillance information and reporting channels.					
42. Assess the extent of outbreak situation.					
43. Identify the risk factors and collect the appropriate data during infection outbreak.					
44. Advise the control measures and investigations to the involved parties and evaluate the effectiveness during outbreak situations.					
45. Share the findings of outbreak investigation to the relevant parties.					
Research and development					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
46. Critically review the related research.					
47. Incorporate the relevant published research findings into practice, education or consultation.					
48. Share findings from surveillance and other infection prevention and control activities.					
49. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.					
Qualification					
50. Demonstrate knowledge in areas of patient care practices.					
51. Demonstrate knowledge of microbiology.					

Attributes of core competency of ICN (specialist) in hospitals	**Representativeness** 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				**Comment**
	1	2	3	4	
52. Demonstrate knowledge of asepsis.					
53. Demonstrate knowledge of decontamination.					
54. Demonstrate knowledge of adult education.					
55. Demonstrate knowledge of infectious diseases.					
56. Demonstrate knowledge of communication.					
57. Demonstrate knowledge of programme administration.					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
58. Demonstrate knowledge of epidemiology.					
59. Demonstrate knowledge of biostatistics.					
60. Have two to five years of experience in infection control practice.					
61. Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.					
Continuing education and professional development					

Attributes of core competency of ICN (specialist) in hospitals	Representativeness 1 = The item is not representative of core competency of ICN (specialist) 2 = The item needs major revisions to be representative of core competency of ICN (specialist) 3 = The item needs minor revisions to be representative of core competency of ICN (specialist) 4 = The item is representative of core competency of ICN (specialist) Please ✓ as appropriate				Comment
	1	2	3	4	
62. Advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control.					
63. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings.					
64. Advance the field of infection prevention and control through the support of related research.					

65. All dimensions of the content domain are included in the instrument☐ Yes☐ No, please specify:

Completed by: ____Contact Tel. No.: ____________________________________

~ End ~

Thank you very much for your participation!

Appendix 7- 8: Questionnaire for reliability testing (first questionnaire) in Phase One

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

School of Nursing
護理學院

Reliability Testing of the Questionnaire on Proposed Core Competency for Infection Control Nurses

Questionnaire

Please keep this information confidential.

Introduction:
This study is to assess the internal consistency and test-retest reliability of the questionnaire of proposed core competency for hospital infection control nurse specialists by the field practitioners.

Instruction:
Please answer the questions and return it to Ms. Chan Wai Fong by email (chanwf3@ha.org.hk) or Fax (22346466) on or before **10 October 2007**. For further enquiry, please contact the investigator, Ms. Chan Wai Fong at 2162 / 6172 . Thank you very much.

Part I: Please rate the importance of the attributes of the proposed core competency of ICNs (Specialist level) in hospitals

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Undecided (3)	Not Important (2)	Not very Important (1)
1. Periodically evaluate the effectiveness of the infection prevention and control programme and integrate the findings during modification of the programme.					
2. Critically evaluate significance of findings of surveillance.					
3. Use standardized definitions to conduct surveillance.					
4. Demonstrate knowledge of biostatistics.					
5. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.					
6. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications and make application to, modify or incorporate into own infection control programme to meet an evidence based practice.					
7. Share findings from surveillance and other infection prevention and control activities.					
8. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.					
9. Evaluate the use of technology or products to achieve cost-effective purpose.					
10. Select appropriate indicators to benchmark externally.					
11. Critically review the related research.					
12. Recommend appropriate resources for the proposed plan.					
13. Develop educational objectives and strategies to meet the client needs.					
14. Advise the control measures and investigations to the involved parties and evaluate the effectiveness during outbreak situations.					

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Undecided (3)	Not Important (2)	Not very Important (1)
15. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.					
16. Communicate with clients on the objectives and value of the programme.					
17. Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.					
18. Continuously evaluate the effectiveness of educational programmes and learner outcomes.					
19. Demonstrate knowledge of infectious diseases.					
20. Demonstrate knowledge of epidemiology.					
21. Demonstrate knowledge of communication skills.					
22. Advance the field of infection prevention and control through the involvement of related research.					
23. Demonstrate knowledge of decontamination.					
24. Act as expert resource in infection prevention and control in clinical and organizational level.					
25. Consider clinical outcomes when initiating changes in practice.					
26. Identify the needs of involvement of the other parties in the infection prevention and control programmes.					
27. Assess the extent of outbreak situation.					
28. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems.					

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Undecided (3)	Not Important (2)	Not very Important (1)
29. Integrate relevant public health issues into practice when applicable.					
30. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.					
31. Share knowledge and skills with other team members and clients.					
32. Select appropriate indicators to monitor internal trend of infection.					
33. Use epidemiological knowledge to identify the risk factors and collect the appropriate data during infection outbreak investigation.					
34. Advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control.					
35. Analyze surveillance data by appropriate statistical techniques.					
36. Demonstrate knowledge of asepsis.					
37. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.					
38. Design a surveillance plan for the served population(s) using epidemiological principles.					
39. Periodically assess the educational needs of clients.					
40. Recognize an outbreak through surveillance information and reporting channels.					
41. Assess and incorporate the client needs into the programme plan.					
42. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.					
43. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.					
44. Update infection prevention and control information through peer networking, internet					

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Undecided (3)	Not Important (2)	Not very Important (1)
access, published literature, and/ or professional meetings.					
45. Demonstrate knowledge of educational skills, methodologies and tactics.					
46. Demonstrate knowledge in areas of patient care practices.					
47. Give recommendations to clients during reporting the surveillance findings.					
48. Consider financial implications when initiating changes in practice.					
49. Incorporate the relevant published research findings into practice, education or consultation.					
50. Develop and annually review the programme plan with measurable outcomes.					
51. Demonstrate knowledge of microbiology.					
52. Evaluate client needs and satisfaction and modify the infection prevention and control programmes accordingly.					
53. Report the surveillance findings to appropriate clients.					
54. Demonstrate knowledge of programme administration.					
55. Have two to five years of experience in infection control practice.					
56. Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.					
57. Seek opportunities to influence policymakers.					
58. Select a database(s) that matches internal/ external data of surveillance.					
59. Disseminate the findings, recommendations and policies of the infection prevention and control programmes to concerned clients.					
60. Identify opportunities for service improvement.					

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Undecided (3)	Not Important (2)	Not very Important (1)
61. Share the findings of outbreak investigation to the relevant parties.					
62. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.					
63. Select a database(s) that ensures efficient and accurate data management.					
64. Communicate the necessary resources to administration/ management and modify programme plan if needed.					

You have completed Part I of the questionnaire. Go head to Part II as it is simple and short!

Part II: Demographics (Please fill in the blank or * delete as appropriate)

1. Sex: * Male[1] / Female[2]

2. Age: * 21-30[1] / 31-40[2] / 41-50[3] / 51-60[4]

3. Highest academic qualification attained: * Diploma[1] / Bachelor[2] / Master[3] / Above Master[4]

4. How many years that you worked as an ICN in hospital? ________Years

5. What is your last year working as an ICN in hospital? Year __________

6. During your work as an ICN in hospital, do you work as full time? * Yes[1] → Go to Q8 / No[2]

7. What is the % of time that you spend in infection control in hospital? _______%

8. Work setting in hospital: * Acute[1] / Non-acute[2]

9. Organization: * Public[1] / Private[2]

10. Size of hospital (No. of bed): * ≤250[1] / 251-500[2] / 501-750[3] / 751-1000[4] / >1000[5]

~ End ~

Thank you very much for your participation!

Appendix 7- 9: Questionnaire of opinion survey in Phase Two

Importance of the Attributes of the Proposed Core Competency for Infection Control Nurses

Questionnaire

Please keep this information confidential.

Introduction:
This study is to assess the importance of different attributes of the proposed core competency for hospital infection control nurse specialists. The investigator would like to collect the opinion from the field practitioners.

Instruction:
Please answer the questions and return it to Ms. Chan Wai Fong by email (chanwf3@ha.org.hk) or Fax (22346466) on or before **26 September 2008**. For further enquiry, please contact the investigator, Ms. Chan Wai Fong at 2162 / 6172 . Thank you very much.

<u>Part I</u>: Please rate the importance of the attributes of the proposed core competency of ICNs (Specialist level) in hospitals

Attributes of proposed competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Neutral (3)	Not Important (2)	Not very Important (1)
1. Demonstrate knowledge of infectious diseases.					
2. Communicate the necessary resources to administration/ management.					
3. Periodically assess the educational needs of clients.					
4. Incorporate the relevant published research findings into education.					
5. Give recommendations to clients during reporting the surveillance findings.					
6. Identify opportunities for service improvement.					
7. Demonstrate knowledge of epidemiology.					
8. Communicate with clients on the values of the programme.					
9. Integrate the evaluated findings during modification of the programme.					
10. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.					
11. Integrate relevant public health issues into practice when applicable.					
12. Select a database(s) that ensures efficient data management for surveillance.					
13. Demonstrate knowledge in areas of patient care practices.					
14. Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.					
15. Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.					
16. Use standardized definitions to conduct surveillance.					
17. Incorporate the relevant published research findings into practice, including when providing					

Attributes of proposed competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Neutral (3)	Not Important (2)	Not very Important (1)
consultation service.					
18. Assess the client needs on infection prevention and control programme during planning.					
19. Develop educational objectives and strategies to meet the client needs.					
20. Incorporate the client needs into the programme plan.					
21. Demonstrate knowledge of microbiology.					
22. Evaluate the effectiveness of the control measures during outbreak situations.					
23. Collaborate in the development of educational programmes/ tools that related to infection prevention and control.					
24. Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.					
25. Demonstrate knowledge of decontamination.					
26. Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.					
27. Periodically, e.g. annually, review the programme.					
28. Communicate with clients on the objectives of the programme.					
29. Demonstrate knowledge of asepsis.					
30. Evaluate client satisfaction after implementing the infection prevention and control programme.					
31. Evaluate client needs after implementing the infection prevention and control programme.					
32. Share knowledge and skills with other team members and clients.					
33. Seek opportunities to influence policymakers.					

Attributes of proposed competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Neutral (3)	Not Important (2)	Not very Important (1)
34. Select appropriate indicators for surveillance to benchmark externally.					
35. Advance the relevant knowledge and skills through educational programmes, peer networking, internet access, published literature, and/ or professional meetings.					
36. Demonstrate knowledge of communication skills.					
37. Design a surveillance plan for the served population(s) using epidemiological principles.					
38. Recommend appropriate resources for the proposed programme plan.					
39. Report the surveillance findings to appropriate clients.					
40. Consider financial implications when initiating changes in practice.					
41. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.					
42. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.					

You have completed the half of Part I questionnaire! Please take a short break and continue!

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Neutral (3)	Not Important (2)	Not very Important (1)
43. Select a database(s) that matches internal/ external data structure of surveillance.					
44. Disseminate the policies of the infection prevention and control programmes to concerned clients.					
45. Collect the appropriate data during infection outbreak investigation.					
46. Publish or present the participated research findings to contribute in advancing the field of infection prevention and control.					
47. Demonstrate knowledge of programme administration.					
48. Share the findings of outbreak investigation to the relevant parties.					
49. Analyze surveillance data by appropriate statistical techniques.					
50. Act as expert resource in infection prevention and control in clinical and organizational level.					
51. Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.					
52. Demonstrate knowledge of educational skills and tactics.					
53. Periodically evaluate the effectiveness of the infection prevention and control programme.					
54. Continuously evaluate the learner outcomes of the educational programme.					
55. Disseminate the findings of the infection prevention and control programmes to concerned clients.					
56. Demonstrate knowledge of educational methodologies.					
57. Use epidemiological knowledge to identify the risk factors during outbreak situations.					
58. Integrate relevant cost information into the analysis of findings and recommendations,					

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Neutral (3)	Not Important (2)	Not very Important (1)
including document cost saving in the organization through infection prevention and control programmes activities, if any.					
59. Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.					
60. Manage the expanded resources for infection prevention and control in the organization, e.g. infection control link system.					
61. Recognize an outbreak through surveillance information and reporting channels.					
62. Assess the extent of outbreak situation.					
63. Have two to five years of experience in infection control practice.					
64. Recruit other relevant parties to involve in the infection prevention and control programmes if necessary.					
65. Modify the programme plan if needed after communicating the necessary resources to administration/ management.					
66. Critically review the related research.					
67. Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control.					
68. Share findings with other infection control practitioners from surveillance and other infection prevention and control activities.					
69. Participate in inter-departmental and organization's infection prevention and control improvement activities.					
70. Recommend new or revised practices in accordance to currently accepted, evidence-based					

Attributes of proposed core competency of ICNs (specialist level) in hospitals.	Please ✓ one as appropriate				
	Very Important (5)	Important (4)	Neutral (3)	Not Important (2)	Not very Important (1)
infection prevention and control strategies.					
71. Advance the field of infection prevention and control through the involvement of related research.					
72. Critically evaluate significance of findings of surveillance.					
73. Evaluate the use of technology or products to achieve cost-effective purpose.					
74. Select a database(s) that ensures accurate data management for surveillance.					
75. Advise the control measures to the involved parties during outbreak situations.					
76. Consider clinical outcomes when initiating changes in practice.					
77. Develop the programme plan with measurable outcomes.					
78. Select appropriate indicators to monitor internal trend of infection.					
79. Advise the investigations to the involved parties during outbreak situations.					
80. Demonstrate knowledge of biostatistics.					
81. Continuously evaluate the effectiveness of educational programmes.					
82. Disseminate the recommendations of the infection prevention and control programmes to concerned clients.					
83. Evaluate the educational programmes/ tools that related to infection prevention and control.					

Congratulations! You have completed Part I of the questionnaire. Kindly double check if you have completed all (83) items.
Then, please go ahead to Part II as it is simple and short!

<u>Part II</u>: Demographics (Please fill in the blank or * delete as appropriate)

1. Sex: * Male / Female
2. Age: * 21-30 / 31-40 / 41-50 / 51-60
3. Rank: * RN / NO / NS / APN / WM / SNO / DOM / Others: ________________
4. Highest academic qualification attained: * Certificate / Diploma / Bachelor / Master / Above Master
5. Did you complete the Infection Control Specialty Course organized by APSIC/ HKU/ PolyU? * Yes / No
6. How many years (complete years) that you have worked as an ICN in hospital? ______Years (fill in “0” if you have less than one year)
7. Do you currently work as full time ICN? * Yes → Go to Q9 / No
8. What is the % of time that you work as ICN? ______%
9. Work setting of your current hospital: * Acute (with AED) / Non-acute (without AED)
10. Current organization: * Public / Private
11. Size of current hospital (No. of bed): * ≤250 / 251-500 / 501-750 / 751-1000 / >1000

~ End ~

Thank you very much for your participation!

Appendix 7- 10: Questionnaire for defining the critical competency of infection control nurses in Hong Kong in Phase Three

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

School of Nursing 護理學院

Defining the Essential Core Competency Items for Infection Control Nurses

Questionnaire

Please keep this information confidential.

Introduction:

The core competency items of hospital infection control **nurse specialists** were drafted in 2006. After validating the items, they were incorporated into a questionnaire. The questionnaire was then sent out to infection control nurses to collect their ratings on importance of each core competency item. After data analysis, the items were available for ranking. However, the item list was too long to be practical using for training and/ or assessment. Therefore, I need your expert contribution to trim down the list. This study is to identify the **most essential** (critical competency) items for hospital infection control **nurse specialists** of Hong Kong among the developed list.

Instruction:

The core competency items are listed by ranking, from the most important at the top and the least important at the bottom. Some items have the same ranking, which means they are ranked at the same level of importance. Please read through the items carefully to decide the cut-off point to separate the **most essential** items from the **preferred** items, and provide some comments to justify your decision. (Kindly refrain from placing the cut-off point between items with the same ranking.)

Please return the reply slip to Ms. Chan Wai Fong by email (chanwf3@ha.org.hk) or Fax (22346466) on or before **4 March 2010**. If you have any questions, please contact the investigator, Ms. Chan Wai Fong at 2162 / 6172 . Thank you very much.

The Core Competency Items for ICNs of Hong Kong by Ranking of Importance

Rank	Core Competency Item
1	Demonstrate knowledge of infectious diseases.
2	Collect the appropriate data during infection outbreak investigation.
3	Evaluate the effectiveness of the control measures during outbreak situations.
4	Use standardized definitions to conduct surveillance.
5	Advise the control measures to the involved parties during outbreak situations.
6	Assess the extent of outbreak situation.
7	Demonstrate knowledge of decontamination.
7	Recognize an outbreak through surveillance information and reporting channels.
8	Demonstrate knowledge of asepsis.
9	Communicate the necessary resources to administration/ management.
10	Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into polices and procedures.
10	Demonstrate knowledge of communication skills.
11	Demonstrate knowledge in areas of patient care practices.
12	Share the findings of outbreak investigation to the relevant parties.
13	Assess the client needs on the infection prevention and control programme during planning.
13	Advise the investigation to the involved parties during outbreak situations.
14	Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.
14	Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.
14	Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.
15	Use epidemiological knowledge to identify the risk factors during outbreak situations.
16	Demonstrate knowledge of epidemiology.
16	Disseminate the policies of the infection prevention and control programmes to concerned clients.
16	Demonstrate knowledge o of educational skills and tactics.
17	Develop educational objectives and strategies to meet the client needs.
17	Act as expert resource in infection prevention and control in clinical and organizational level.
18	Share knowledge and skills with other team members and clients.

Rank	Core Competency Item
18	Periodically evaluate the effectiveness of the infection prevention and control programme.
18	Consider clinical outcomes when initiating changes in practice.
19	Identify opportunities for service improvement.
19	Collaborate in the development of educational programmes/ tools that related to infection prevention and control.
19	Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.
19	Evaluate client needs after implementing the infection prevention and control programme.
19	Report the surveillance findings to appropriate clients.
19	Select appropriate indicators to monitor internal trend of infection.
20	Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.
21	Advance the relevant knowledge and skills through educational programmes, peer networking, internet access, published literature, and/ or professional meetings.
21	Evaluate the educational programmes/ tools that related to infection prevention and control.
22	Analyze surveillance data by appropriate statistical techniques.
23	Incorporate the client needs into the programme plan.
23	Manage the expanded resources for infection prevention and control in the organization, e.g. infection control link systems.
23	Participate in inter-departmental and organization's infection prevention and control improvement activities.
23	Critically evaluate significance of findings of surveillance.
24	Disseminate the recommendations of the infection prevention and control programmes to concerned clients.
25	Demonstrate knowledge of microbiology.
26	Incorporate the relevant published research findings into practice, including when providing consultation service.
26	Disseminate the findings of the infection prevention and control programmes to concerned clients.
26	Share findings with other infection control practitioners from surveillance and other infection prevention and control activities.
26	Develop the programme plan with measurable outcomes.
27	Seek opportunities to influence policymakers
27	Select appropriate indicators for surveillance to benchmark externally.
27	Periodically evaluate the effectiveness of the surveillance plan and modify

Rank	Core Competency Item
	as necessary.
28	Periodically, e.g. annually, review the programme.
28	Evaluate client satisfaction after implementing the infection prevention and control programme.
28	Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.
29	Integrate the evaluated findings during modification of the programme.
29	Communicate with clients on the objectives of the programme.
29	Continuously evaluate the effectiveness of educational programmes.
30	Incorporate the relevant published research findings into education.
30	Select a database(s) that ensures efficient data management for surveillance.
30	Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.
31	Select a database(s) that ensures accurate data management for surveillance.
32	Continuously evaluate the learner outcomes to educational programmes.
33	Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control.
34	Modify the programme plan if needed after communicating the necessary resources to administration/ management.
35	Design a surveillance plan for the served population(s) using epidemiological principles.
36	Recommend appropriate resources for the proposed programme plan.
36	Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.
36	Advance the field of infection prevention and control through the involvement of related research.
37	Publish or present the participated research findings to contribute in advancing the field of infection prevention and control.
37	Recruit other relevant parties to involve in the infection prevention and control programmes if necessary.
38	Demonstrate knowledge of programme administration.
39	Demonstrate knowledge of educational methodologies.
39	Select a database(s) that matches internal/ external data structure of surveillance.
40	Periodically assess the educational needs of clients.
40	Communicate with clients on the value of the programme.
40	Critically review the related research.
41	Demonstrate knowledge of biostatistics.

Reply Slip
(Please return on or before 4 March 2010)

From:

Date:

The cut-off point separating essential from preferred core competency items is between rank number _____ and _____ because:

~ End ~
Thank you very much for your participation

Appendix 7- 11: Information Sheet for Phase One: Drafting the core competency

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

School of Nursing 護理學院

Information Sheet for Phase One: Drafting the core competency

A Process Model for Developing Content for Certification Programmes: The Case of Infection Control Nurses in Hong Kong

You are invited to participate in a study conducted by Ms. Chan Wai Fong, who is a post-graduate student of the School of Nursing in The Hong Kong Polytechnic University.

The aim of this research is to build a model of certification for healthcare professionals of Hong Kong. This phase is to draft the core competency of infection control nurses of Hong Kong. It will involve completing five or more questionnaires, which will take you about one hour.

You have every right to withdraw from the study before or during the measurement without penalty of any kind.

If you have any complaints about the conduct of this research study, please do not hesitate to contact Mr. Eric Chan, Secretary of the Human Subjects Ethics Sub-Committee of The Hong Kong Polytechnic University in person or in writing (c/o Human Resources Office of the University).

If you would like to have more information about this study, please contact Ms. Chan Wai Fong on telephone no. 2162 / 6172 or email:

Thank you for your interest in participating in this study.

Ms. Chan Wai Fong
PhD student
Under supervision of Dr. Meyrick Chow

Appendix 7- 12: Information Sheet for Phase One: Content validity survey

Information Sheet for Phase One: Content validity survey

A Process Model for Developing Content for Certification Programmes: The Case of Infection Control Nurses in Hong Kong

You are invited to serve as a content expert in a study conducted by Ms. Chan Wai Fong, who is a post-graduate student of the School of Nursing in The Hong Kong Polytechnic University.

The aim of this research is to build a model of certification for healthcare professionals in Hong Kong. This phase is to assess the relevancy of the item content in the draft core competency for hospital infection control nurse specialists of Hong Kong. It will involve completing a questionnaire, which will take you about 15 to 30 minutes. If necessary, the investigator may interview you to collect further information regarding your reply.

You have every right to withdraw from the study before or during the measurement without penalty of any kind.

If you have any complaints about the conduct of this research study, please do not hesitate to contact Mr. Eric Chan, Secretary of the Human Subjects Ethics Sub-Committee of The Hong Kong Polytechnic University in person or in writing (c/o Human Resources Office of the University).

If you would like to have more information about this study, please contact Ms. Chan Wai Fong on telephone no. 2162 / 6172 or email:

Thank you for your interest in participating in this study.

Ms. Chan Wai Fong
PhD student
Under supervision of Dr. Meyrick Chow

Appendix 7- 13: Information Sheet for Phase One: Reliability testing

THE HONG KONG POLYTECHNIC UNIVERSITY
香港理工大學

School of Nursing 護理學院

Information Sheet for Phase One: Reliability Testing

A Process Model for Developing Content for Certification Programmes:
The Case of Infection Control Nurses in Hong Kong

You are invited to participate in a study conducted by Ms. Chan Wai Fong, who is a post-graduate student of the School of Nursing, The Hong Kong Polytechnic University.

The aim of this research is to build a model of certification for healthcare professionals of Hong Kong. This phase is to assess the internal consistency and test-retest reliability of the questionnaire of proposed core competency for infection control nurse specialists of Hong Kong. It will involve completing the same questionnaire twice within two to three weeks' time, which will take you about half an hour for each.

You have every right to withdraw from the study at any time without penalty of any kind.

If you have any complaints about the conduct of this research study, please do not hesitate to contact Mr. Eric Chan, Secretary of the Human Subjects Ethics Sub-Committee of The Hong Kong Polytechnic University in person or in writing (c/o Human Resources Office of the University).

If you would like to have more information about this study, please contact Ms. Chan Wai Fong on telephone no. 2162 / 6172 or email:

Thank you for your interest in participating in this study.

Ms. Chan Wai Fong
PhD student
Under supervision of Dr. Meyrick Chow

Appendix 7- 14: Information Sheet for Phase Two

Information Sheet for Phase Two

A Process Model for Developing Content for Certification Programmes: The Case of Infection Control Nurses in Hong Kong

You are invited to participate in a study conducted by Ms. Chan Wai Fong, who is a post-graduate student of the School of Nursing, The Hong Kong Polytechnic University.

The aim of this research is to build a model of certification for healthcare professionals of Hong Kong. This phase is to assess the importance of the different attributes of proposed core competency for infection control nurse specialists of Hong Kong. It will involve completing a questionnaire, which will take you about half an hour. You are invited because you are the infection control nurse of Hong Kong and the investigator would like to collect your opinion, which representing the idea of field practitioners.

You have every right to withdraw from the study at any time without penalty of any kind.

If you have any complaints about the conduct of this research study, please do not hesitate to contact Mr. Eric Chan, Secretary of the Human Subjects Ethics Sub-Committee of The Hong Kong Polytechnic University in person or in writing (c/o Human Resources Office of the University).

If you would like to have more information about this study, please contact Ms. Chan Wai Fong on telephone no. 2162 / 6172 or email:

Thank you for your interest in participating in this study.

Ms. Chan Wai Fong
PhD student
Under supervision of Dr. Meyrick Chow

Appendix 7- 15: Information Sheet for Phase Three

THE HONG KONG POLYTECHNIC UNIVERSITY 香港理工大學

School of Nursing 護理學院

Information Sheet for Phase Three

A Process Model for Developing Content for Certification Programmes:
The Case of Infection Control Nurses in Hong Kong

You are invited to participate in a study conducted by Ms. Chan Wai Fong, who is a post-graduate student of the School of Nursing in The Hong Kong Polytechnic University.

The aim of this research is to build a model of certification for healthcare professionals of Hong Kong. This phase is to identify the most essential core competency items (critical competency items) for hospital infection control nurse specialists of Hong Kong among the developed list. It will involve completing a questionnaire, which will take you about half an hour.

You have every right to withdraw from the study before or during the measurement without penalty of any kind.

If you have any complaints about the conduct of this research study, please do not hesitate to contact Mr. Eric Chan, Secretary of the Human Subjects Ethics Sub-Committee of The Hong Kong Polytechnic University in person or in writing (c/o Human Resources Office of the University).

If you would like to have more information about this study, please contact Ms. Chan Wai Fong on telephone no. 2162 / 6172 or email:

Thank you for your interest in participating in this study.

Ms. Chan Wai Fong
PhD student
Under supervision of Dr. Meyrick Chow

Appendix 8- 1: Result of Round 3 Delphi Survey

Competency item	**Agreement**	**Action**
Surveillance		
1. Design a surveillance plan for the served population(s) using epidemiological principles.	100%	Confirmed
2. Use standardized definitions to conduct surveillance.	100%	Confirmed
3. Select appropriate indicators to monitor internal trend and benchmark externally.	100%	Confirmed
4. Select a database(s) that matches internal/ external data.	83.3%	Confirmed
5. Ensure the data management is accurate and minimize the repeated data entry.	83.3%	Confirmed. To integrate with item 4.
6. Analyze surveillance data by appropriate statistical techniques.	100%	Confirmed
7. Critically evaluate significance of findings.	100%	Confirmed
8. Report the findings to appropriate clients and give recommendations accordingly.	100%	Confirmed
9. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.	100%	Confirmed
Program management and evaluation		
10. Develop and annually review a programme plan with measurable outcomes.	100%	Confirmed
11. Assess and incorporate the client needs into the programme plan.	100%	Confirmed
12. Recommend appropriate resources for the proposed plan.	100%	Confirmed
13. Communicate the necessary resources to administration/ management and modify programme plan if needed.	83.3%	Confirmed
14. Periodically evaluate the effectiveness of the infection surveillance, prevention and control programme and integrate the findings during modification.	100%	Confirmed
15. Evaluate client needs and satisfaction and modify the infection surveillance, prevention and control programmes accordingly.	100%	Confirmed
Consultation		
16. Maintain access to update information on infection prevention and control.	66.7%	Removed

Competency item	Agreement	Action
17. Communicate with clients on the function, role and value of the programme.	83.3%	Confirmed. To put under "programme management and evaluation" and modify wordings
18. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	100%	Confirmed. To put under "team and service management"
19. Disseminate the findings, recommendations and policies of the infection surveillance, prevention and control programmes to appropriate clients.	100%	Confirmed. To put under "education" and modify wordings
20. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.	100%	Confirmed
Evidence based practice on infection prevention and control practice (includes occupational health)		
21. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	100%	Confirmed
22. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications.	100%	Confirmed
23. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	100%	Confirmed
24. Integrate relevant public health issues into practice when applicable.	100%	Confirmed
Education		
25. Periodically assess the educational needs of clients	100%	Confirmed
26. Develop educational objectives and strategies to meet the client needs.	100%	Confirmed
27. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.	100%	Confirmed

Competency item	Agreement	Action
28. Continuously evaluate the effectiveness of educational programmes and learner outcomes.	100%	Confirmed
Team and service management		
29. Share knowledge and skills with other team members and clients if appropriate.	83.3%	Confirmed. To modify wordings
30. Support and promote the importance of research in shaping the practice of infection prevention and control.		To circulate after modifying wordings
31. Emphasize the value of scientific basis of infection prevention and control.	83.3%	Removed. Content covered by item 23
32. Initiate creativity and innovation to practice.	66.7%	Removed
33. Seek opportunities to influence policymakers.	83.3%	Confirmed
34. Consider both clinical outcomes and financial implications when initiating changes in practice.	83.3%	Confirmed
35. Evaluate the use of technology or products to achieve cost-effective purpose.	100%	Confirmed
36. Integrate relevant cost information into the analysis of findings and recommendations.	83.3%	Confirmed
37. Document cost saving in the organization through infection surveillance, prevention and control programme activities.	83.3%	To integrate with item 36
38. Identify opportunities for service improvement.	100%	Confirmed
39. Contribute epidemiologic skills to improvement process.	66.7%	Removed
40. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems	83.3%	Confirmed
Team work/ Partnership		
41. Identify the needs of involvement of the other parties in the infection prevention and control programmes.	100%	Confirmed
42. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.	100%	Confirmed
Outbreak investigation and control		

Competency item	Agreement	Action
43. Recognize an outbreak through surveillance information and reporting channels.	100%	Confirmed
44. Assess the extent of outbreak situation.	100%	Confirmed
45. Identify the risk factors and collect the appropriate data.	100%	Confirmed
46. Advise the control measures and investigations to the involved parties and evaluate the effectiveness.	100%	Confirmed
47. Share the findings of outbreak investigation to the relevant parties.	100%	Confirmed
Research and development		
48. Critically review the research.	83.3%	Confirmed
49. Incorporate the relevant published research findings into practice, education or consultation.	83.3%	Confirmed
50. Organize and share findings from surveillance and other infection prevention and control activities.	83.3%	Confirmed
51. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.	83.3%	Confirmed
Qualification		
52. Demonstrate knowledge in areas of patient care practices, microbiology, asepsis, disinfection/ sterilization, adult education, infectious diseases, communication, programme administration, epidemiology and biostatistics.	100%	Confirmed with minor wordings adjustment
53. Has at least two years of experience in infection control practice.	83.3%	To re-circulate after modification
54. Completed at least a certificate-level of infection control training for infection control practitioners organized by university, university collaborated programme or equivalent.	100%	Confirmed
Continuing education and professional development		
55. Advance the knowledge and skills through continuing education	100%	Confirmed
56. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings.	100%	Confirmed
57. Advance the field of infection prevention and control through the support of related research.	100%	Confirmed
58. Participate in or support the professional organizations.	66.7%	Removed

Appendix 8- 2: The draft core competency of infection control nurses of Hong Kong (51-item vs. 64-item)

Draft core competency items (51 items)	**Draft core competency items (64 items after splitting)**
Surveillance	
● Design a surveillance plan for the served population(s) using epidemiological principles. ● Use standardized definitions to conduct surveillance. ● Select appropriate indicators to monitor internal trend of infection. ● Select a database(s) that matches internal/ external data to ensure efficient and accurate data management. ● Analyze surveillance data by appropriate statistical techniques. ● Critically evaluate significance of findings. ● Report the findings to appropriate clients and give recommendations accordingly. ● Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.	1. Design a surveillance plan for the served population(s) using epidemiological principles. 2. Use standardized definitions to conduct surveillance. 3. Select appropriate indicators to monitor internal trend of infection. 4. Select appropriate indicators to benchmark externally. 5. Select a database(s) that matches internal/ external data of surveillance. 6. Select a database(s) that ensures efficient and accurate data management. 7. Analyze surveillance data by appropriate statistical techniques. 8. Critically evaluate significance of findings of surveillance. 9. Report the surveillance findings to appropriate clients. 10. Give recommendations to clients during reporting the surveillance findings. 11. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.
Programme management and evaluation	

Draft core competency items (51 items)	Draft core competency items (64 items after splitting)
● Develop and annually review a programme plan with measurable outcomes. ● Assess and incorporate the client needs into the programme plan. ● Recommend appropriate resources for the proposed plan. ● Communicate with clients on the objectives, function, role and value of the programme. ● Communicate the necessary resources to administration/ management and modify programme plan if needed. ● Periodically evaluate the effectiveness of the infection surveillance, prevention and control programme and integrate the findings during modification. ● Evaluate client needs and satisfaction and modify the infection surveillance, prevention and control programmes accordingly.	12. Develop and annually review the programme plan with measurable outcomes. 13. Assess and incorporate the client needs into the programme plan. 14. Recommend appropriate resources for the proposed plan. 15. Communicate with clients on the objectives and value of the programme. 16. Communicate the necessary resources to administration/ management and modify programme plan if needed. 17. Periodically evaluate the effectiveness of the infection prevention and control programme and integrate the findings during modification of the programme. 18. Evaluate client needs and satisfaction and modify the infection prevention and control programmes accordingly.
Consultation	
● Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.	19. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.
Evidence based practice	

Draft core competency items (51 items)	Draft core competency items (64 items after splitting)
● Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome. ● Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications. ● Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies. ● Integrate relevant public health issues into practice when applicable.	20. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome. 21. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications and make application to, modify or incorporate into own infection control programme to meet an evidence based practice. 22. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies. 23. Integrate relevant public health issues into practice when applicable.
Education	
● Periodically assess the educational needs of clients. ● Develop educational objectives and strategies to meet the client needs. ● Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control. ● Disseminate the findings, recommendations and policies of the infection surveillance, prevention and control programmes to concerned clients. ● Continuously evaluate the effectiveness of educational programmes and learner outcomes.	24. Periodically assess the educational needs of clients. 25. Develop educational objectives and strategies to meet the client needs. 26. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control. 27. Disseminate the findings, recommendations and policies of the infection prevention and control programmes to concerned clients. 28. Continuously evaluate the effectiveness of educational programmes and learner outcomes.
Team and service management	

Draft core competency items (51 items)	Draft core competency items (64 items after splitting)
● Share knowledge and skills with other team members and clients. ● Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members. ● Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures. ● Seek opportunities to influence policymakers. ● Consider both clinical outcomes and financial implications when initiating changes in practice. ● Evaluate the use of technology or products to achieve cost-effective purpose. ● Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection surveillance, prevention and control programme activities, if any. ● Identify opportunities for service improvement. ● Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems	29. Share knowledge and skills with other team members and clients. 30. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members. 31. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures. 32. Seek opportunities to influence policymakers. 33. Consider clinical outcomes when initiating changes in practice. 34. Consider financial implications when initiating changes in practice. 35. Evaluate the use of technology or products to achieve cost-effective purpose. 36. Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any. 37. Identify opportunities for service improvement. 38. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems.
Collaboration and partnership	
● Identify the needs of involvement of the other parties in the infection prevention and control programmes. ● Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.	39. Identify the needs of involvement of the other parties in the infection prevention and control programmes. 40. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.
Outbreak investigation and control	

Draft core competency items (51 items)	Draft core competency items (64 items after splitting)
● Recognize an outbreak through surveillance information and reporting channels. ● Assess the extent of outbreak situation. ● Identify the risk factors and collect the appropriate data. ● Advise the control measures and investigations to the involved parties and evaluate the effectiveness. ● Share the findings of outbreak investigation to the relevant parties.	41. Recognize an outbreak through surveillance information and reporting channels. 42. Assess the extent of outbreak situation. 43. Use epidemiological knowledge to identify the risk factors and collect the appropriate data during infection outbreak investigation. 44. Advise the control measures and investigations to the involved parties and evaluate the effectiveness during outbreak situations. 45. Share the findings of outbreak investigation to the relevant parties.
Research and development	
● Critically review the related research. ● Incorporate the relevant published research findings into practice, education or consultation. ● Organize and share findings from surveillance and other infection prevention and control activities. ● Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.	46. Critically review the related research. 47. Incorporate the relevant published research findings into practice, education or consultation. 48. Share findings from surveillance and other infection prevention and control activities. 49. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.
Qualification	

Draft core competency items (51 items)	**Draft core competency items (64 items after splitting)**
● Demonstrate knowledge in areas of patient care practices, microbiology, asepsis, decontamination, adult education, infectious diseases, communication, programme administration, epidemiology and biostatistics. ● Have two to five years of experience in infection control practice. ● Completed at least a certificate-level of infection control training for infection control practitioners organized by university, university collaborated programme or equivalent.	50. Demonstrate knowledge in areas of patient care practices. 51. Demonstrate knowledge of microbiology. 52. Demonstrate knowledge of asepsis. 53. Demonstrate knowledge of decontamination. 54. Demonstrate knowledge of educational skills, methodologies and tactics. 55. Demonstrate knowledge of infectious diseases. 56. Demonstrate knowledge of communication skills. 57. Demonstrate knowledge of programme administration. 58. Demonstrate knowledge of epidemiology. 59. Demonstrate knowledge of biostatistics. 60. Have two to five years of experience in infection control practice. 61. Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.
Continuing education and professional development	
● Advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control. ● Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings. ● Advance the field of infection prevention and control through the support of related research.	62. Advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control. 63. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings. 64. Advance the field of infection prevention and control through the involvement of related research.

Appendix 8- 3: Result of content validity study

Draft core competency items Items agreed (rating 3 or 4) by the content experts	Numbers of responses rating (1)	(2)	(3)	(4)
Surveillance				
65. Design a surveillance plan for the served population(s) using epidemiological principles.				3
66. Use standardized definitions to conduct surveillance.				3
67. Select appropriate indicators to monitor internal trend of infection.				3
68. Select appropriate indicators to benchmark externally.				3
69. Select a database(s) that matches internal/ external data of surveillance.		1		2
70. Select a database(s) that ensures efficient and accurate data management.		1		2
71. Analyze surveillance data by appropriate statistical techniques.				3
72. Critically evaluate significance of findings of surveillance.				3
73. Report the surveillance findings to appropriate clients.	1			2
74. Give recommendations to clients during reporting the surveillance findings.				3
75. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.				3
Programme management and evaluation				
76. Develop and annually review a programme plan with measurable outcomes.			2	1
77. Assess and incorporate the client needs into the programme plan.				3
78. Recommend appropriate resources for the proposed plan.				3
79. Communicate with clients on the objectives, function, role and value of the programme.			1	2
80. Communicate the necessary resources to administration/ management and modify programme plan if		1		2

Draft core competency items [shaded box] Items agreed (rating 3 or 4) by the content experts	Numbers of responses rating (1)	(2)	(3)	(4)
needed.				
81. Periodically evaluate the effectiveness of the infection prevention and control programme and integrate the findings during modification of the programme.			1	2
82. Evaluate client needs and satisfaction and modify the infection prevention and control programmes accordingly.				3
Consultation				
83. Provide consultation to clients, including administration/ management, committees, staff and managers, on issues regarding infection prevention and control.		1	1	1
Evidence based practice on infection prevention and control practice				
84. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	1	1		1
85. Review and analyze the existing regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications.			1	2
86. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.				3
87. Integrate relevant public health issues into practice when applicable.				3
Education				
88. Periodically assess the educational needs of clients.				3
89. Develop educational objectives and strategies to meet the client needs.				3

Draft core competency items [shaded box] Items agreed (rating 3 or 4) by the content experts	Numbers of responses rating (1)	(2)	(3)	(4)
90. Collaborate in the development, delivery and evaluation of educational programmes or tools that relating to infection prevention and control.				3
91. Disseminate the findings, recommendations and policies of the infection prevention and control programmes to concerned clients.	1			2
92. Continuously evaluate the effectiveness of educational programmes and learner outcomes.				3
Team and service management				
93. Share knowledge and skills with other team members and clients.				3
94. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.				3
95. Collaborate and integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.				3
96. Seek opportunities to influence policymakers.		1	1	1
97. Consider clinical outcomes when initiating changes in practice.				3
98. Consider financial implications when initiating changes in practice.				3
99. Evaluate the use of technology or products to achieve cost-effective purpose.				3
100. Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.				3
101. Identify opportunities for service improvement.		1		2
102. Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems.				3

Draft core competency items Items agreed (rating 3 or 4) by the content experts	Numbers of responses rating (1)	(2)	(3)	(4)
Collaboration and partnership				
103. Identify the needs of involvement of the other parties in the infection prevention and control programmes.				3
104. Coordinate and participate in inter-departmental and organization's infection prevention and control improvement activities.				3
Outbreak investigation and control				
105. Recognize an outbreak through surveillance information and reporting channels.				3
106. Assess the extent of outbreak situation.				3
107. Identify the risk factors and collect the appropriate data during infection outbreak.			1	2
108. Advise the control measures and investigations to the involved parties and evaluate the effectiveness during outbreak situations.				3
109. Share the findings of outbreak investigation to the relevant parties.		1		2
Research and development				

Draft core competency items Items agreed (rating 3 or 4) by the content experts	Numbers of responses rating (1)	(2)	(3)	(4)
110. Critically review the related research.	1			2
111. Incorporate the relevant published research findings into practice, education or consultation.				3
112. Share findings from surveillance and other infection prevention and control activities.				3
113. Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control.				3
Qualification				

Draft core competency items [shaded box] Items agreed (rating 3 or 4) by the content experts	Numbers of responses rating			
	(1)	(2)	(3)	(4)
114. Demonstrate knowledge in areas of patient care practices.				3
115. Demonstrate knowledge of microbiology.			1	2
116. Demonstrate knowledge of asepsis.			1	2
117. Demonstrate knowledge of decontamination.				3
118. Demonstrate knowledge of adult education.		1	1	1
119. Demonstrate knowledge of infectious diseases.			1	2
120. Demonstrate knowledge of communication.	1		1	1
121. Demonstrate knowledge of programme administration.	2			1
122. Demonstrate knowledge of epidemiology.				3
123. Demonstrate knowledge of biostatistics.				3
124. Have two to five years of experience in infection control practice.	1	1		1
125. Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.	1		1	1
Continuing education and professional development				
126. Advance the knowledge and skills through continuing education, including accessing update information on infection prevention and control.			1	2
127. Update infection prevention and control information through peer networking, internet access, published literature, and/ or professional meetings.			1	2
128. Advance the field of infection prevention and control through the support of related research.			1	2

Appendix 8- 4: Summary statistics of 18 persons and 64 items for ex-infection control nurses

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     SUMMARY OF 18 MEASURED persons
+-----------------------------------------------------------------------------+
|          RAW                          MODEL         INFIT        OUTFIT     |
|         SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     282.1      64.0        3.75     .34        .99     .0    .96    -.1 |
| S.D.      22.0        .0        2.05     .17        .27    1.4    .33    1.3 |
| MAX.     319.0      64.0        8.64    1.02       1.53    3.1   1.59    2.6 |
| MIN.     246.0      64.0         .75     .27        .67   -2.9    .39   -2.5 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .40  ADJ.SD    2.01  SEPARATION  5.07  person RELIABILITY  .96 |
|MODEL RMSE    .38  ADJ.SD    2.01  SEPARATION  5.27  person RELIABILITY  .97 |
| S.E. OF person MEAN = .50                                                    |
+-----------------------------------------------------------------------------+
person RAW SCORE-TO-MEASURE CORRELATION = .98
CRONBACH ALPHA (KR-20) person RAW SCORE RELIABILITY = .98

     SUMMARY OF 64 MEASURED items
+-----------------------------------------------------------------------------+
|          RAW                          MODEL         INFIT        OUTFIT     |
|         SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN      79.3      18.0         .00     .57       1.00     .0    .96     .1 |
| S.D.       3.5        .0        1.11     .03        .45    1.2    .79     .8 |
| MAX.      87.0      18.0        2.63     .71       2.53    3.6   6.03    3.8 |
| MIN.      70.0      18.0       -2.79     .47        .38   -2.1    .29   -1.4 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .62  ADJ.SD     .93  SEPARATION  1.50  item   RELIABILITY  .69 |
|MODEL RMSE    .57  ADJ.SD     .96  SEPARATION  1.67  item   RELIABILITY  .74 |
| S.E. OF item MEAN = .14                                                      |
+-----------------------------------------------------------------------------+
UMEAN=.000 USCALE=1.000
item RAW SCORE-TO-MEASURE CORRELATION = -1.00
1152 DATA POINTS. APPROXIMATE LOG-LIKELIHOOD CHI-SQUARE: 1221.24
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Appendix 8- 5: Splitting of double- and triple-barrelled items of 64 draft items

Double-/ triple-barrelled item	**Split items**
(6) Select a database(s) that ensures efficient and accurate data management	6) Select a database(s) that ensures efficient data management
	7) Select a database(s) that ensures accurate data management
(12) Develop and annually review the programme plan with measurable outcomes	13) Develop the programme plan with measurable outcomes
	14) Periodically, e.g. annually, review the programme
(13) Assess and incorporate the client needs into the programme plan	15) Assess the client needs on infection prevention and control programme during planning
	16) Incorporate the client needs into the programme plan
(15) Communicate with clients on the objectives and value of the programme	18) Communicate with clients on the objectives of the programme
	19) Communicate with clients on the value of the programme
(16) Communicate the necessary resources to administration/ management and modify programme plan if needed	20) Communicate the necessary resources to administration/ management
	21) Modify the programme plan if needed after communicating the necessary resources to administration/ management
(17) Periodically evaluate the effectiveness of the infection prevention and control programme and integrate the findings during modification of the programme	22) Periodically evaluate the effectiveness of the infection prevention and control programme
	23) Integrate the evaluated findings during modification of the programme
(18) Evaluate client needs and satisfaction and modify the infection prevention and control programmes accordingly	24) Evaluate client needs after implementing the infection prevention and control programme
	25) Evaluate client satisfaction after implementing the infection prevention and control programme
	26) Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction
(26) Collaborate in the development, delivery and evaluation of educational programmes or tools that related to infection prevention and control	33) Collaborate in the development of educational programmes/ tools that related to infection prevention and control
	34) Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control
	35) Evaluate the educational programmes/ tools that related to infection prevention and control
(27) Disseminate the findings, recommendations and policies of the infection prevention and control programmes to concerned clients	36) Disseminate the findings of the infection prevention and control programmes to concerned clients
	37) Disseminate the recommendations of the infection prevention and control programmes to concerned clients
	38) Disseminate the policies of the infection prevention and control programmes to concerned clients

Double-/ triple-barrelled item	**Split items**
(28) Continuously evaluate the effectiveness of educational programmes and learners outcomes	39) Continuously evaluate the effectiveness of educational programmes
	40) Continuously evaluate the learner outcomes of educational programmes
(38) Expand and manage the resources for infection prevention and control in the organization, e.g. use of infection control link systems	50) Expand the resources for infection prevention and control in the organization, e.g. infection control link systems
	51) Manage the resources for infection prevention and control in the organization, e.g. infection control link systems
(43) Use epidemiological knowledge to identify the risk factors and collect the appropriate data during infection outbreak investigation	56) Use epidemiological knowledge to identify the risk factors during outbreak situations
	57) Collect the appropriate data during infection outbreak investigation
(44) Advise the control measures and investigations to the involved parties and evaluate the effectiveness during outbreak situations	58) Advise the control measures to the involved parties during outbreak situations
	59) Advise the investigations to the involved parties during outbreak situations
	60) Evaluate the effectiveness of the control measures during outbreak situations
(47) Incorporate the relevant published research findings into practice, education or consultation	63) Incorporate the relevant published research findings into practice, including when providing consultation service
	64) Incorporate the relevant published research findings into education
(49) Participate in infection prevention and control-related research and publish or present research findings to contribute in advancing the field of infection prevention and control	66) Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control
	67) Publish or present the participated research findings to contribute in advancing the field of infection prevention and control
(54) Demonstrate knowledge of educational skills, methodologies and tactics	72) Demonstrate knowledge of educational skills and tactics
	73) Demonstrate knowledge of educational methodologies

Appendix 8- 6: 83-item proposed core competency of infection control nurses of Hong Kong

Surveillance

1. Design a surveillance plan for the served population(s) using epidemiological principles.
2. Use standardized definitions to conduct surveillance.
3. Select appropriate indicators to monitor internal trend of infection.
4. Select appropriate indicators to benchmark externally.
5. Select a database(s) that matches internal/ external data structure of surveillance.
6. Select a database(s) that ensures efficient data management for surveillance.
7. Select a database(s) that ensures accurate data management for surveillance.
8. Analyze surveillance data by appropriate statistical techniques.
9. Critically evaluate significance of findings of surveillance.
10. Report the surveillance findings to appropriate clients.
11. Give recommendations to clients during reporting the surveillance findings.
12. Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.

Programme management and evaluation

13. Develop the programme plan with measurable outcomes.
14. Periodically, e.g. annually, review the programme.
15. Assess the client needs on infection prevention and control programme during planning.
16. Incorporate the client needs into the programme plan.
17. Recommend appropriate resources for the proposed programme plan.
18. Communicate with clients on the objectives of the programme.
19. Communicate with clients on the value of the programme.
20. Communicate the necessary resources to administration/ management,
21. Modify the programme plan if needed after communicating the necessary resources to administration/ management.
22. Periodically evaluate the effectiveness of the infection prevention and control programme.
23. Integrate the evaluated findings during modification of the programme.
24. Evaluate client needs after implementing the infection prevention and control programme.
25. Evaluate client satisfaction after implementing the infection prevention and control programme.
26. Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.

Evidence based practice

27. Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.
28. Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.
29. Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.
30. Integrate relevant public health issues into practice when applicable.

Education

31. Periodically assess the educational needs of clients.
32. Develop educational objectives and strategies to meet the client needs.
33. Collaborate in the development of educational programmes/ tools that related to infection prevention and control.
34. Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.
35. Evaluate the educational programmes/ tools that related to infection prevention and control.
36. Disseminate the findings of the infection prevention and control programmes to

concerned clients.

37. Disseminate the recommendations of the infection prevention and control programmes to concerned clients.
38. Disseminate the policies of the infection prevention and control programmes to concerned clients.
39. Continuously evaluate the effectiveness of educational programmes.
40. Continuously evaluate the learner outcomes of educational programmes.

Team and service management

41. Share knowledge and skills with other team members and clients.
42. Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.
43. Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.
44. Seek opportunities to influence policymakers.
45. Consider clinical outcomes when initiating changes in practice.
46. Consider financial implications when initiating changes in practice.
47. Evaluate the use of technology or products to achieve cost-effective purpose.
48. Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.
49. Identify opportunities for service improvement.
50. Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.
51. Manage the expanded resources for infection prevention and control in the organization, e.g. infection control link systems.

Collaboration and partnership

52. Recruit other relevant parties to involve in the infection prevention and control programmes if necessary.
53. Participate in inter-departmental and organization’s infection prevention and control improvement activities.

Outbreak investigation and control

54. Recognize an outbreak through surveillance information and reporting channels.
55. Assess the extent of outbreak situation.
56. Use epidemiological knowledge to identify the risk factors during outbreak situations.
57. Collect the appropriate data during infection outbreak investigation.
58. Advise the control measures to the involved parties during outbreak situations.
59. Advise the investigations to the involved parties during outbreak situations.
60. Evaluate the effectiveness of the control measures during outbreak situations.
61. Share the findings of outbreak investigation to the relevant parties.

Research and development

62. Critically review the related research.
63. Incorporate the relevant published research findings into practice, including when providing consultation service.
64. Incorporate the relevant published research findings into education.
65. Share findings with other infection control practitioners from surveillance and other infection prevention and control activities.
66. Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control.
67. Publish or present the participated research findings to contribute in advancing the field of infection prevention and control.

Expert knowledge

68. Demonstrate knowledge in areas of patient care practices.
69. Demonstrate knowledge of microbiology.
70. Demonstrate knowledge of asepsis.
71. Demonstrate knowledge of decontamination.
72. Demonstrate knowledge of educational skills and tactics.
73. Demonstrate knowledge of educational methodologies.
74. Demonstrate knowledge of infectious diseases.

75. Demonstrate knowledge of communication skills.
76. Demonstrate knowledge of programme administration.
77. Demonstrate knowledge of epidemiology.
78. Demonstrate knowledge of biostatistics.
79. Demonstrate two to five years of experience in infection control practice.
80. Act as expert resource in infection prevention and control in clinical and organizational level.
81. Completed at least a certificate-level of infection control training for infection control practitioners organized by formal institution that offers programmes specializing in infection control.

Continuing education and professional development

82. Advance the relevant knowledge and skills through educational programmes, peer networking, internet access, published literature, and/ or professional meetings.
83. Advance the field of infection prevention and control through the involvement of related research.

Appendix 9- 1: Summary statistics of 91 persons and 83 items

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     SUMMARY OF 90 MEASURED (NON-EXTREME) Persons
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     350.6      82.9        2.68     .25      1.01    -.2   1.01    -.3 |
| S.D.      29.8        .4        1.70     .10       .43    2.5    .52    2.5 |
| MAX.     414.0      83.0        8.31    1.01      2.60    6.7   3.55    6.8 |
| MIN.     281.0      80.0        -.65     .19       .24   -6.0    .22   -6.1 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .29  ADJ.SD    1.68  SEPARATION  5.89  Person RELIABILITY  .97 |
|MODEL RMSE    .27  ADJ.SD    1.68  SEPARATION  6.24  Person RELIABILITY  .97 |
| S.E. OF Person MEAN = .18                                                   |
+-----------------------------------------------------------------------------+
  MAXIMUM EXTREME SCORE:      1 Persons
        VALID RESPONSES:  99.9%

     SUMMARY OF 91 MEASURED (EXTREME AND NON-EXTREME) Persons
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     351.3      82.9        2.75     .27                                |
| S.D.      30.4        .4        1.84     .19                                |
| MAX.     415.0      83.0        9.52    1.83                                |
| MIN.     281.0      80.0        -.65     .19                                |
|-----------------------------------------------------------------------------|
| REAL RMSE    .34  ADJ.SD    1.81  SEPARATION  5.28  Person RELIABILITY  .97 |
|MODEL RMSE    .33  ADJ.SD    1.81  SEPARATION  5.49  Person RELIABILITY  .97 |
| S.E. OF Person MEAN = .19                                                   |
+-----------------------------------------------------------------------------+
Person RAW SCORE-TO-MEASURE CORRELATION = .97 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = .98 (approximate due to missing data)

     SUMMARY OF 83 MEASURED (NON-EXTREME) Items
+-----------------------------------------------------------------------------+
|           RAW                          MODEL         INFIT        OUTFIT    |
|          SCORE     COUNT     MEASURE   ERROR      MNSQ   ZSTD   MNSQ   ZSTD |
|-----------------------------------------------------------------------------|
| MEAN     380.2      89.9         .00     .22      1.00    -.1   1.01     .0 |
| S.D.      15.5        .3         .79     .01       .26    1.6    .37    1.4 |
| MAX.     420.0      90.0        1.72     .25      1.85    4.2   2.75    3.8 |
| MIN.     344.0      89.0       -2.13     .20       .53   -3.3    .49   -3.0 |
|-----------------------------------------------------------------------------|
| REAL RMSE    .24  ADJ.SD     .75  SEPARATION  3.18  Item   RELIABILITY  .91 |
|MODEL RMSE    .22  ADJ.SD     .75  SEPARATION  3.35  Item   RELIABILITY  .92 |
| S.E. OF Item MEAN = .09                                                     |
+-----------------------------------------------------------------------------+
UMEAN=.000 USCALE=1.000
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00 (approximate due to missing data)
7464 DATA POINTS. APPROXIMATE LOG-LIKELIHOOD CHI-SQUARE: 9705.07
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Appendix 9- 2: Person statistics of 91 persons and 83 items

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person	Fit type
1	337	83	1.87	.23	.49	-3.3	.49	-3.3	.20	89.2	74.3	01 SESFNGB	
2	346	83	2.34	.23	.67	-2.1	.67	-2.1	.28	80.7	72.0	02 SNJFAGM	
3	328	83	1.40	.23	.28	-5.6	.24	-5.8	.40	92.8	73.9	03 PNJFAGM	
4	335	83	1.76	.23	.31	-5.1	.31	-5.0	.22	94.0	74.4	04 PESFAGB	
5	339	83	1.97	.23	.86	-.7	.86	-.7	.56	75.9	74.0	05 SNJPNPB	
6	346	83	2.34	.23	.51	-3.5	.49	-3.6	.40	85.5	72.0	06 SNJFNGB	
7	326	83	1.30	.23	1.11	.7	1.10	.6	.48	78.3	73.5	07 SNJPNGM	
8	393	83	4.80	.26	1.50	3.2	1.34	1.6	.35	78.3	74.2	08 PNJFAGM	misfit
9	352	83	2.65	.23	1.31	1.9	1.29	1.7	.43	63.9	69.4	09 PNSPNGB	
10	337	83	1.87	.23	1.96	4.2	1.97	4.1	.29	50.6	74.3	10 SESFNGB	misfit
11	337	83	1.87	.23	2.22	5.0	2.23	5.0	.55	42.2	74.3	11 SESFAGM	misfit
12	339	83	1.97	.23	.58	-2.7	.58	-2.6	.36	85.5	74.0	12 PNJFAGB	
13	301	83	.14	.20	.88	-.8	.89	-.7	.14	59.0	63.1	13 SNJFAGB	
14	405	83	5.83	.34	.93	-.2	.71	-.8	.33	88.0	88.0	14 PNJFNGM	
15	310	83	.53	.21	.95	-.2	.97	-.1	.54	62.7	66.9	15 P JPNGM	
16	343	83	2.18	.23	.43	-4.2	.40	-4.3	.54	86.7	73.0	16 SESFAGM	
17	345	83	2.29	.23	.51	-3.5	.50	-3.4	.35	86.7	72.4	17 SNJFNGM	
18	335	83	1.76	.23	1.72	3.2	1.72	3.2	.61	50.6	74.4	18 SNJFAGM	misfit
19	325	83	1.25	.22	.64	-2.2	.62	-2.3	.59	78.3	73.3	19 SESFAGM	
20	391	83	4.67	.25	.88	-.9	.83	-.9	.42	78.3	72.4	20 PESFAGB	
21	344	83	2.24	.23	.57	-2.9	.55	-2.9	.36	83.1	72.7	21 PNJFAGB	
22	320	83	1.00	.22	1.08	.5	1.09	.5	.30	72.3	71.5	22 PESFNGB	
23	356	83	2.85	.22	.98	-.1	.99	.0	.49	68.7	67.5	23 SESFNGM	
24	389	83	4.55	.25	1.49	3.5	1.34	1.9	.33	68.7	70.6	24 PNJPNGM	misfit
25	306	83	.35	.21	.94	-.3	.94	-.3	.12	62.7	65.0	25 PNJPNPB	
26	402	83	5.51	.31	.92	-.4	.78	-.7	.35	84.3	84.4	26 PNSPNGB	
27	399	83	5.25	.29	.98	-.1	.76	-.9	.45	81.9	80.8	27 SNSPNGM	
28	399	83	5.25	.29	1.03	.2	.96	-.1	.23	79.5	80.8	28 SESFAGB	
29	350	83	2.54	.23	.89	-.7	.87	-.8	.25	72.3	70.3	29 PNJFAGB	
30	352	83	2.65	.23	.75	-1.8	.73	-1.8	.26	73.5	69.4	30 SESPNGM	
31	373	83	3.69	.22	1.07	.6	1.06	.6	.27	62.7	63.7	31 PNJFAGB	
32	356	83	2.85	.22	.84	-1.1	.84	-1.1	.23	68.7	67.5	32 PNJFAGB	
33	414	83	8.31	1.01	.99	.3	.57	.1	.12	98.8	98.8	33 PESFAGB	
34	356	83	2.85	.22	.84	-1.1	.84	-1.1	.23	68.7	67.5	34 SESFAGM	
35	320	83	1.00	.22	1.01	.1	.99	.0	.59	63.9	71.5	35 SNSPNPM	
36	342	83	2.13	.23	1.99	4.4	2.02	4.4	.36	45.8	73.3	36 SESFAGM	misfit
37	302	83	.18	.21	1.22	1.4	1.21	1.3	.29	60.2	63.5	37 PESFAGM	
38	303	83	.22	.21	1.42	2.5	1.38	2.2	.24	62.7	63.9	38 PNJFAGB	misfit
39	324	83	1.20	.22	.98	-.1	.99	.0	.40	72.3	73.0	39 SNSPAPB	
40	337	83	1.87	.23	.79	-1.1	.77	-1.3	.56	74.7	74.3	40 SNJPAPM	
41	407	83	6.10	.38	.89	-.3	.58	-1.0	.38	90.4	90.4	41 SESFAGM	
42	292	83	-.23	.20	.87	-.9	.90	-.7	.49	61.4	61.1	42 PNJFAGB	
43	345	83	2.29	.23	1.02	.2	1.03	.2	.58	69.9	72.4	43 SNJFAGB	
44	315	83	.76	.22	.98	.0	1.02	.2	.52	66.3	69.2	44 PNJFAGB	
45	334	83	1.71	.23	.31	-5.2	.29	-5.2	.34	95.2	74.5	45 SESFAGM	
46	396	83	5.01	.27	.94	-.3	.90	-.4	.33	74.7	77.4	46 PNJFNGM	
47	341	83	2.08	.23	.68	-2.0	.67	-1.9	.44	80.7	73.6	47 SESFNPB	
48	392	83	4.74	.25	1.30	2.1	1.15	.8	.35	74.7	73.3	48 SESPNPB	
49	415	83	9.52	1.83	MAXIMUM ESTIMATED MEASURE							49 PESFAGB	
50	326	83	1.30	.23	.45	-3.7	.44	-3.7	.33	89.2	73.5	50 PNJFAGB	
51	335	83	1.76	.23	.69	-1.8	.69	-1.8	.22	81.9	74.4	51 SESFAGB	
52	335	83	1.76	.23	.32	-5.0	.31	-5.1	.21	91.6	74.4	52 PNJFNGB	
53	322	83	1.10	.22	.99	.0	1.01	.1	.23	74.7	72.3	53 PNJFAGM	
54	340	83	2.03	.23	2.08	4.6	2.13	4.7	.30	51.8	73.8	54 PESFAGM	misfit
55	325	83	1.25	.22	.91	-.4	.92	-.4	.35	73.5	73.3	55 SNSPNPB	
56	351	83	2.60	.23	1.56	3.1	1.57	3.0	.51	54.2	69.8	56 SNSPAPB	misfit
57	347	83	2.39	.23	.77	-1.5	.77	-1.4	.18	77.1	71.6	57 PNJFAGM	
58	333	83	1.66	.23	.24	-6.0	.22	-6.1	.21	94.0	74.5	58 SESFAGM	
59	346	83	2.34	.23	.93	-.4	.91	-.4	.52	71.1	72.0	59 SESFNGB	

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Person	Fit type
60	406	83	5.96	.36	1.04	.2	1.07	.3	.14	89.2	89.2	60 SNJFAGM	
61	350	82	2.77	.23	1.33	2.1	1.34	2.1	.28	57.3	68.4	61 PNSPNGM	
62	311	83	.57	.21	.60	-2.8	.57	-2.9	.39	77.1	67.4	62 PNJPAGB	
63	365	83	3.29	.22	1.38	2.9	1.38	2.7	.35	48.2	63.9	63 PNJFAGB	misfit
64	377	83	3.89	.23	.99	-.1	1.05	.4	.37	69.9	64.3	64 SNJFAPB	
65	335	83	1.76	.23	.48	-3.5	.46	-3.5	.54	86.7	74.4	65 PESFAGB	
66	343	83	2.18	.23	.85	-.8	.83	-.9	.51	74.7	73.0	66 SNJFAGM	
67	394	83	4.87	.26	1.28	1.9	1.35	1.6	.07	72.3	75.2	67 SNJPAPB	
68	375	83	3.79	.23	1.47	3.8	1.49	3.5	.24	56.6	64.0	68 PNJPAPB	misfit
69	281	83	-.65	.19	.71	-2.2	.74	-1.9	.29	67.5	59.6	69 PNSPAPM	
70	355	83	2.80	.22	.84	-1.1	.84	-1.1	.20	68.7	68.0	70 SNSPNPB	
71	337	83	1.87	.23	1.10	.6	1.10	.6	.40	69.9	74.3	71 SESFAPB	
72	333	83	1.66	.23	.91	-.4	.88	-.6	.30	88.0	74.5	72 SNJPNPM	
73	413	83	7.60	.72	1.06	.3	3.55	2.0	-.20	97.6	97.6	73 SNJPNPB	
74	348	83	2.44	.23	1.41	2.3	1.43	2.3	-.09	63.9	71.1	74 SNJFAGB	misfit
75	349	83	2.49	.23	1.19	1.2	1.23	1.4	-.05	66.3	70.7	75 PNJFAGM	
76	346	83	2.34	.23	2.60	6.7	2.70	6.8	.47	41.0	72.0	76 PNJFAGB	misfit
77	339	80	2.62	.23	.67	-2.3	.66	-2.3	.35	80.0	69.6	77 SESFAGM	
78	325	83	1.25	.22	.91	-.4	.92	-.4	.46	71.1	73.3	78 PNJFAGM	
79	407	83	6.10	.38	1.26	.9	.93	.0	.23	91.6	90.4	79 SESFNGM	
80	369	83	3.49	.22	1.18	1.5	1.24	1.9	.21	54.2	63.5	80 PNJFAGM	
81	376	83	3.84	.23	1.01	.1	.99	.0	.46	77.1	64.1	81 PESFNGB	
82	363	83	3.19	.22	.76	-2.0	.74	-2.1	.55	69.9	64.5	82 SESFAGB	
83	375	83	3.79	.23	1.43	3.6	1.47	3.4	.08	54.2	64.0	83 PNJFAGB	misfit
84	389	83	4.55	.25	.98	-.1	.87	-.7	.44	67.5	70.6	84 SESFAGB	
85	356	83	2.85	.22	1.05	.4	1.08	.6	.40	66.3	67.5	85 PNJFAGB	
86	321	83	1.05	.22	1.07	.4	1.07	.4	.16	73.5	72.0	86 P JP PB	
87	382	83	4.15	.23	.96	-.4	.92	-.6	.34	63.9	66.0	87 PNJFAGB	
88	353	82	2.91	.22	.92	-.5	.93	-.5	.15	64.6	66.9	88 PNJPAPB	
89	348	83	2.44	.23	.66	-2.3	.64	-2.4	.60	77.1	71.1	89 SNSPNPB	
90	345	82	2.50	.23	1.87	4.4	1.89	4.3	.53	46.3	70.6	90 PNJFAGM	misfit
91	392	83	4.74	.25	1.10	.8	1.11	.6	.39	80.7	73.3	91 SESFAGM	
MEAN	351.3	82.9	2.75	.27	1.01	-.2	1.01	-.3		72.6	72.3		
S.D.	30.4	.4	1.84	.19	.43	2.5	.52	2.5		13.2	7.0		

Appendix 9- 3: Item statistics of 91 persons and 83 items

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item	Fit type
80	344	90	1.72	.20	1.29	1.9	1.28	1.7	.51	66.7	66.3	78	
43	348	89	1.38	.21	.85	-1.0	.85	-.8	.68	68.5	68.2	5	
3	354	90	1.29	.21	1.27	1.7	1.28	1.5	.64	63.3	68.9	31	
8	354	90	1.29	.21	1.24	1.5	1.30	1.6	.60	58.9	68.9	19	
66	356	90	1.20	.21	.76	-1.6	.76	-1.4	.70	72.2	69.3	62	
56	357	90	1.15	.21	.98	.0	.97	-.1	.65	71.1	69.6	73	
47	358	90	1.11	.21	1.18	1.1	1.13	.8	.60	68.9	69.8	76	
11	360	90	1.02	.21	1.36	2.1	1.35	1.8	.56	58.9	70.3	30	Misfit
37	361	90	.97	.22	1.01	.2	1.00	.1	.64	71.1	70.6	1	
73	361	90	.97	.22	1.36	2.1	1.47	2.3	.44	62.2	70.6	47	Misfit
58	363	90	.88	.22	1.08	.5	1.13	.7	.58	71.1	71.1	48	
38	364	90	.83	.22	.58	-3.0	.55	-2.8	.70	76.7	71.4	17	***Overfit***
46	364	90	.83	.22	1.28	1.6	1.75	3.3	.51	62.2	71.4	67	
71	364	90	.83	.22	.86	-.8	.88	-.6	.67	76.7	71.4	83	
64	365	90	.78	.22	1.15	.9	1.14	.8	.54	63.3	71.6	52	
4	367	90	.69	.22	1.18	1.1	1.11	.6	.62	72.2	72.0	64	
28	367	90	.69	.22	.94	-.3	.95	-.2	.60	81.1	72.0	18	
40	367	90	.69	.22	1.85	4.1	1.79	3.4	.49	58.9	72.0	46	Misfit
54	369	90	.59	.22	.71	-1.9	.67	-1.8	.65	81.1	72.4	40	
65	369	90	.59	.22	.80	-1.3	.76	-1.3	.65	77.8	72.4	21	
30	370	90	.54	.22	1.17	1.0	1.16	.8	.52	70.0	72.6	25	
74	370	90	.54	.22	.90	-.6	.91	-.4	.65	72.2	72.6	7	
67	366	89	.54	.22	.89	-.6	.87	-.6	.63	71.9	72.6	66	
12	371	90	.50	.22	1.15	.9	1.15	.8	.63	65.6	72.8	6	
41	371	90	.50	.22	.82	-1.1	.77	-1.1	.65	72.2	72.8	42	
9	373	90	.40	.22	.83	-1.0	.82	-.9	.65	76.7	73.1	23	
60	373	90	.40	.22	1.11	.7	1.07	.4	.64	73.3	73.1	51	
17	374	90	.35	.22	1.08	.5	1.10	.5	.64	71.1	73.2	63	
20	374	90	.35	.22	1.24	1.4	1.21	1.0	.56	67.8	73.2	16	
33	374	90	.35	.22	1.48	2.5	1.45	2.0	.59	64.4	73.2	44	Misfit
42	374	90	.35	.22	.53	-3.3	.49	-3.0	.77	86.7	73.2	12	***Overfit***
21	375	90	.30	.22	1.36	2.0	1.30	1.4	.54	61.1	73.3	69	Satis
27	375	90	.30	.22	.63	-2.5	.61	-2.1	.67	83.3	73.3	14	***Overfit***
31	375	90	.30	.22	1.29	1.7	1.24	1.1	.57	71.1	73.3	24	
34	375	90	.30	.22	1.04	.3	.98	.0	.60	77.8	73.3	4	
51	375	90	.30	.22	1.04	.3	1.02	.2	.60	81.1	73.3	26	
81	371	89	.29	.22	.58	-2.9	.56	-2.4	.70	85.4	73.3	39	***Overfit***
72	379	90	.10	.23	.68	-2.1	.77	-1.1	.68	82.2	73.6	9	***Overfit***
68	380	90	.05	.23	.74	-1.6	.69	-1.5	.66	78.9	73.6	65	***Overfit***
77	380	90	.05	.23	.85	-.9	.81	-.8	.65	74.4	73.6	13	
49	381	90	-.01	.23	1.05	.4	1.02	.1	.64	74.4	73.7	8	
6	382	90	-.06	.23	1.33	1.8	1.25	1.1	.59	68.9	73.7	49	
55	382	90	-.06	.23	.74	-1.7	.79	-.9	.63	77.8	73.7	36	***Overfit***
69	382	90	-.06	.23	.72	-1.8	.65	-1.7	.65	83.3	73.7	53	***Overfit***
82	382	90	-.06	.23	.63	-2.5	.71	-1.3	.68	82.2	73.7	37	***Overfit***
19	383	90	-.11	.23	1.07	.5	1.10	.5	.61	70.0	73.7	32	
26	383	90	-.11	.23	.94	-.3	.87	-.5	.65	78.9	73.7	28	
83	383	90	-.11	.23	.60	-2.8	.59	-2.0	.67	85.6	73.7	35	***Overfit***
23	385	90	-.21	.23	.61	-2.7	.56	-2.1	.71	86.7	73.6	33	***Overfit***
32	385	90	-.21	.23	1.08	.5	.99	.0	.63	74.4	73.6	41	
53	385	90	-.21	.23	.57	-3.0	.52	-2.4	.71	84.4	73.6	22	***Overfit***
7	386	90	-.26	.23	1.19	1.1	1.21	.9	.51	71.1	73.5	77	
15	387	90	-.31	.23	1.14	.9	1.14	.6	.56	68.9	73.4	50	
35	387	90	-.31	.23	.82	-1.1	.73	-1.2	.69	80.0	73.4	82	
39	387	90	-.31	.23	1.04	.3	1.09	.4	.57	73.3	73.4	10	
52	387	90	-.31	.23	.98	-.1	1.07	.4	.57	73.3	73.4	72	
18	388	90	-.37	.23	1.09	.6	1.05	.3	.56	73.3	73.3	15	
78	388	90	-.37	.23	.90	-.6	.84	-.6	.60	71.1	73.3	3	
14	384	89	-.38	.23	.80	-1.3	.77	-.9	.62	79.8	73.4	34	

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item	Fit type
63	384	89	-.38	.23	1.47	2.6	1.44	1.6	.50	62.9	73.4	79	Misfit
44	390	90	-.47	.23	.94	-.3	.98	.0	.63	70.0	73.1	38	
70	390	90	-.47	.23	.68	-2.3	.61	-1.7	.66	78.9	73.1	29	*Overfit*
76	390	90	-.47	.23	.89	-.7	.87	-.5	.63	70.0	73.1	45	
10	391	90	-.52	.23	.86	-.9	.86	-.5	.57	72.2	73.0	27	
50	391	90	-.52	.23	.89	-.7	.80	-.7	.64	78.9	73.0	80	
57	391	90	-.52	.23	.85	-.9	.78	-.8	.65	80.0	73.0	56	
2	393	90	-.63	.23	.96	-.2	.90	-.3	.53	75.6	72.6	20	
5	393	90	-.63	.23	1.63	3.5	1.49	1.7	.53	62.2	72.6	11	Misfit
24	393	90	-.63	.23	.89	-.7	.79	-.8	.64	76.7	72.6	43	
36	395	90	-.73	.23	.97	-.1	.97	.0	.58	65.6	72.0	75	
59	395	90	-.73	.23	1.76	4.2	1.67	2.1	.44	56.7	72.0	81	Misfit
13	393	89	-.86	.23	1.05	.4	2.39	3.6	.47	73.0	71.7	68	
79	398	90	-.89	.23	.82	-1.3	.69	-1.1	.66	73.3	71.4	59	
29	399	90	-.94	.23	1.04	.3	.97	.0	.54	66.7	71.3	70	
48	399	90	-.94	.23	.77	-1.7	.67	-1.2	.59	73.3	71.3	61	
61	401	90	-1.05	.23	.91	-.6	.81	-.5	.60	71.1	70.9	54	
25	403	90	-1.16	.23	1.04	.3	2.75	3.8	.51	68.9	70.7	71	
62	403	90	-1.16	.23	.75	-1.9	.71	-.9	.58	74.4	70.7	55	
16	405	90	-1.26	.23	1.05	.4	.98	.1	.53	68.9	70.6	2	
75	410	90	-1.54	.24	1.03	.3	.91	-.1	.48	68.9	71.0	58	
22	414	90	-1.77	.24	1.03	.3	.86	-.2	.53	72.2	71.8	60	
45	419	90	-2.07	.25	1.06	.5	.87	-.1	.48	72.2	74.0	57	
1	420	90	-2.13	.25	1.07	.6	.98	.1	.40	68.9	74.5	74	
MEAN	380.2	89.9	.00	.22	1.00	-.1	1.01	.0		72.6	72.3		
S.D.	15.5	.3	.79	.01	.26	1.6	.37	1.4		6.9	1.5		

Appendix 9- 4: Summary statistics of 76 persons and 83 items

SUMMARY OF 75 MEASURED (NON-EXTREME) Persons

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	350.3	82.9	3.11	.27	1.00	-.1	1.01	-.1
S.D.	31.1	.4	2.03	.11	.29	1.8	.46	1.8
MAX.	414.0	83.0	9.08	1.01	1.56	3.3	3.72	3.1
MIN.	281.0	80.0	-.85	.21	.28	-4.8	.25	-4.8

REAL RMSE .31 ADJ.SD 2.01 SEPARATION 6.56 Person RELIABILITY .98
MODEL RMSE .29 ADJ.SD 2.01 SEPARATION 6.86 Person RELIABILITY .98
S.E. OF Person MEAN = .24

MAXIMUM EXTREME SCORE: 1 Persons
VALID RESPONSES: 99.9%

SUMMARY OF 76 MEASURED (EXTREME AND NON-EXTREME) Persons

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	351.2	82.9	3.20	.29				
S.D.	31.7	.4	2.18	.21				
MAX.	415.0	83.0	10.30	1.83				
MIN.	281.0	80.0	-.85	.21				

REAL RMSE .37 ADJ.SD 2.15 SEPARATION 5.81 Person RELIABILITY .97
MODEL RMSE .36 ADJ.SD 2.15 SEPARATION 5.99 Person RELIABILITY .97
S.E. OF Person MEAN = .25

Person RAW SCORE-TO-MEASURE CORRELATION = .98 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = .98 (approximate due to missing data)

SUMMARY OF 83 MEASURED (NON-EXTREME) Items

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	316.5	74.9	.00	.27	1.00	-.1	1.01	-.1
S.D.	12.2	.2	.89	.01	.28	1.5	.46	1.3
MAX.	348.0	75.0	1.90	.29	1.78	3.4	3.30	3.8
MIN.	289.0	74.0	-2.36	.24	.48	-3.3	.42	-2.9

REAL RMSE .29 ADJ.SD .84 SEPARATION 2.95 Item RELIABILITY .90
MODEL RMSE .27 ADJ.SD .85 SEPARATION 3.13 Item RELIABILITY .91
S.E. OF Item MEAN = .10

UMEAN=.000 USCALE=1.000
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00 (approximate due to missing data)

6220 DATA POINTS. APPROXIMATE LOG-LIKELIHOOD CHI-SQUARE: 7062.73

Appendix 9- 5: Item statistics of 76 persons and 83 items

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item	Fittype
80	289	75	1.90	.24	1.17	1.0	1.23	1.2	.64	65.3	70.3	78	
3	296	75	1.47	.25	1.31	1.7	1.39	1.7	.68	69.3	72.8	31	
8	296	75	1.47	.25	1.25	1.4	1.37	1.7	.63	66.7	72.8	19	
66	296	75	1.47	.25	.82	-1.1	.81	-.9	.74	74.7	72.8	62	
43	294	74	1.34	.26	.83	-.9	.83	-.8	.74	73.0	73.2	5	
56	298	75	1.34	.25	1.05	.4	1.03	.2	.69	74.7	73.4	73	
47	299	75	1.28	.26	1.01	.1	.94	-.2	.71	77.3	73.7	76	
11	302	75	1.08	.26	1.46	2.3	1.50	2.0	.59	62.7	74.5	30	Misfit
46	302	75	1.08	.26	1.32	1.7	1.75	2.8	.54	64.0	74.5	67	
64	302	75	1.08	.26	1.22	1.2	1.15	.7	.63	66.7	74.5	52	
38	303	75	1.01	.26	.56	-2.8	.49	-2.7	.75	82.7	74.9	17	*Overfit*
58	303	75	1.01	.26	1.02	.2	1.02	.2	.64	76.0	74.9	48	
71	303	75	1.01	.26	.85	-.8	.83	-.7	.71	77.3	74.9	83	
73	303	75	1.01	.26	1.46	2.3	1.57	2.2	.52	62.7	74.9	47	Misfit
37	305	75	.87	.26	.84	-.8	.78	-.9	.73	80.0	75.6	1	
40	306	75	.80	.26	1.78	3.4	1.71	2.6	.54	65.3	75.9	46	Misfit
65	306	75	.80	.26	.70	-1.7	.66	-1.6	.73	78.7	75.9	21	
67	302	74	.79	.27	.91	-.4	.86	-.5	.67	74.3	75.9	66	
54	307	75	.73	.27	.72	-1.5	.65	-1.6	.69	84.0	76.3	40	
74	308	75	.66	.27	1.04	.3	1.04	.3	.68	74.7	76.5	7	
4	309	75	.59	.27	1.04	.3	.96	-.1	.69	78.7	76.8	64	
12	309	75	.59	.27	1.35	1.7	1.40	1.5	.64	66.7	76.8	6	M.fit*
41	309	75	.59	.27	.78	-1.2	.69	-1.3	.70	77.3	76.8	42	
9	310	75	.52	.27	.67	-1.9	.61	-1.7	.72	85.3	77.0	23	
28	310	75	.52	.27	.81	-1.0	.79	-.8	.67	82.7	77.0	18	
81	310	75	.52	.27	.61	-2.3	.56	-2.0	.74	88.0	77.0	39	*Overfit*
27	311	75	.45	.27	.66	-1.9	.63	-1.6	.72	85.3	77.3	14	
30	311	75	.45	.27	1.33	1.6	1.34	1.3	.53	69.3	77.3	25	
51	311	75	.45	.27	1.05	.3	1.00	.1	.66	85.3	77.3	26	
33	312	75	.37	.27	1.27	1.4	1.28	1.1	.68	74.7	77.4	44	
34	312	75	.37	.27	.77	-1.2	.67	-1.4	.74	84.0	77.4	4	
42	312	75	.37	.27	.48	-3.3	.42	-2.9	.82	92.0	77.4	12	*Overfit*
17	313	75	.30	.27	1.33	1.6	1.38	1.4	.67	69.3	77.5	63	
55	313	75	.30	.27	.66	-1.9	.66	-1.4	.72	85.3	77.5	36	
68	313	75	.30	.27	.70	-1.7	.61	-1.7	.72	82.7	77.5	65	
77	313	75	.30	.27	.91	-.4	.87	-.5	.70	77.3	77.5	13	
21	314	75	.23	.27	1.39	1.9	1.33	1.2	.56	68.0	77.6	69	
82	315	75	.15	.27	.65	-2.0	.68	-1.3	.73	85.3	77.7	37	
20	316	75	.08	.27	1.26	1.3	1.17	.7	.59	73.3	77.8	16	
60	316	75	.08	.27	.77	-1.2	.68	-1.2	.75	82.7	77.8	51	
69	316	75	.08	.27	.60	-2.3	.52	-2.1	.74	88.0	77.8	53	*Overfit*
72	316	75	.08	.27	.69	-1.7	.76	-.9	.74	85.3	77.8	9	
49	317	75	.00	.27	1.25	1.3	1.14	.6	.67	78.7	77.9	8	
35	318	75	-.07	.27	.91	-.4	.79	-.7	.72	81.3	77.9	82	
83	318	75	-.07	.27	.67	-1.9	.63	-1.4	.70	86.7	77.9	35	
14	315	74	-.17	.28	.86	-.7	.81	-.6	.67	82.4	77.9	34	
6	320	75	-.22	.27	1.31	1.6	1.23	.8	.62	70.7	77.8	49	
23	320	75	-.22	.27	.53	-2.9	.49	-2.1	.76	90.7	77.8	33	*Overfit*
26	320	75	-.22	.27	.85	-.8	.76	-.8	.72	82.7	77.8	28	
31	320	75	-.22	.27	.99	.0	.94	-.1	.65	77.3	77.8	24	
39	320	75	-.22	.27	1.10	.6	1.17	.6	.63	77.3	77.8	10	
78	320	75	-.22	.27	.95	-.2	.85	-.4	.67	74.7	77.8	3	
32	321	75	-.30	.27	1.04	.3	.93	-.1	.66	80.0	77.7	41	
53	321	75	-.30	.27	.69	-1.8	.61	-1.4	.73	84.0	77.7	22	*Overfit*
76	321	75	-.30	.27	.83	-.9	.75	-.8	.71	78.7	77.7	45	
19	322	75	-.37	.27	1.06	.4	1.17	.6	.65	76.0	77.6	32	
50	322	75	-.37	.27	.77	-1.3	.71	-1.0	.73	86.7	77.6	80	
7	323	75	-.45	.27	1.09	.5	1.18	.7	.59	74.7	77.5	77	
44	323	75	-.45	.27	1.00	.0	1.06	.3	.67	74.7	77.5	38	

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item	Fittype
52	323	75	-.45	.27	1.20	1.1	1.33	1.1	.58	69.3	77.5	72	
57	324	75	-.52	.27	.91	-.5	.83	-.4	.71	85.3	77.3	56	
10	325	75	-.60	.27	.96	-.2	.91	-.2	.61	76.0	77.1	27	
15	325	75	-.60	.27	1.14	.8	1.20	.7	.61	73.3	77.1	50	
70	325	75	-.60	.27	.66	-2.1	.55	-1.5	.71	84.0	77.1	29	***Overfit***
18	326	75	-.67	.27	1.02	.2	1.00	.1	.60	74.7	76.8	15	
79	326	75	-.67	.27	.82	-1.0	.67	-1.0	.72	82.7	76.8	59	
63	322	74	-.70	.28	1.55	2.7	1.59	1.6	.56	70.3	76.9	79	Misfit
5	328	75	-.82	.27	1.45	2.4	1.35	1.0	.60	68.0	76.1	11	Misfit
48	328	75	-.82	.27	.83	-1.0	.73	-.7	.63	82.7	76.1	61	
13	324	74	-.86	.28	1.25	1.4	2.96	3.7	.49	68.9	76.2	68	
24	329	75	-.90	.27	.70	-1.9	.58	-1.2	.72	80.0	75.7	43	***Overfit***
36	329	75	-.90	.27	1.01	.1	1.01	.2	.66	72.0	75.7	75	
2	330	75	-.97	.27	.81	-1.2	.73	-.7	.63	76.0	75.5	20	
29	331	75	-1.05	.27	1.21	1.2	1.19	.6	.57	69.3	75.3	70	
59	331	75	-1.05	.27	1.67	3.4	1.62	1.5	.51	62.7	75.3	81	Misfit
25	332	75	-1.12	.27	1.18	1.1	3.30	3.8	.55	72.0	75.1	71	
61	332	75	-1.12	.27	.94	-.3	.84	-.3	.64	76.0	75.1	54	
62	333	75	-1.20	.27	.70	-2.0	.57	-1.1	.67	81.3	74.9	55	***Overfit***
75	339	75	-1.65	.28	1.17	1.1	1.04	.3	.52	69.3	74.5	58	
16	340	75	-1.73	.28	1.11	.8	1.11	.4	.56	69.3	74.6	2	
22	344	75	-2.04	.28	1.22	1.5	1.04	.3	.55	73.3	75.3	60	
45	347	75	-2.28	.28	1.23	1.5	1.07	.3	.50	73.3	75.9	57	
1	348	75	-2.36	.29	1.17	1.1	1.02	.3	.46	68.0	76.4	74	
MEAN	316.5	74.9	.00	.27	1.00	-.1	1.01	-.1		76.5	76.3		
S.D.	12.2	.2	.89	.01	.28	1.5	.46	1.3		7.1	1.6		

*M.fit = Marginal fit

Appendix 9- 6: Summary statistics of 76 persons and 76 items

SUMMARY OF 75 MEASURED (NON-EXTREME) Persons

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	350.3	82.9	3.11	.27	1.00	-.1	1.01	-.1
S.D.	31.1	.4	2.03	.11	.29	1.8	.46	1.8
MAX.	414.0	83.0	9.08	1.01	1.56	3.3	3.72	3.1
MIN.	281.0	80.0	-.85	.21	.28	-4.8	.25	-4.8

REAL RMSE .31	ADJ.SD 2.01	SEPARATION 6.56	Person RELIABILITY .98
MODEL RMSE .29	ADJ.SD 2.01	SEPARATION 6.86	Person RELIABILITY .98
S.E. OF Person MEAN = .24			

MAXIMUM EXTREME SCORE: 1 Persons
VALID RESPONSES: 99.9%

SUMMARY OF 76 MEASURED (EXTREME AND NON-EXTREME) Persons

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	351.2	82.9	3.20	.29				
S.D.	31.7	.4	2.18	.21				
MAX.	415.0	83.0	10.30	1.83				
MIN.	281.0	80.0	-.85	.21				

REAL RMSE .37	ADJ.SD 2.15	SEPARATION 5.81	Person RELIABILITY .97
MODEL RMSE .36	ADJ.SD 2.15	SEPARATION 5.99	Person RELIABILITY .97
S.E. OF Person MEAN = .25			

Person RAW SCORE-TO-MEASURE CORRELATION = .98 (approximate due to missing data)
CRONBACH ALPHA (KR-20) Person RAW SCORE RELIABILITY = .99 (approximate due to missing data)

SUMMARY OF 76 MEASURED (NON-EXTREME) Items

	RAW SCORE	COUNT	MEASURE	MODEL ERROR	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD
MEAN	316.7	74.9	-.01	.27	.95	-.3	.97	-.2
S.D.	12.2	.2	.89	.01	.23	1.3	.45	1.3
MAX.	348.0	75.0	1.90	.29	1.39	1.9	3.30	3.8
MIN.	289.0	74.0	-2.36	.24	.48	-3.3	.42	-2.9

REAL RMSE .28	ADJ.SD .84	SEPARATION 3.01	Item RELIABILITY .90
MODEL RMSE .27	ADJ.SD .85	SEPARATION 3.13	Item RELIABILITY .91
S.E. OF Item MEAN = .10			

DELETED: 7 Items
UMEAN=.000 USCALE=1.000
Item RAW SCORE-TO-MEASURE CORRELATION = -1.00 (approximate due to missing data)
6220 DATA POINTS. APPROXIMATE LOG-LIKELIHOOD CHI-SQUARE: 7062.73

Appendix 9- 7: Item statistics of 76 persons and 76 items

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item	Fit type
80	289	75	1.90	.24	1.17	1.0	1.23	1.2	.64	65.3	70.3	78	
3	296	75	1.47	.25	1.31	1.7	1.39	1.7	.68	69.3	72.8	31	
8	296	75	1.47	.25	1.25	1.4	1.37	1.7	.63	66.7	72.8	19	
66	296	75	1.47	.25	.82	-1.1	.81	-.9	.74	74.7	72.8	62	
43	294	74	1.34	.26	.83	-.9	.83	-.8	.74	73.0	73.2	5	
56	298	75	1.34	.25	1.05	.4	1.03	.2	.69	74.7	73.4	73	
47	299	75	1.28	.26	1.01	.1	.94	-.2	.71	77.3	73.7	76	
46	302	75	1.08	.26	1.32	1.7	1.75	2.8	.54	64.0	74.5	67	
64	302	75	1.08	.26	1.22	1.2	1.15	.7	.63	66.7	74.5	52	
38	303	75	1.01	.26	.56	-2.8	.49	-2.7	.75	82.7	74.9	17	**Overfit**
58	303	75	1.01	.26	1.02	.2	1.02	.2	.64	76.0	74.9	48	
71	303	75	1.01	.26	.85	-.8	.83	-.7	.71	77.3	74.9	83	
37	305	75	.87	.26	.84	-.8	.78	-.9	.73	80.0	75.6	1	
65	306	75	.80	.26	.70	-1.7	.66	-1.6	.73	78.7	75.9	21	Overfit
67	302	74	.79	.27	.91	-.4	.86	-.5	.67	74.3	75.9	66	
54	307	75	.73	.27	.72	-1.5	.65	-1.6	.69	84.0	76.3	40	
74	308	75	.66	.27	1.04	.3	1.04	.3	.68	74.7	76.5	7	
4	309	75	.59	.27	1.04	.3	.96	-.1	.69	78.7	76.8	64	
41	309	75	.59	.27	.78	-1.2	.69	-1.3	.70	77.3	76.8	42	
9	310	75	.52	.27	.67	-1.9	.61	-1.7	.72	85.3	77.0	23	Overfit
28	310	75	.52	.27	.81	-1.0	.79	-.8	.67	82.7	77.0	18	
81	310	75	.52	.27	.61	-2.3	.56	-2.0	.74	88.0	77.0	39	**Overfit**
27	311	75	.45	.27	.66	-1.9	.63	-1.6	.72	85.3	77.3	14	Overfit
30	311	75	.45	.27	1.33	1.6	1.34	1.3	.53	69.3	77.3	25	
51	311	75	.45	.27	1.05	.3	1.00	.1	.66	85.3	77.3	26	
33	312	75	.37	.27	1.27	1.4	1.28	1.1	.68	74.7	77.4	44	
34	312	75	.37	.27	.77	-1.2	.67	-1.4	.74	84.0	77.4	4	
42	312	75	.37	.27	.48	-3.3	.42	-2.9	.82	92.0	77.4	12	**Overfit**
17	313	75	.30	.27	1.33	1.6	1.38	1.4	.67	69.3	77.5	63	
55	313	75	.30	.27	.66	-1.9	.66	-1.4	.72	85.3	77.5	36	Overfit
68	313	75	.30	.27	.70	-1.7	.61	-1.7	.72	82.7	77.5	65	
77	313	75	.30	.27	.91	-.4	.87	-.5	.70	77.3	77.5	13	
21	314	75	.23	.27	1.39	1.9	1.33	1.2	.56	68.0	77.6	69	
82	315	75	.15	.27	.65	-2.0	.68	-1.3	.73	85.3	77.7	37	**Overfit**
20	316	75	.08	.27	1.26	1.3	1.17	.7	.59	73.3	77.8	16	
60	316	75	.08	.27	.77	-1.2	.68	-1.2	.75	82.7	77.8	51	
69	316	75	.08	.27	.60	-2.3	.52	-2.1	.74	88.0	77.8	53	**Overfit**
72	316	75	.08	.27	.69	-1.7	.76	-.9	.74	85.3	77.8	9	
49	317	75	.00	.27	1.25	1.3	1.14	.6	.67	78.7	77.9	8	
35	318	75	-.07	.27	.91	-.4	.79	-.7	.72	81.3	77.9	82	
83	318	75	-.07	.27	.67	-1.9	.63	-1.4	.70	86.7	77.9	35	Overfit
14	315	74	-.17	.28	.86	-.7	.81	-.6	.67	82.4	77.9	34	
6	320	75	-.22	.27	1.31	1.6	1.23	.8	.62	70.7	77.8	49	
23	320	75	-.22	.27	.53	-2.9	.49	-2.1	.76	90.7	77.8	33	**Overfit**
26	320	75	-.22	.27	.85	-.8	.76	-.8	.72	82.7	77.8	28	
31	320	75	-.22	.27	.99	.0	.94	-.1	.65	77.3	77.8	24	
39	320	75	-.22	.27	1.10	.6	1.17	.6	.63	77.3	77.8	10	
78	320	75	-.22	.27	.95	-.2	.85	-.4	.67	74.7	77.8	3	
32	321	75	-.30	.27	1.04	.3	.93	-.1	.66	80.0	77.7	41	
53	321	75	-.30	.27	.69	-1.8	.61	-1.4	.73	84.0	77.7	22	Overfit
76	321	75	-.30	.27	.83	-.9	.75	-.8	.71	78.7	77.7	45	
19	322	75	-.37	.27	1.06	.4	1.17	.6	.65	76.0	77.6	32	
50	322	75	-.37	.27	.77	-1.3	.71	-1.0	.73	86.7	77.6	80	

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item	Fit type
7	323	75	-.45	.27	1.09	.5	1.18	.7	.59	74.7	77.5	77	
44	323	75	-.45	.27	1.00	.0	1.06	.3	.67	74.7	77.5	38	
52	323	75	-.45	.27	1.20	1.1	1.33	1.1	.58	69.3	77.5	72	
57	324	75	-.52	.27	.91	-.5	.83	-.4	.71	85.3	77.3	56	
10	325	75	-.60	.27	.96	-.2	.91	-.2	.61	76.0	77.1	27	
15	325	75	-.60	.27	1.14	.8	1.20	.7	.61	73.3	77.1	50	
70	325	75	-.60	.27	.66	-2.1	.55	-1.5	.71	84.0	77.1	29	**Overfit**
18	326	75	-.67	.27	1.02	.2	1.00	.1	.60	74.7	76.8	15	
79	326	75	-.67	.27	.82	-1.0	.67	-1.0	.72	82.7	76.8	59	
48	328	75	-.82	.27	.83	-1.0	.73	-.7	.63	82.7	76.1	61	
13	324	74	-.86	.28	1.25	1.4	2.96	3.7	.49	68.9	76.2	68	
24	329	75	-.90	.27	.70	-1.9	.58	-1.2	.72	80.0	75.7	43	
36	329	75	-.90	.27	1.01	.1	1.01	.2	.66	72.0	75.7	75	
2	330	75	-.97	.27	.81	-1.2	.73	-.7	.63	76.0	75.5	20	
29	331	75	-1.05	.27	1.21	1.2	1.19	.6	.57	69.3	75.3	70	
25	332	75	-1.12	.27	1.18	1.1	3.30	3.8	.55	72.0	75.1	71	
61	332	75	-1.12	.27	.94	-.3	.84	-.3	.64	76.0	75.1	54	
62	333	75	-1.20	.27	.70	-2.0	.57	-1.1	.67	81.3	74.9	55	**Overfit**
75	339	75	-1.65	.28	1.17	1.1	1.04	.3	.52	69.3	74.5	58	
16	340	75	-1.73	.28	1.11	.8	1.11	.4	.56	69.3	74.6	2	
22	344	75	-2.04	.28	1.22	1.5	1.04	.3	.55	73.3	75.3	60	
45	347	75	-2.28	.28	1.23	1.5	1.07	.3	.50	73.3	75.9	57	
1	348	75	-2.36	.29	1.17	1.1	1.02	.3	.46	68.0	76.4	74	
MEAN	316.7	74.9	-.01	.27	.95	-.3	.97	-.2		77.5	76.4		
S.D.	12.2	.2	.89	.01	.23	1.3	.45	1.3		6.5	1.6		

Appendix 9- 8: Pairwise comparisons between inexperienced and experienced infection control nurses (76 persons and 76 items)

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	Mantel Prob.	Hanzl Size	Item Number	Name
N	-2.44	.36	E	-2.09	.48	-.35	.60	-.57	71	.5678	.1565	-.	1	74
N	-.97	.34	E	-.98	.47	.01	.58	.01	71	.9909	.5597	.69	2	20
N	1.23	.33	E	1.88	.41	-.66	.53	-1.24	71	.2177	.1766	-.	3	31
N	.68	.34	E	.55	.46	.12	.57	.22	71	.8291	.4759	+.	4	64
N	-.14	.34	E	-.54	.47	.40	.58	.68	71	.5002	.4406	+.	6	49
N	-.26	.34	E	-.98	.47	.72	.58	1.23	71	.2214	.5285	+.	7	77
N	1.64	.32	E	1.16	.44	.48	.54	.89	71	.3744	.2653	.00	8	19
N	.68	.34	E	.12	.47	.55	.58	.96	71	.3410	.8671	.69	9	23
N	-.62	.34	E	-.54	.47	-.08	.58	-.14	71	.8912	.9516	+.	10	27
N	-.91	.35	E	-.76	.47	-.15	.59	-.26	70	.7968	.7260	+.	13	68
N	-.14	.34	E	-.15	.48	.01	.59	.01	70	.9909	.5293	-.69	14	34
N	-.74	.34	E	-.54	.47	-.20	.58	-.34	71	.7345	.6068	.69	15	50
N	-1.57	.35	E	-2.33	.49	.76	.60	1.27	71	.2090	.6591	-.69	16	2
N	.21	.34	E	.34	.46	-.13	.58	-.22	71	.8241	.5814	-.	17	63
N	-1.09	.34	E	.12	.47	-1.22	.58	-2.10	71	.0396	.3519	-.	18	15
N	-.62	.34	E	-.10	.47	-.52	.58	-.90	71	.3721	.8980	+.	19	32
N	-.14	.34	E	.34	.46	-.48	.58	-.84	71	.4047	.5497	-.	20	16
N	.09	.34	E	.55	.46	-.46	.57	-.80	71	.4255	.4524	-.	21	69
N	-1.93	.35	E	-2.33	.49	.40	.60	.66	71	.5112	.5595	-.69	22	60
N	-.02	.34	E	-.54	.47	.51	.58	.88	71	.3810	.6116	+.	23	33
N	-.74	.34	E	-1.20	.47	.46	.58	.80	71	.4285	.4428	-.	24	43
N	-.97	.34	E	-1.42	.47	.45	.58	.77	71	.4457	.6374	-.	25	71
N	-.02	.34	E	-.54	.47	.51	.58	.88	71	.3810	.6500	.69	26	28
N	.56	.34	E	.12	.47	.44	.58	.76	71	.4507	.5485	+.	27	14
N	.45	.34	E	.76	.45	-.31	.57	-.56	71	.5805	.6447	-.	28	18
N	-1.45	.34	E	-.32	.47	-1.13	.58	-1.94	71	.0568	.3780	-.	29	70
N	.33	.34	E	.96	.45	-.63	.56	-1.13	71	.2639	.4720	+.	30	25
N	-.50	.34	E	.55	.46	-1.05	.57	-1.84	71	.0704	.8554	-.	31	24
N	-.50	.34	E	-.10	.47	-.40	.58	-.69	71	.4898	.7794	+.	32	41
N	.56	.34	E	.12	.47	.44	.58	.76	71	.4507	.4293	+.	33	44
N	.33	.34	E	.55	.46	-.22	.57	-.39	71	.6969	.4192	-.	34	4
N	.21	.34	E	-.32	.47	.53	.58	.91	71	.3669	.5374	-.69	35	82
N	-.74	.34	E	-1.42	.47	.68	.58	1.17	71	.2446	1.000	-.	36	75
N	1.01	.33	E	.76	.45	.25	.56	.45	71	.6550	.0143	-.	37	1
N	1.12	.33	E	.76	.45	.36	.56	.64	71	.5212	.6394	+.	38	17
N	.09	.34	E	-.98	.47	1.07	.58	1.85	71	.0688	.3540	+.	39	10
N	.09	.34	E	1.35	.43	-1.25	.55	-2.27	71	.0262	.3518	-.	41	42
N	.56	.34	E	.12	.47	.44	.58	.76	71	.4507	.3173	+.	42	12
N	1.33	.32	E	1.35	.44	-.02	.54	-.03	70	.9776	.8769	+.	43	5
N	-.26	.34	E	-.54	.47	.28	.58	.47	71	.6372	.7860	-.69	44	38
N	-1.93	.35	E	-2.85	.53	.92	.63	1.44	71	.1532	.6131	+.	45	57
N	.56	.34	E	2.05	.41	-1.49	.53	-2.81	71	.0064	.6537	.69	46	67
N	1.54	.32	E	.76	.45	.78	.55	1.41	71	.1630	.3028	+.	47	76
N	-.86	.34	E	-.76	.47	-.10	.58	-.16	71	.8701	.8769	-.	48	61
N	.09	.34	E	-.10	.47	.19	.58	.33	71	.7456	.2100	-.	49	8
N	-.26	.34	E	-.54	.47	.28	.58	.47	71	.6372	.5004	-.	50	80
N	.21	.34	E	.96	.45	-.75	.56	-1.33	71	.1865	.1673	-.	51	26
N	-.26	.34	E	-.54	.47	.28	.58	.47	71	.6372	.9032	-.	52	72
N	-.26	.34	E	-.10	.47	-.17	.58	-.29	71	.7757	.2626	-.	53	22
N	.56	.34	E	.96	.45	-.40	.56	-.71	71	.4771	.8610	-.69	54	40
N	.68	.34	E	-.32	.47	.99	.58	1.72	71	.0907	.3621	+.	55	36
N	1.54	.32	E	.96	.45	.58	.55	1.06	71	.2948	.2041	+.	56	73
N	-.50	.34	E	-.54	.47	.04	.58	.07	71	.9474	.7070	+.	57	56
N	.79	.34	E	1.35	.43	-.56	.55	-1.02	71	.3113	.2850	+.	58	48
N	-.14	.34	E	.34	.46	-.48	.58	-.84	71	.4047	.8292	+.	60	51
N	-1.21	.34	E	-.98	.47	-.23	.58	-.39	71	.6941	.3275	-.69	61	54
N	-1.33	.34	E	-.98	.47	-.35	.58	-.60	71	.5517	.5698	.69	62	55
N	1.12	.33	E	.76	.45	.36	.56	.64	71	.5212	1.000	.000	64	52

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
N	.56	.34	E	.96	.45	-.40	.56	-.71	71	.4771	.4452	-.	65	21
N	1.12	.33	E	1.88	.41	-.76	.53	-1.44	71	.1534	.2874	-.	66	62
N	.54	.34	E	1.16	.44	-.62	.56	-1.11	70	.2728	.2191	-.	67	66
N	.21	.34	E	.34	.46	-.13	.58	-.22	71	.8241	.9013	-.	68	65
N	-.02	.34	E	.12	.47	-.15	.58	-.26	71	.7987	.4504	+.	69	53
N	-.62	.34	E	-.54	.47	-.08	.58	-.14	71	.8912	.0801	-.	70	29
N	.90	.33	E	1.16	.44	-.26	.55	-.46	71	.6434	.8292	-.	71	83
N	.09	.34	E	.12	.47	-.03	.58	-.05	71	.9589	.1573	-.	72	9
N	.90	.33	E	.12	.47	.78	.57	1.35	71	.1797	.6777	+.	74	7
N	-1.45	.34	E	-1.86	.47	.42	.59	.71	71	.4803	.9642	.69	75	58
N	-.14	.34	E	-.54	.47	.40	.58	.68	71	.5002	.9414	.69	76	45
N	.45	.34	E	-.10	.47	.54	.58	.93	71	.3536	.7472	+.	77	13
N	-.50	.34	E	.34	.46	-.84	.58	-1.46	71	.1498	.2784	-.	78	3
N	-.26	.34	E	-1.42	.47	1.16	.58	1.99	71	.0506	.1167	+.	79	59
N	1.94	.31	E	1.71	.42	.23	.52	.43	71	.6667	.7336	+.	80	78
N	.21	.34	E	.96	.45	-.75	.56	-1.33	71	.1865	.6949	-.	81	39
N	.56	.34	E	-.54	.47	1.10	.58	1.90	71	.0619	.4795	+.	82	37
N	-.14	.34	E	.12	.47	-.27	.58	-.46	71	.6466	.8084	-.	83	35

Size of Mantel-Haenszel slice = .100 logits
Person class: N=Inexperienced E=experienced

Appendix 9- 9: Pairwise comparisons between junior and senior rank infection control nurses (76 persons and 76 items)

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
P	-2.86	.44	S	-1.97	.38	-.89	.58	-1.54	73	.1277	.9512	-.	1	74
P	-.50	.39	S	-1.40	.37	.90	.54	1.66	73	.1012	.1231	+.	2	20
P	1.62	.36	S	1.32	.36	.30	.51	.59	73	.5541	.7697	-.69	3	31
P	.54	.38	S	.64	.38	-.10	.54	-.19	73	.8530	.4277	-.	4	64
P	.25	.38	S	-.69	.38	.94	.54	1.75	73	.0845	.3430	+.	6	49
P	-.50	.39	S	-.40	.38	-.10	.55	-.19	73	.8530	.9638	.69	7	77
P	.96	.37	S	1.92	.34	-.96	.50	-1.92	73	.0585	.9660	+.	8	19
P	.82	.37	S	.20	.39	.62	.54	1.16	73	.2497	.8613	-.69	9	23
P	-.97	.40	S	-.25	.39	-.72	.56	-1.30	73	.1978	.5151	+.	10	27
P	-1.56	.41	S	-.25	.39	-1.31	.57	-2.31	72	.0236	.5983	-.	13	68
P	-.05	.39	S	-.29	.39	.25	.55	.45	72	.6551	.9600	.69	14	34
P	-.50	.39	S	-.69	.38	.19	.55	.35	73	.7279	.8980	-.69	15	50
P	-1.79	.41	S	-1.68	.37	-.11	.56	-.19	73	.8472	.3527	-.	16	2
P	.10	.38	S	.49	.38	-.39	.54	-.72	73	.4739	.6198	-.	17	63
P	-1.62	.41	S	.20	.39	-1.82	.56	-3.24	73	.0018	.2760	.69	18	15
P	-.82	.40	S	.05	.39	-.86	.55	-1.56	73	.1240	.9071	.69	19	32
P	-.35	.39	S	.49	.38	-.84	.55	-1.54	73	.1279	.9071	.69	20	16
P	.40	.38	S	.05	.39	.35	.54	.64	73	.5236	.9512	+.	21	69
P	-1.13	.40	S	-2.91	.42	1.77	.58	3.04	73	.0033	.3886	.69	22	60
P	-.20	.39	S	-.25	.39	.06	.55	.10	73	.9202	.5637	-.	23	33
P	-.66	.40	S	-1.12	.38	.46	.55	.85	73	.3966	.1521	-.	24	43
P	-.97	.40	S	-1.26	.37	.29	.55	.53	73	.5975	.9600	.69	25	71
P	.10	.38	S	-.55	.38	.65	.54	1.20	73	.2344	.5374	+.	26	28
P	.68	.37	S	.20	.39	.48	.54	.90	73	.3726	.0278	+.	27	14
P	.40	.38	S	.64	.38	-.24	.54	-.45	73	.6522	.8415	-.	28	18
P	-.82	.40	S	-1.26	.37	.45	.55	.82	73	.4139	.2027	+.	29	70
P	-.05	.39	S	.92	.37	-.97	.54	-1.80	73	.0757	.8119	-.	30	25
P	-.66	.40	S	.20	.39	-.86	.55	-1.55	73	.1258	.8971	+.	31	24
P	-.20	.39	S	-.40	.38	.20	.55	.37	73	.7107	.3173	-.	32	41
P	.40	.38	S	.35	.38	.05	.54	.09	73	.9277	.5277	-.	33	44
P	-.05	.39	S	.78	.38	-.83	.54	-1.53	73	.1295	.0184	-.	34	4
P	-.35	.39	S	.20	.39	-.55	.55	-.99	73	.3236	.6029	-.	35	82
P	-.66	.40	S	-1.12	.38	.46	.55	.85	73	.3966	.7822	-.	36	75
P	1.09	.37	S	.64	.38	.46	.53	.86	73	.3913	.1025	-.	37	1
P	1.36	.36	S	.64	.38	.72	.52	1.38	73	.1732	.1573	-.	38	17
P	.10	.38	S	-.55	.38	.65	.54	1.20	73	.2344	.4769	+.	39	10
P	.40	.38	S	.78	.38	-.39	.53	-.72	73	.4730	.3754	+.	41	42
P	.40	.38	S	.35	.38	.05	.54	.09	73	.9277	.4142	+.	42	12
P	1.23	.36	S	1.45	.36	-.22	.51	-.43	72	.6676	.2337	-.	43	5
P	-.20	.39	S	-.69	.38	.50	.54	.91	73	.3642	.0978	.69	44	38
P	-1.79	.41	S	-2.73	.41	.94	.58	1.62	73	.1091	.3947	+.	45	57
P	.68	.37	S	1.44	.35	-.76	.51	-1.48	73	.1422	.9709	-.69	46	67
P	1.09	.37	S	1.44	.35	-.35	.51	-.69	73	.4931	.3636	-.	47	76
P	-.82	.40	S	-.84	.38	.02	.55	.04	73	.9661	.7901	+.	48	61
P	.10	.38	S	-.10	.39	.21	.55	.38	73	.7082	.2332	-.	49	8
P	-.20	.39	S	-.55	.38	.35	.55	.64	73	.5220	.6171	+.	50	80
P	.25	.38	S	.64	.38	-.39	.54	-.72	73	.4732	.6534	-.	51	26
P	-.66	.40	S	-.25	.39	-.41	.55	-.74	73	.4643	.2769	+.	52	72
P	-.35	.39	S	-.25	.39	-.10	.55	-.18	73	.8602	.6744	+.	53	22
P	.68	.37	S	.78	.38	-.10	.53	-.19	73	.8506	.1809	.69	54	40
P	.54	.38	S	.05	.39	.49	.54	.91	73	.3667	.0183	+.	55	36
P	.96	.37	S	1.69	.34	-.73	.51	-1.44	73	.1530	.3173	-.	56	73
P	-.66	.40	S	-.40	.38	-.26	.55	-.47	73	.6418	.7009	-.69	57	56
P	.68	.37	S	1.32	.36	-.64	.52	-1.23	73	.2221	.7132	+.	58	48
P	-.05	.39	S	.20	.39	-.24	.55	-.45	73	.6574	.4795	-.	60	51
P	-.50	.39	S	-1.68	.37	1.18	.54	2.17	73	.0330	.1794	.69	61	54
P	-.82	.40	S	-1.54	.37	.73	.55	1.33	73	.1861	.1150	-.69	62	55
P	.68	.37	S	1.44	.35	-.76	.51	-1.48	73	.1422	.3414	-.	64	52

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
P	.96	.37	S	.64	.38	.32	.53	.60	73	.5483	.5151	-.	65	21
P	1.62	.36	S	1.32	.36	.30	.51	.59	73	.5541	.3627	+.	66	62
P	1.08	.37	S	.49	.38	.59	.53	1.11	72	.2724	.5637	+.	67	66
P	.25	.38	S	.35	.38	-.10	.54	-.18	73	.8599	.1698	-.	68	65
P	.25	.38	S	-.10	.39	.35	.54	.65	73	.5194	.1336	+.	69	53
P	-.66	.40	S	-.55	.38	-.11	.55	-.20	73	.8419	.0624	-.	70	29
P	.82	.37	S	1.19	.36	-.37	.52	-.71	73	.4798	.1573	-.	71	83
P	-.35	.39	S	.49	.38	-.84	.55	-1.54	73	.1279	.0896	-.	72	9
P	.82	.37	S	.49	.38	.33	.53	.61	73	.5423	.0423	-.	74	7
P	-.97	.40	S	-2.26	.39	1.28	.56	2.31	73	.0236	.4696	-.69	75	58
P	-.20	.39	S	-.40	.38	.20	.55	.37	73	.7107	.2560	-.69	76	45
P	.40	.38	S	.20	.39	.20	.54	.37	73	.7159	.4328	-.	77	13
P	-.35	.39	S	-.10	.39	-.25	.55	-.45	73	.6551	.5521	-.69	78	3
P	-.35	.39	S	-.98	.38	.63	.54	1.16	73	.2483	.5019	+.	79	59
P	1.87	.35	S	1.92	.34	-.05	.49	-.10	73	.9233	.5188	+.	80	78
P	.40	.38	S	.64	.38	-.24	.54	-.45	73	.6522	.2253	+.	81	39
P	.25	.38	S	.05	.39	.20	.54	.37	73	.7111	.2253	+.	82	37
P	-.50	.39	S	.35	.38	-.85	.55	-1.54	73	.1270	.8084	-.	83	35

Size of Mantel-Haenszel slice = .100 logits
Person class: P=junior rank S=senior rank

Appendix 9- 10: Pairwise comparisons between infection control nurses of non-master and master degree holders (76 persons and 76 items)

Person	DIF	DIF	Person	DIF	DIF	DIF	JOINT				Mantel	Hanzl	Item	
CLASS	MEASURE	S.E.	CLASS	MEASURE	S.E.	CONTRAST	S.E.	t	d.f.	Prob.	Prob.	Size	Number	Name
B	-2.38	.38	M	-2.34	.43	-.05	.58	-.08	73	.9360	.4649	-.	1	74
B	-.90	.36	M	-1.08	.42	.17	.55	.31	73	.7538	.8445	.69	2	20
B	1.22	.34	M	1.78	.37	-.56	.50	-1.11	73	.2686	.2190	-.	3	31
B	.87	.35	M	.19	.42	.68	.55	1.24	73	.2180	.7794	+.	4	64
B	.00	.36	M	-.54	.43	.54	.56	.97	73	.3356	.0211	+.	6	49
B	-.13	.36	M	-.90	.42	.77	.55	1.39	73	.1683	.1082	+.	7	77
B	1.67	.33	M	1.20	.39	.47	.51	.92	73	.3622	.4705	.00	8	19
B	.87	.35	M	.00	.43	.86	.55	1.57	73	.1212	.1147	.69	9	23
B	-.39	.36	M	-.90	.42	.51	.55	.93	73	.3575	.5485	+.	10	27
B	-.65	.36	M	-1.17	.43	.53	.56	.94	72	.3488	.7950	+.	13	68
B	-.26	.36	M	-.04	.43	-.22	.56	-.40	72	.6936	.9300	-.69	14	34
B	-.65	.36	M	-.54	.43	-.10	.56	-.19	73	.8515	.1092	.69	15	50
B	-1.69	.37	M	-1.79	.42	.10	.56	.17	73	.8617	.4198	-.69	16	2
B	.62	.35	M	-.18	.43	.80	.55	1.45	73	.1512	.1399	+.	17	63
B	-.26	.36	M	-1.26	.42	1.00	.55	1.81	73	.0751	.0572	+.	18	15
B	-.13	.36	M	-.72	.42	.59	.56	1.07	73	.2902	.0308	+.	19	32
B	.62	.35	M	-.72	.42	1.34	.55	2.45	73	.0169	.0211	+.	20	16
B	.12	.36	M	.36	.42	-.24	.55	-.43	73	.6657	.9552	-.	21	69
B	-2.53	.39	M	-1.43	.42	-1.10	.57	-1.92	73	.0588	.4772	-.69	22	60
B	-.52	.36	M	.19	.42	-.70	.56	-1.26	73	.2108	.2807	-.	23	33
B	-1.29	.36	M	-.36	.43	-.94	.56	-1.67	73	.0986	.0906	-.	24	43
B	-1.29	.36	M	-.90	.42	-.39	.56	-.71	73	.4811	.8497	+.	25	71
B	.00	.36	M	-.54	.43	.54	.56	.97	73	.3356	.0206	.69	26	28
B	.38	.35	M	.54	.42	-.16	.55	-.30	73	.7664	.3173	+.	27	14
B	.50	.35	M	.54	.42	-.04	.54	-.07	73	.9437	.7175	+.	28	18
B	-1.16	.36	M	-.90	.42	-.26	.56	-.47	73	.6369	.7648	.69	29	70
B	.62	.35	M	.19	.42	.44	.55	.80	73	.4282	.6847	-.	30	25
B	-.39	.36	M	.00	.43	-.39	.56	-.70	73	.4840	.1415	-.	31	24
B	-.39	.36	M	-.18	.43	-.21	.56	-.38	73	.7075	.8953	-.	32	41
B	.25	.35	M	.54	.42	-.29	.55	-.53	73	.6000	.9824	.69	33	44
B	.38	.35	M	.36	.42	.01	.55	.02	73	.9820	.1221	-.	34	4
B	.12	.36	M	-.36	.43	.48	.56	.87	73	.3866	.6451	-.69	35	82
B	-.77	.36	M	-1.08	.42	.30	.55	.55	73	.5849	.7033	.69	36	75
B	.74	.35	M	1.04	.40	-.29	.53	-.55	73	.5807	.2743	-.	37	1
B	1.10	.34	M	.88	.41	.22	.53	.42	73	.6729	.5019	-.	38	17
B	-.65	.36	M	.36	.42	-1.01	.55	-1.82	73	.0723	.6172	.69	39	10
B	.87	.35	M	.19	.42	.68	.55	1.24	73	.2180	.8221	+.	41	42
B	.50	.35	M	.19	.42	.31	.55	.57	73	.5692	.6831	-.	42	12
B	1.44	.34	M	1.19	.40	.25	.52	.48	72	.6301	.4112	-.	43	5
B	-.52	.36	M	-.36	.43	-.16	.56	-.28	73	.7791	.9300	-.69	44	38
B	-1.96	.37	M	-2.73	.45	.77	.58	1.31	73	.1928	.1983	+.	45	57
B	1.10	.34	M	1.04	.40	.06	.53	.12	73	.9052	.9787	.69	46	67
B	1.33	.34	M	1.20	.39	.14	.52	.26	73	.7931	.5221	+.	47	76
B	-.52	.36	M	-1.26	.42	.74	.55	1.34	73	.1852	.7702	+.	48	61
B	.00	.36	M	.00	.43	-.01	.56	-.01	73	.9898	.5828	.69	49	8
B	-.13	.36	M	-.72	.42	.59	.56	1.07	73	.2902	.2363	+.	50	80
B	.50	.35	M	.36	.42	.14	.55	.25	73	.8040	.6152	-.	51	26
B	-.77	.36	M	.00	.43	-.78	.56	-1.40	73	.1663	.0496	-.	52	72
B	-.26	.36	M	-.36	.43	.10	.56	.18	73	.8570	.4901	-.	53	22
B	.74	.35	M	.71	.41	.03	.54	.06	73	.9487	.7455	-.69	54	40
B	.00	.36	M	.71	.41	-.71	.54	-1.31	73	.1948	.2253	-.	55	36
B	.98	.34	M	1.78	.37	-.79	.51	-1.57	73	.1208	.4328	-.	56	73
B	-.90	.36	M	.00	.43	-.91	.56	-1.63	73	.1073	.1213	-.	57	56
B	.87	.35	M	1.20	.39	-.33	.52	-.63	73	.5299	.8311	-.	58	48
B	-.26	.36	M	.54	.42	-.80	.55	-1.45	73	.1510	.0624	+.	60	51
B	-1.16	.36	M	-1.08	.42	-.09	.55	-.15	73	.8783	.3718	-.69	61	54
B	-1.29	.36	M	-1.08	.42	-.22	.56	-.39	73	.6988	.7348	.69	62	55
B	1.10	.34	M	1.04	.40	.06	.53	.12	73	.9052	.6513	+.	64	52

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
B	.98	.34	M	.54	.42	.45	.54	.82	73	.4124	.1698	+.	65	21
B	1.22	.34	M	1.78	.37	-.56	.50	-1.11	73	.2686	.7564	-.	66	62
B	1.09	.34	M	.36	.42	.73	.54	1.34	72	.1847	.4855	+.	67	66
B	.38	.35	M	.19	.42	.19	.55	.35	73	.7305	.5163	-.	68	65
B	.38	.35	M	-.36	.43	.74	.55	1.33	73	.1884	.4683	+.	69	53
B	-1.03	.36	M	.00	.43	-1.04	.56	-1.86	73	.0666	.0395	-.	70	29
B	1.33	.34	M	.54	.42	.79	.54	1.48	73	.1432	.1439	+.	71	83
B	.12	.36	M	.00	.43	.12	.55	.22	73	.8295	.8084	-.	72	9
B	.12	.36	M	1.35	.39	-1.22	.53	-2.33	73	.0228	.0050	-.	74	7
B	-1.69	.37	M	-1.61	.42	-.08	.56	-.14	73	.8861	.7906	.69	75	58
B	-.52	.36	M	.00	.43	-.52	.56	-.93	73	.3530	.0860	.69	76	45
B	.38	.35	M	.19	.42	.19	.55	.35	73	.7305	.5745	+.	77	13
B	-.26	.36	M	-.18	.43	-.08	.56	-.15	73	.8844	.0903	-.	78	3
B	-.65	.36	M	-.72	.42	.08	.56	.14	73	.8918	.3964	-.	79	59
B	1.67	.33	M	2.18	.36	-.51	.49	-1.05	73	.2994	.4516	-.	80	78
B	.50	.35	M	.54	.42	-.04	.54	-.07	73	.9437	.4927	+.	81	39
B	.12	.36	M	.19	.42	-.06	.55	-.11	73	.9130	.8084	-.	82	37
B	-.13	.36	M	.00	.43	-.13	.56	-.24	73	.8091	.1573	-.	83	35

Size of Mantel-Haenszel slice = .100 logits
Person class: B=non-master degree holder M=master degree holder

Appendix 9- 11: Pairwise comparisons between part-time and full-time infection control nurses (76 persons and 76 items)

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
P	-3.44	.56	F	-1.93	.33	-1.51	.65	-2.31	73	.0235	.1831	-.	1	74
P	-1.52	.51	F	-.75	.33	-.77	.60	-1.28	73	.2043	.9335	-.	2	20
P	.90	.46	F	1.73	.30	-.83	.55	-1.50	73	.1373	.7519	-.	3	31
P	.46	.48	F	.65	.32	-.19	.58	-.33	73	.7431	.0226	+.	4	64
P	.23	.49	F	-.43	.33	.65	.59	1.12	73	.2683	.4465	+.	6	49
P	.46	.48	F	-.86	.33	1.32	.58	2.27	73	.0259	.3210	+.	7	77
P	1.88	.43	F	1.26	.31	.62	.53	1.18	73	.2427	.1959	+.	8	19
P	.90	.46	F	.33	.33	.57	.57	1.01	73	.3176	.5019	+.	9	23
P	-.51	.50	F	-.64	.33	.14	.60	.23	73	.8201	.5485	-.	10	27
P	-.60	.52	F	-.96	.33	.36	.61	.59	72	.5599	.6854	+.	13	68
P	-.51	.50	F	-.02	.33	-.49	.60	-.81	72	.4191	.3518	-.	14	34
P	-.26	.50	F	-.75	.33	.49	.60	.83	73	.4102	.7132	+.	15	50
P	-.76	.50	F	-2.16	.34	1.40	.61	2.31	73	.0240	.2957	+.	16	2
P	.46	.48	F	.22	.33	.24	.58	.41	73	.6848	.7813	+.	17	63
P	-.76	.50	F	-.64	.33	-.12	.60	-.19	73	.8481	.6939	+.	18	15
P	-.26	.50	F	-.43	.33	.17	.60	.29	73	.7761	.9335	+.	19	32
P	-.01	.49	F	.11	.33	-.13	.59	-.21	73	.8310	.9335	+.	20	16
P	.23	.49	F	.22	.33	.00	.59	.01	73	.9942	.3005	-.	21	69
P	-2.04	.51	F	-2.04	.34	.00	.61	.00	73	.9973	.2515	-.	22	60
P	-.26	.50	F	-.21	.33	-.05	.60	-.08	73	.9382	.4795	+.	23	33
P	-.76	.50	F	-.96	.33	.21	.60	.34	73	.7325	1.000	+.	24	43
P	-.76	.50	F	-1.28	.33	.53	.60	.88	73	.3840	.2378	-.	25	71
P	.23	.49	F	-.43	.33	.65	.59	1.12	73	.2683	.7132	+.	26	28
P	.46	.48	F	.44	.33	.02	.58	.04	73	.9702	.3035	-.	27	14
P	.46	.48	F	.54	.33	-.08	.58	-.15	73	.8841	.2858	-.	28	18
P	-1.78	.51	F	-.75	.33	-1.03	.60	-1.70	73	.0928	.0276	-.	29	70
P	-.51	.50	F	.86	.32	-1.36	.59	-2.29	73	.0248	1.000	.000	30	25
P	-1.01	.50	F	.11	.33	-1.13	.60	-1.87	73	.0654	.2103	-.	31	24
P	-.76	.50	F	-.10	.33	-.66	.60	-1.09	73	.2788	.6831	-.	32	41
P	1.50	.44	F	-.21	.33	1.72	.55	3.13	73	.0025	.0481	+.	33	44
P	.68	.47	F	.22	.33	.46	.57	.80	73	.4242	.2660	+.	34	4
P	.46	.48	F	-.32	.33	.78	.58	1.34	73	.1841	.1834	+.	35	82
P	-.51	.50	F	-1.07	.33	.56	.60	.94	73	.3483	.2636	-.	36	75
P	.46	.48	F	1.06	.32	-.60	.57	-1.05	73	.2982	.0423	-.	37	1
P	1.11	.45	F	.96	.32	.15	.55	.27	73	.7880	.8084	-.	38	17
P	-.01	.49	F	-.32	.33	.31	.59	.52	73	.6059	.9784	+.	39	10
P	.46	.48	F	.65	.32	-.19	.58	-.33	73	.7431	.1181	-.	41	42
P	.23	.49	F	.44	.33	-.21	.58	-.36	73	.7204	1.000	-.	42	12
P	1.70	.43	F	1.16	.32	.54	.54	1.00	72	.3190	.6737	+.	43	5
P	-1.27	.51	F	-.10	.33	-1.16	.60	-1.93	73	.0574	.5577	-.	44	38
P	-2.30	.52	F	-2.27	.34	-.03	.62	-.05	73	.9580	.2858	-.	45	57
P	.90	.46	F	1.16	.31	-.26	.56	-.47	73	.6432	.3584	-.	46	67
P	2.24	.42	F	.75	.32	1.49	.53	2.81	73	.0064	.0785	+.	47	76
P	-.76	.50	F	-.86	.33	.10	.60	.16	73	.8694	.3035	+.	48	61
P	.23	.49	F	-.10	.33	.33	.59	.56	73	.5767	.4285	-.	49	8
P	-.01	.49	F	-.53	.33	.52	.59	.88	73	.3796	.6831	-.	50	80
P	.23	.49	F	.54	.33	-.32	.58	-.54	73	.5898	.4285	-.	51	26
P	-.76	.50	F	-.32	.33	-.44	.60	-.73	73	.4673	.1184	-.	52	72
P	-1.52	.51	F	.22	.33	-1.75	.60	-2.89	73	.0051	.0788	-.	53	22
P	.23	.49	F	.96	.32	-.73	.58	-1.26	73	.2118	.2515	-.	54	40
P	-.51	.50	F	.65	.32	-1.15	.60	-1.94	73	.0567	.2253	-.	55	36
P	1.70	.43	F	1.16	.31	.54	.54	1.00	73	.3194	.4061	+.	56	73
P	-.51	.50	F	-.53	.33	.03	.60	.05	73	.9616	.9347	-.	57	56
P	1.31	.45	F	.86	.32	.45	.55	.83	73	.4117	.7530	+.	58	48
P	.46	.48	F	-.10	.33	.56	.58	.97	73	.3368	.1573	+.	60	51
P	-1.78	.51	F	-.86	.33	-.92	.60	-1.53	73	.1311	.0814	-.	61	54
P	-1.52	.51	F	-1.07	.33	-.45	.60	-.75	73	.4554	.4313	-.	62	55
P	1.31	.45	F	.96	.32	.35	.55	.64	73	.5235	.1123	+.	64	52

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
P	.68	.47	F	.86	.32	-.17	.57	-.31	73	.7612	.4795	+.	65	21
P	1.11	.45	F	1.63	.30	-.53	.54	-.97	73	.3365	.3193	-.	66	62
P	.41	.49	F	.96	.32	-.54	.58	-.93	72	.3549	1.000	.000	67	66
P	.23	.49	F	.33	.33	-.10	.59	-.18	73	.8605	.0856	+.	68	65
P	-.01	.49	F	.11	.33	-.13	.59	-.21	73	.8310	.3173	+.	69	53
P	-.76	.50	F	-.53	.33	-.22	.60	-.37	73	.7115	.8292	-.	70	29
P	.90	.46	F	1.06	.32	-.16	.56	-.29	73	.7755	.2253	+.	71	83
P	-.01	.49	F	.11	.33	-.13	.59	-.21	73	.8310	.8084	+.	72	9
P	1.31	.45	F	.33	.33	.98	.55	1.77	73	.0808	.2305	+.	74	7
P	-1.52	.51	F	-1.71	.33	.19	.60	.31	73	.7551	.8221	-.	75	58
P	.23	.49	F	-.53	.33	.76	.59	1.30	73	.1976	.9219	+.	76	45
P	.46	.48	F	.22	.33	.24	.58	.41	73	.6848	.6473	+.	77	13
P	-.51	.50	F	-.10	.33	-.40	.60	-.67	73	.5024	.4759	-.	78	3
P	-.51	.50	F	-.75	.33	.24	.60	.41	73	.6847	.6916	+.	79	59
P	2.06	.42	F	1.82	.30	.25	.52	.48	73	.6347	.8351	+.	80	78
P	.23	.49	F	.65	.32	-.42	.58	-.72	73	.4721	.6473	-.	81	39
P	-.51	.50	F	.44	.33	-.94	.60	-1.58	73	.1190	.2253	-.	82	37
P	-.76	.50	F	.22	.33	-.98	.60	-1.63	73	.1068	.2253	-.	83	35

Size of Mantel-Haenszel slice = .100 logits
Person class: P=part-time F=full-time

Appendix 9- 12: Pairwise comparisons between infection control nurses working in acute hospitals and non-acute hospitals (76 persons and 76 items)

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
N	-2.62	.49	A	-2.25	.36	-.37	.61	-.60	72	.5478	.6013	.69	1	74
N	-1.31	.46	A	-.79	.34	-.52	.57	-.92	72	.3629	.9515	+.	2	20
N	1.34	.42	A	1.59	.32	-.24	.53	-.46	72	.6453	.8840	-.69	3	31
N	.58	.45	A	.62	.34	-.04	.56	-.06	72	.9494	.1452	+.	4	64
N	-.04	.46	A	-.32	.34	.27	.58	.47	72	.6402	.2534	+.	6	49
N	-.26	.46	A	-.67	.34	.41	.58	.72	72	.4765	.5496	.69	7	77
N	1.85	.40	A	1.28	.32	.57	.52	1.11	72	.2707	.4116	+.	8	19
N	.78	.44	A	.39	.34	.39	.56	.70	72	.4844	.1303	+.	9	23
N	-.26	.46	A	-.79	.34	.53	.58	.92	72	.3597	.4245	+.	10	27
N	-1.00	.47	A	-.79	.34	-.21	.58	-.36	71	.7207	.6958	-.	13	68
N	-.04	.46	A	-.23	.35	.18	.58	.32	71	.7526	.8469	.69	14	34
N	-.69	.46	A	-.67	.34	-.01	.58	-.02	72	.9813	.7813	-.	15	50
N	-2.16	.47	A	-1.63	.35	-.53	.58	-.91	72	.3642	.8697	-.69	16	2
N	.38	.46	A	.16	.34	.22	.57	.39	72	.6997	.4027	+.	17	63
N	-.90	.46	A	-.55	.34	-.34	.57	-.60	72	.5512	.9809	.69	18	15
N	-.26	.46	A	-.43	.34	.18	.58	.30	72	.7621	.7507	.69	19	32
N	-.04	.46	A	.16	.34	-.20	.57	-.35	72	.7273	.5409	.69	20	16
N	-.04	.46	A	.50	.34	-.55	.57	-.96	72	.3412	.7175	-.	21	69
N	-2.87	.51	A	-1.63	.35	-1.24	.62	-2.02	72	.0473	.1753	-.	22	60
N	-.04	.46	A	-.32	.34	.27	.58	.47	72	.6402	.1421	+.	23	33
N	-.69	.46	A	-1.03	.35	.34	.58	.60	72	.5524	.3627	+.	24	43
N	-1.11	.46	A	-1.15	.35	.04	.57	.07	72	.9417	.6394	.69	25	71
N	-.47	.46	A	-.08	.34	-.39	.58	-.68	72	.4961	.6292	-.	26	28
N	.17	.46	A	.62	.34	-.45	.57	-.79	72	.4321	.3035	-.	27	14
N	.78	.44	A	.50	.34	.28	.56	.50	72	.6202	.8322	-.	28	18
N	-.90	.46	A	-1.03	.35	.13	.57	.23	72	.8182	.2422	.69	29	70
N	.58	.45	A	.50	.34	.08	.56	.14	72	.8899	.2706	-.	30	25
N	-.26	.46	A	-.08	.34	-.18	.58	-.31	72	.7556	.1010	-.	31	24
N	-.26	.46	A	-.32	.34	.06	.58	.10	72	.9221	.8953	.69	32	41
N	.97	.44	A	.04	.34	.94	.55	1.69	72	.0960	.1292	+.	33	44
N	.97	.44	A	.04	.34	.94	.55	1.69	72	.0960	.0572	+.	34	4
N	-.04	.46	A	-.08	.34	.03	.58	.06	72	.9534	.1809	+.	35	82
N	-.69	.46	A	-1.03	.35	.34	.58	.60	72	.5524	.3638	-.	36	75
N	.78	.44	A	.95	.33	-.17	.55	-.31	72	.7579	.3841	-.	37	1
N	.97	.44	A	1.06	.33	-.09	.55	-.16	72	.8738	.8864	+.	38	17
N	-.26	.46	A	-.20	.34	-.06	.58	-.11	72	.9148	.6184	-.	39	10
N	.78	.44	A	.50	.34	.28	.56	.50	72	.6202	.2445	-.	41	42
N	.58	.45	A	.27	.34	.31	.56	.55	72	.5859	.6171	+.	42	12
N	1.34	.42	A	1.28	.33	.07	.53	.12	71	.9012	.8865	-.	43	5
N	-1.31	.46	A	.04	.34	-1.35	.57	-2.37	72	.0204	.7472	-.	44	38
N	-2.62	.49	A	-2.13	.36	-.50	.61	-.82	72	.4159	.7043	+.	45	57
N	1.16	.43	A	1.06	.33	.10	.54	.18	72	.8541	.1378	-.	46	67
N	1.69	.41	A	1.06	.33	.62	.52	1.19	72	.2380	.2233	+.	47	76
N	-.90	.46	A	-.79	.34	-.11	.57	-.18	72	.8544	.2196	+.	48	61
N	-.26	.46	A	.16	.34	-.42	.58	-.72	72	.4730	.6420	-.	49	8
N	-.04	.46	A	-.55	.34	.51	.58	.88	72	.3811	.1809	.69	50	80
N	1.16	.43	A	.04	.34	1.12	.55	2.04	72	.0445	.6158	+.	51	26
N	-1.31	.46	A	.04	.34	-1.35	.57	-2.37	72	.0204	.1258	-.	52	72
N	-.26	.46	A	-.20	.34	-.06	.58	-.11	72	.9148	.7794	-.	53	22
N	.97	.44	A	.62	.34	.36	.55	.65	72	.5192	.9741	.69	54	40
N	-.04	.46	A	.50	.34	-.55	.57	-.96	72	.3412	.4726	-.	55	36
N	1.69	.41	A	1.17	.33	.52	.52	.99	72	.3270	.2636	+.	56	73
N	-.47	.46	A	-.55	.34	.08	.58	.14	72	.8896	.5082	-.69	57	56
N	1.16	.43	A	.95	.33	.21	.54	.39	72	.7011	.6042	-.	58	48
N	.38	.46	A	-.08	.34	.46	.57	.80	72	.4271	.6949	+.	60	51
N	-1.31	.46	A	-1.03	.35	-.29	.57	-.50	72	.6191	.5144	-.	61	54
N	-1.11	.46	A	-1.27	.35	.16	.57	.28	72	.7789	.8083	.00	62	55
N	1.16	.43	A	.95	.33	.21	.54	.39	72	.7011	.6068	-.69	64	52

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
N	.58	.45	A	.84	.33	-.26	.56	-.46	72	.6434	.3202	-.	65	21
N	1.34	.42	A	1.48	.32	-.14	.53	-.27	72	.7892	.0764	-.	66	62
N	.58	.45	A	.83	.34	-.25	.56	-.44	71	.6618	.4997	-.	67	66
N	-.04	.46	A	.39	.34	-.43	.57	-.76	72	.4520	.5584	+.	68	65
N	-.04	.46	A	.04	.34	-.08	.58	-.15	72	.8843	.9219	-.	69	53
N	-.90	.46	A	-.43	.34	-.46	.57	-.81	72	.4229	.7687	.69	70	29
N	1.16	.43	A	.84	.33	.32	.54	.59	72	.5584	.7857	-.	71	83
N	-.04	.46	A	.16	.34	-.20	.57	-.35	72	.7273	.6949	-.	72	9
N	.78	.44	A	.50	.34	.28	.56	.50	72	.6202	.9353	.69	74	7
N	-2.16	.47	A	-1.39	.35	-.78	.58	-1.33	72	.1881	.8166	-.69	75	58
N	-.69	.46	A	-.08	.34	-.61	.57	-1.06	72	.2945	.4500	-.69	76	45
N	.78	.44	A	.04	.34	.74	.56	1.32	72	.1895	.1727	.69	77	13
N	-.26	.46	A	-.20	.34	-.06	.58	-.11	72	.9148	.9330	-.69	78	3
N	-1.11	.46	A	-.43	.34	-.67	.57	-1.17	72	.2444	.2784	-.	79	59
N	2.16	.39	A	1.69	.32	.48	.50	.95	72	.3458	.7700	-.69	80	78
N	.78	.44	A	.39	.34	.39	.56	.70	72	.4844	.8658	+.	81	39
N	-.26	.46	A	.39	.34	-.65	.57	-1.13	72	.2630	.2253	-.	82	37
N	-.26	.46	A	.04	.34	-.30	.58	-.52	72	.6066	.2253	-.	83	35

Size of Mantel-Haenszel slice = .100 logits
Person class: N=non-acute hospital A=acute hospital

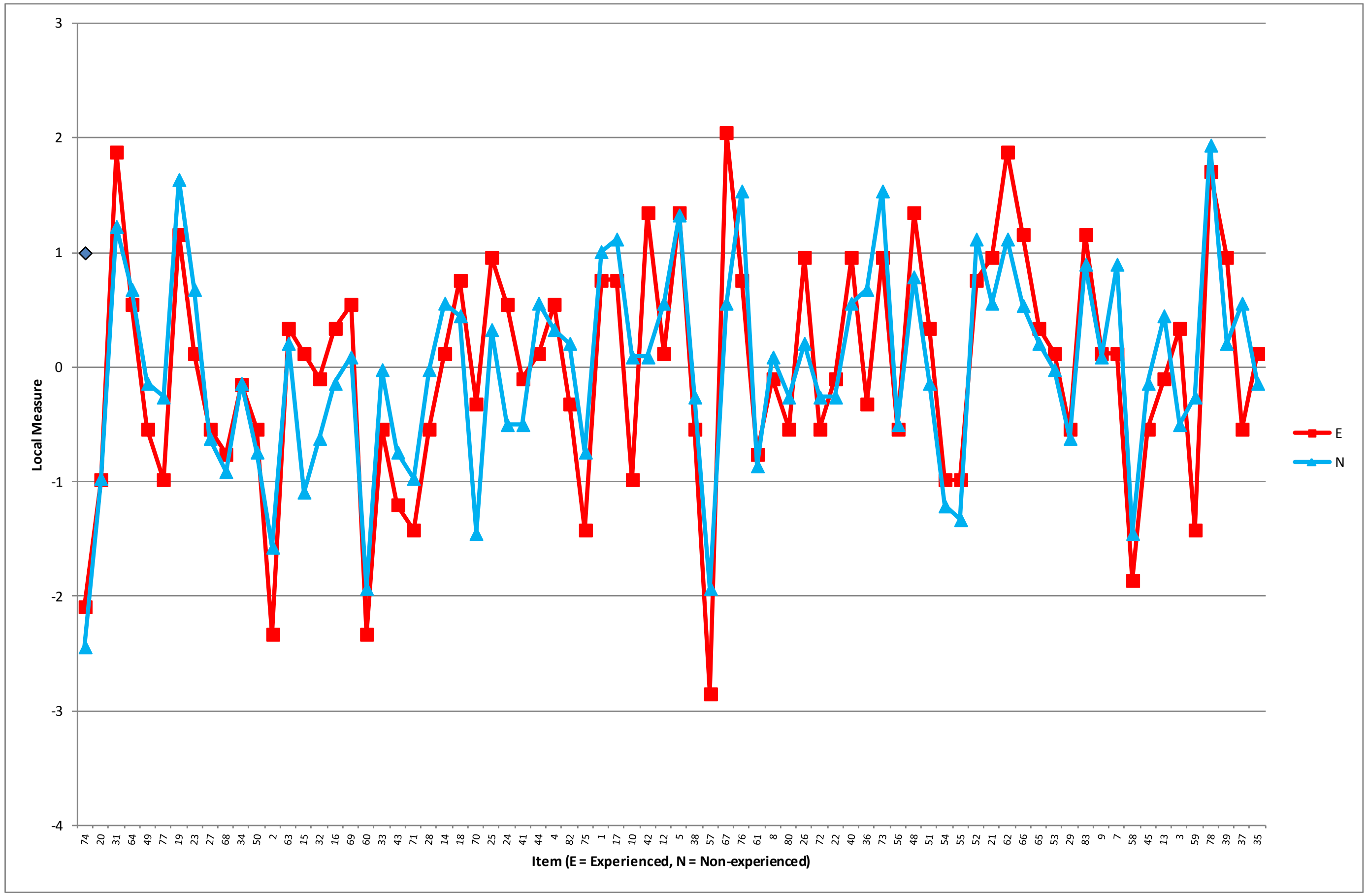
Appendix 9- 13: Pairwise comparisons between infection control nurses working in public and private hospitals (76 persons and 76 items)

Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number Name
P	-2.25	.56	G	-2.40	.33	.14	.65	.22	73	.8253	.4999	-.	1 74
P	-1.32	.56	G	-.87	.31	-.45	.64	-.71	73	.4793	.6939	-.	2 20
P	.82	.53	G	1.67	.29	-.84	.60	-1.40	73	.1659	.1773	-.	3 31
P	.82	.53	G	.51	.31	.31	.61	.51	73	.6126	.0659	+.	4 64
P	.54	.54	G	-.47	.32	1.01	.63	1.61	73	.1122	.2276	+.	6 49
P	-.07	.56	G	-.57	.31	.50	.64	.78	73	.4366	.6870	+.	7 77
P	2.55	.47	G	1.07	.30	1.49	.56	2.66	73	.0096	.2433	+.	8 19
P	1.10	.52	G	.32	.31	.78	.61	1.29	73	.2014	.4142	+.	9 23
P	-.38	.56	G	-.67	.31	.29	.64	.45	73	.6565	.1573	-.	10 27
P	.24	.55	G	-1.22	.32	1.46	.64	2.29	72	.0251	.1596	+.	13 68
P	-.70	.56	G	.00	.32	-.70	.64	-1.09	72	.2809	.3518	-.	14 34
P	-.70	.56	G	-.57	.31	-.13	.64	-.20	73	.8444	.1051	+.	15 50
P	-.07	.56	G	-2.29	.33	2.22	.65	3.42	73	.0010	.0134	+.	16 2
P	.82	.53	G	.12	.31	.70	.62	1.14	73	.2593	.7477	+.	17 63
P	.24	.55	G	-.97	.31	1.20	.63	1.90	73	.0616	.0629	+.	18 15
P	-.07	.56	G	-.47	.32	.40	.64	.63	73	.5325	.3414	+.	19 32
P	.54	.54	G	-.08	.31	.61	.63	.97	73	.3329	.3414	+.	20 16
P	-.38	.56	G	.41	.31	-.80	.64	-1.24	73	.2173	.2029	-.	21 69
P	-2.91	.59	G	-1.76	.32	-1.15	.67	-1.71	73	.0910	.1051	-.	22 60
P	-.70	.56	G	-.08	.31	-.62	.64	-.97	73	.3361	.4795	-.	23 33
P	-1.01	.56	G	-.87	.31	-.14	.64	-.22	73	.8238	.4795	-.	24 43
P	-1.63	.56	G	-.97	.31	-.67	.64	-1.04	73	.3008	.1983	-.	25 71
P	-.38	.56	G	-.17	.31	-.21	.64	-.32	73	.7462	.9458	+.	26 28
P	-.38	.56	G	.70	.31	-1.08	.64	-1.70	73	.0942	.2253	-.	27 14
P	.54	.54	G	.51	.31	.02	.62	.04	73	.9683	.4927	-.	28 18
P	-2.91	.59	G	-.47	.32	-2.44	.67	-3.65	73	.0005	.0153	-.	29 70
P	-.07	.56	G	.61	.31	-.68	.64	-1.06	73	.2917	.6015	-.	30 25
P	-.70	.56	G	-.08	.31	-.62	.64	-.97	73	.3361	.2103	-.	31 24
P	-.38	.56	G	-.27	.32	-.11	.64	-.17	73	.8650	.1336	+.	32 41
P	1.10	.52	G	.12	.31	.98	.61	1.61	73	.1118	.0757	+.	33 44
P	1.10	.52	G	.12	.31	.98	.61	1.61	73	.1118	.2422	+.	34 4
P	.54	.54	G	-.27	.32	.81	.63	1.29	73	.2008	.0531	+.	35 82
P	-.38	.56	G	-1.07	.31	.68	.64	1.06	73	.2916	.9666	-.	36 75
P	.24	.55	G	1.07	.30	-.83	.63	-1.32	73	.1894	.1172	-.	37 1
P	.54	.54	G	1.16	.30	-.62	.62	-1.00	73	.3183	.8084	-.	38 17
P	.24	.55	G	-.37	.32	.61	.63	.96	73	.3399	.7477	+.	39 10
P	.54	.54	G	.61	.31	-.07	.62	-.11	73	.9103	.5416	-.	41 42
P	.54	.54	G	.32	.31	.22	.62	.35	73	.7285	.3173	-.	42 12
P	1.62	.50	G	1.24	.30	.37	.58	.64	72	.5222	.6118	+.	43 5
P	-.70	.56	G	-.37	.32	-.33	.64	-.51	73	.6148	.1439	-.	44 38
P	-1.94	.56	G	-2.40	.33	.46	.65	.70	73	.4834	.3035	-.	45 57
P	1.36	.51	G	.98	.30	.39	.59	.65	73	.5157	.8093	+.	46 67
P	2.33	.48	G	.89	.30	1.44	.56	2.55	73	.0127	.0822	+.	47 76
P	-.38	.56	G	-.97	.31	.58	.64	.91	73	.3666	.3035	+.	48 61
P	-.38	.56	G	.12	.31	-.51	.64	-.79	73	.4341	.5539	-.	49 8
P	-.38	.56	G	-.37	.32	-.01	.64	-.02	73	.9871	1.000	-.	50 80
P	-.07	.56	G	.61	.31	-.68	.64	-1.06	73	.2917	.0372	-.	51 26
P	.24	.55	G	-.67	.31	.91	.63	1.43	73	.1570	.0423	-.	52 72
P	-1.63	.56	G	.12	.31	-1.75	.64	-2.75	73	.0075	.0477	-.	53 22
P	.24	.55	G	.89	.30	-.65	.63	-1.03	73	.3053	.2626	-.	54 40
P	-.38	.56	G	.51	.31	-.89	.64	-1.40	73	.1670	.2253	-.	55 36
P	1.86	.49	G	1.16	.30	.71	.57	1.23	73	.2225	.3096	+.	56 73
P	-.70	.56	G	-.47	.32	-.23	.64	-.35	73	.7265	.9347	-.	57 56
P	1.10	.52	G	.98	.30	.12	.60	.20	73	.8398	.8584	-.	58 48
P	.24	.55	G	.02	.31	.21	.63	.34	73	.7376	.1573	+.	60 51
P	-1.94	.56	G	-.87	.31	-1.07	.64	-1.68	73	.0976	.0576	-.	61 54
P	-1.94	.56	G	-.97	.31	-.97	.64	-1.52	73	.1319	.2445	-.	62 55
P	1.10	.52	G	1.07	.30	.03	.60	.05	73	.9580	.0469	+.	64 52

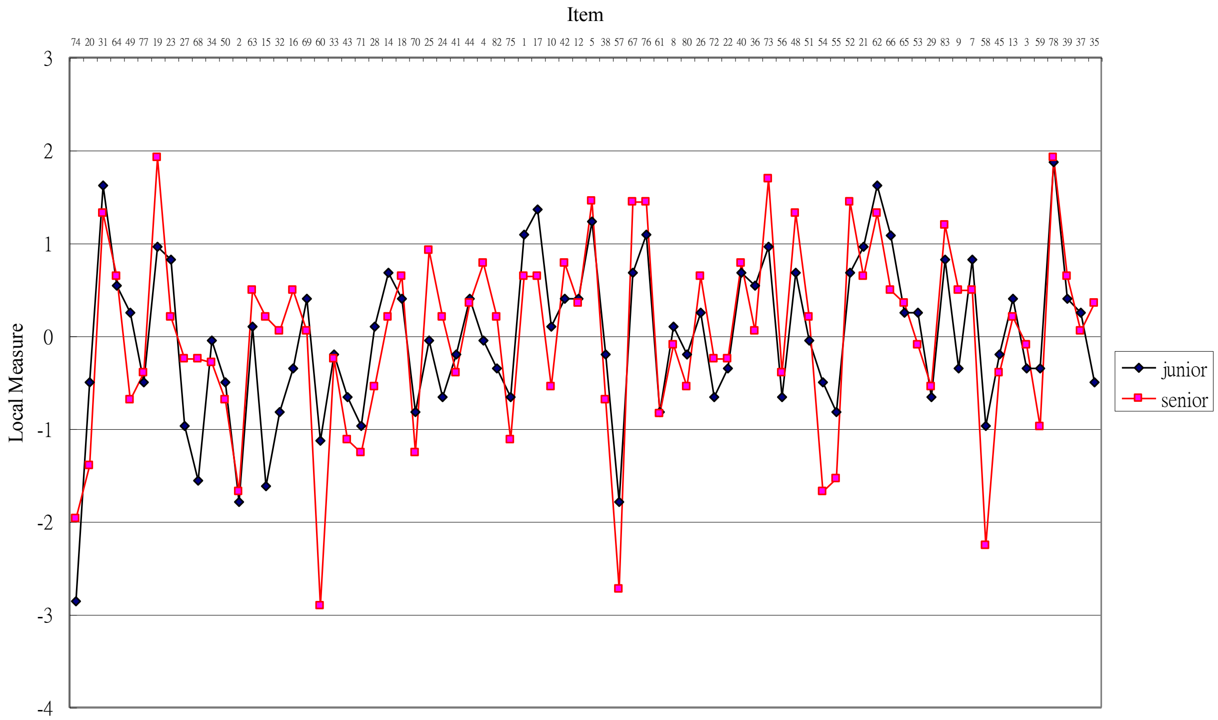
Person CLASS	DIF MEASURE	DIF S.E.	Person CLASS	DIF MEASURE	DIF S.E.	DIF CONTRAST	JOINT S.E.	t	d.f.	Prob.	MantelHanzl Prob.	Size	Item Number	Name
P	.54	.54	G	.89	.30	-.35	.62	-.56	73	.5740	.4795	+.	65	21
P	.54	.54	G	1.75	.28	-1.21	.61	-1.98	73	.0511	.3405	-.	66	62
P	.48	.56	G	.89	.30	-.40	.64	-.64	72	.5270	.3173	+.	67	66
P	.82	.53	G	.12	.31	.70	.62	1.14	73	.2593	.0856	+.	68	65
P	-.07	.56	G	.12	.31	-.19	.64	-.30	73	.7642	.4795	+.	69	53
P	-.70	.56	G	-.57	.31	-.13	.64	-.20	73	.8444	.6171	+.	70	29
P	1.62	.50	G	.79	.30	.82	.58	1.41	73	.1631	.2253	+.	71	83
P	-.07	.56	G	.12	.31	-.19	.64	-.30	73	.7642	.3173	+.	72	9
P	1.36	.51	G	.41	.31	.95	.60	1.59	73	.1158	.3405	+.	74	7
P	-1.63	.56	G	-1.66	.32	.03	.64	.05	73	.9622	.2445	-.	75	58
P	.82	.53	G	-.67	.31	1.49	.62	2.42	73	.0180	.4142	+.	76	45
P	.54	.54	G	.22	.31	.32	.63	.50	73	.6157	.4328	+.	77	13
P	-.38	.56	G	-.17	.31	-.21	.64	-.32	73	.7462	.2551	-.	78	3
P	-.38	.56	G	-.77	.31	.39	.64	.60	73	.5499	.4257	-.	79	59
P	1.10	.52	G	2.14	.28	-1.04	.59	-1.77	73	.0808	.3193	-.	80	78
P	.24	.55	G	.61	.31	-.37	.63	-.58	73	.5606	.7316	-.	81	39
P	.24	.55	G	.12	.31	.11	.63	.18	73	.8568	.3173	-.	82	37
P	-.38	.56	G	.02	.31	-.41	.64	-.63	73	.5287	.3173	-.	83	35

Size of Mantel-Haenszel slice = .100 logits
Person class: P=private hospital G=public hospital

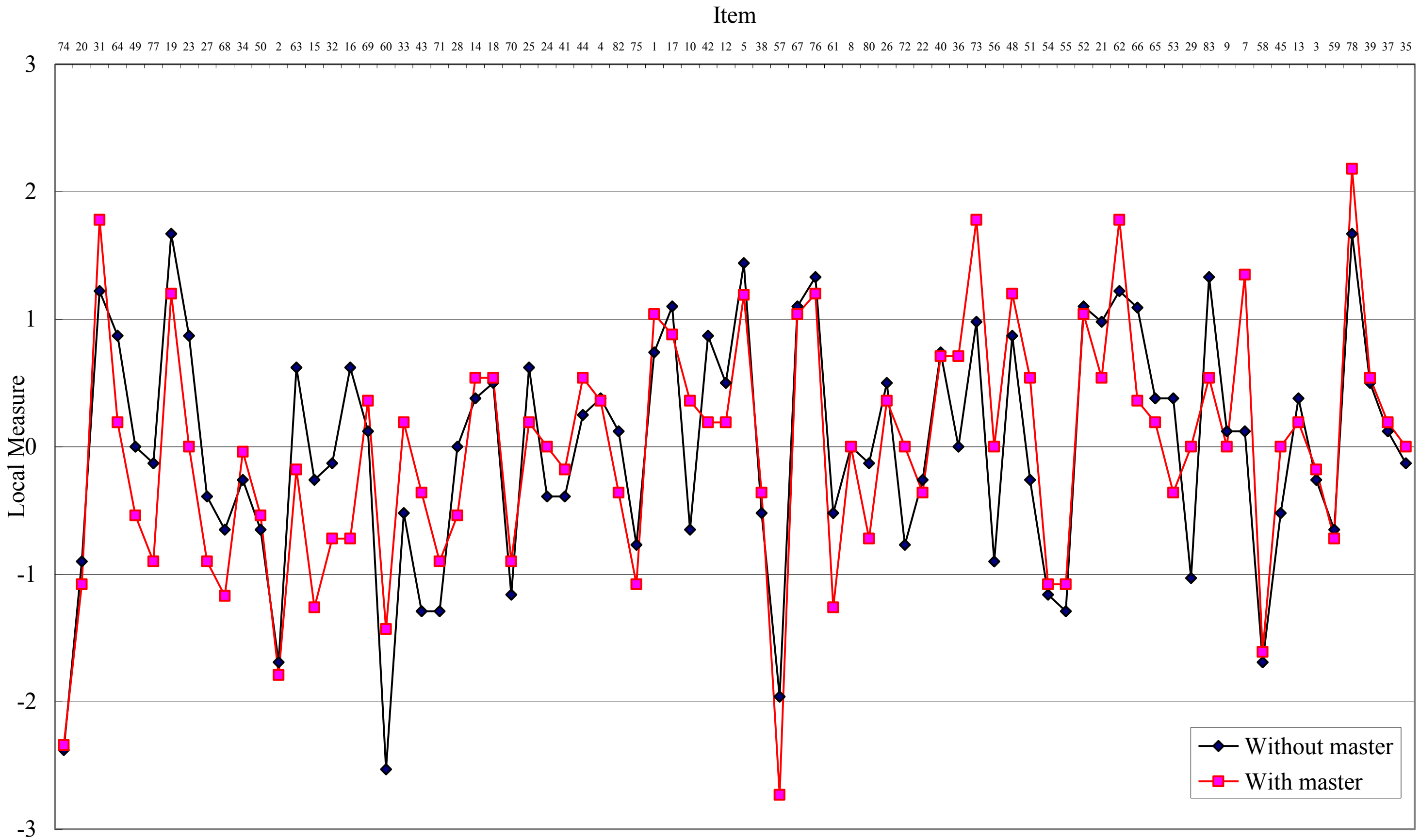
Appendix 9- 14: Differential item functioning plots between experienced and inexperienced infection control nurses



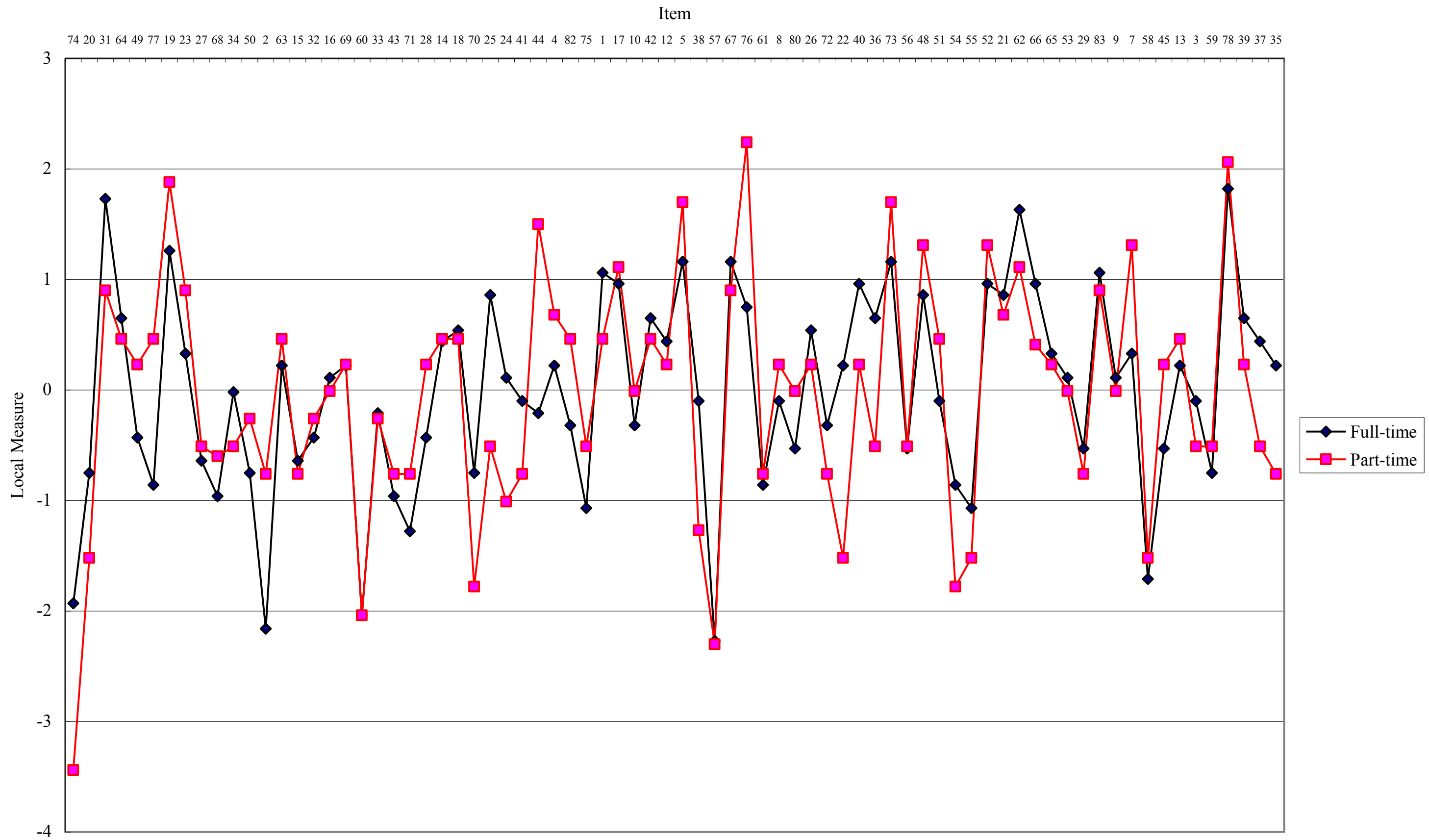
Appendix 9- 15: Differential item functioning plot on junior and senior rank



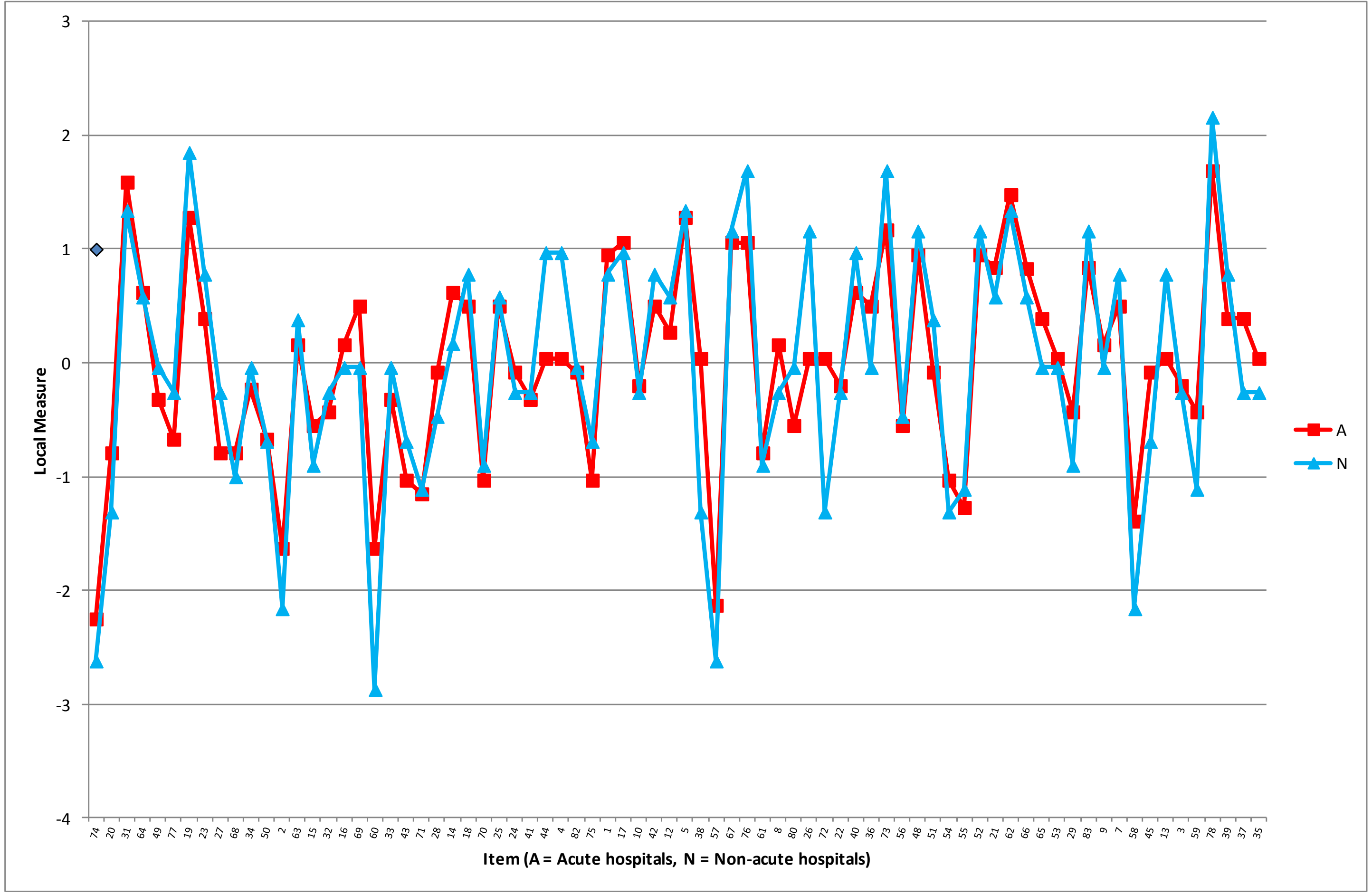
Appendix 9- 16: Differential item functioning plot on infection control nurses with and without master degree



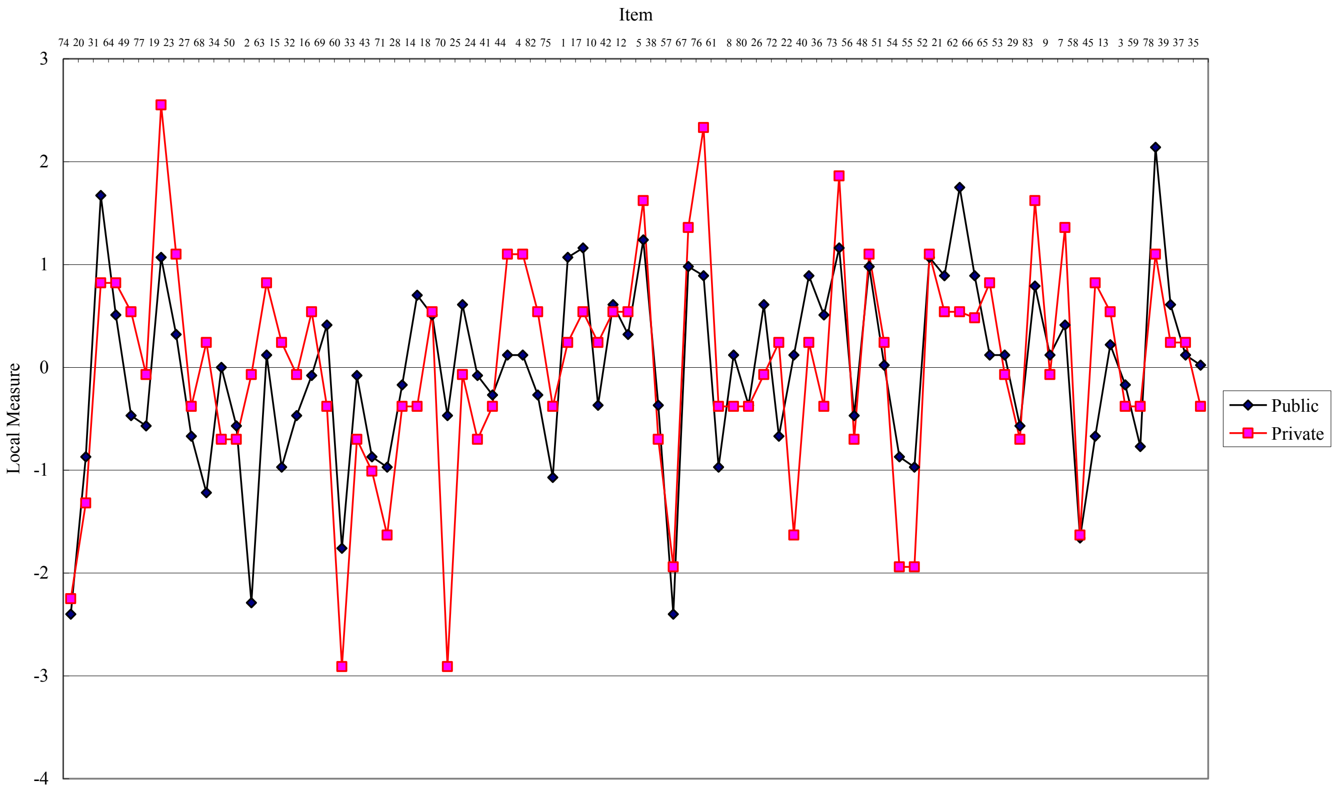
Appendix 9- 17: Differential item functioning plot on part-time and full-time infection control nurses



Appendix 9- 18: Differential item functioning plot on infection control nurses working in non-acute and acute hospitals



Appendix 9- 19: Differential item functioning plot on infection control nurses working in private and public hospitals



Appendix 9- 20: Standardized residual variance scree plot for 76 persons and 76 items

```
      STANDARDIZED RESIDUAL VARIANCE SCREE PLOT
Table of STANDARDIZED RESIDUAL variance (in Eigenvalue units)
                                                 Empirical       Modeled
Total variance in observations     =        335.5 100.0%          100.0%
Variance explained by measures     =        259.5  77.3%           77.7%
Unexplained variance (total)       =         76.0  22.7% 100.0%    22.3%
Unexplned variance in 1st contrast =          5.8   1.7%   7.7%
Unexplned variance in 2nd contrast =          4.5   1.3%   5.9%
Unexplned variance in 3rd contrast =          4.1   1.2%   5.4%
Unexplned variance in 4th contrast =          3.5   1.1%   4.7%
Unexplned variance in 5th contrast =          3.3   1.0%   4.3%
```

```
     VARIANCE COMPONENT SCREE PLOT
      +--+--+--+--+--+--+--+--+--+
   100%+  T                      +
       |                         |
 V 63%+     M                    +
 A     |                         |
 R 40%+                          +
 I     |                         |
 A 25%+                          +
 N     |       U                 |
 C 16%+                          +
 E     |                         |
   10%+                          +
 L     |                         |
 O  6%+                          +
 G     |                         |
 |  4%+                          +
 S     |                         |
 C  3%+                          +
 A     |                         |
 L  2%+           1              +
 E     |             2           |
 D  1%+                 3  4     +
       |                      5  |
  0.5%+                          +
      +--+--+--+--+--+--+--+--+--+
         TV MV UV U1 U2 U3 U4 U5
        VARIANCE COMPONENTS
```

Appendix 9- 21: Summary of category structure for 91 persons and 83 items

```
SUMMARY OF CATEGORY STRUCTURE.  Model="R"
+-----------------------------------------------------------------
|CATEGORY   OBSERVED|OBSVD SAMPLE|INFIT OUTFIT||STRUCTURE|CATEGORY|
|LABEL SCORE COUNT %|AVRGE EXPECT|  MNSQ  MNSQ||CALIBRATN| MEASURE|
|-------------------+------------+------------++---------+--------+
|  2   2      24   0|   .42  -.35|  1.31  1.47||  NONE   |( -4.34)| 2 "Not important"
|  3   3     695   9|   .81   .74|  1.07  1.07||   -3.19 |  -1.82 | 3 Neutral
|  4   4    4304  58|  2.04  2.08|   .96   .99||    -.44 |   1.60 | 4 Important
|  5   5    2441  33|  4.35  4.32|   .96   .96||    3.63 |(  4.74)| 5 "Very important"
|-------------------+------------+------------++---------+--------+
|MISSING       6   0|  2.58      |            ||         |        |
+-----------------------------------------------------------------
OBSERVED AVERAGE is mean of measures in category. It is not a parameter estimate.
```

```
+---------------------------------------------------------------------------
|CATEGORY    STRUCTURE   |  SCORE-TO-MEASURE   | 50% CUM.| COHERENCE|ESTIM|
| LABEL    MEASURE  S.E. | AT CAT. ----ZONE----|PROBABLTY| M->C C->M|DISCR|
|------------------------+---------------------+---------+----------+-----+
|   2      NONE          |( -4.34) -INF   -3.34|         |   0%   0%|     | 2 "Not important"
|   3       -3.19    .21 |  -1.82  -3.34   -.33|   -3.25 |  55%  17%|  .91| 3 Neutral
|   4        -.44    .04 |   1.60   -.33   3.68|    -.40 |  71%  88%|  .96| 4 Important
|   5        3.63    .03 |(  4.74)  3.68  +INF |    3.65 |  77%  61%| 1.05| 5 "Very important"
+---------------------------------------------------------------------------
M->C = Does Measure imply Category?
C->M = Does Category imply Measure?
```

```
        CATEGORY PROBABILITIES: MODES - Structure measures at intersections
P      ++-----+-----+-----+-----+-----+-----+-----+-----+-----+-----++
R  1.0 +                                                             +
O      |                                                             |
B      |                                                             |
A      |22                                                           |
B   .8 +  22                           444444                       5+
I      |    2                        44      444                  55 |
L      |     22                    44           4               5    |
I      |       2        3333333   44              44        55       |
T   .6 +        2     33       33     4              4     5         +
Y      |         2  33          33  4                 44 5           |
    .5 +          2*              34                     *           +
O      |          3 2            43                      5 4         |
F   .4 +        33   2          44  33                 55   4        +
       |       3      2        4      3              5       44      |
R      |      3        2      4        3            5          4     |
E      |    33          22   44          33        55           44   |
S   .2 +  33             2 4              33     55               4+
P      |33               4*2                33  55                   |
O      |              444   222               5**3                   |
N      |          44444        22222    55555    333333              |
S   .0 +**********555555555555555555****222222222222222*************+
E      ++-----+-----+-----+-----+-----+-----+-----+-----+-----+-----++
       -5    -4    -3    -2    -1     0     1     2     3     4     5
        Person [MINUS] Item MEASURE
```

Appendix 9- 22: 76-item core competency of infection control nurses of Hong Kong

Surveillance

1)Design a surveillance plan for the served population(s) using epidemiological principles.
2)Use standardized definitions to conduct surveillance.
3)Select appropriate indicators to monitor internal trend of infection.
4)Select appropriate indicators to benchmark externally.
5) Select a database(s) that matches internal/ external data structure of surveillance.
7) Select a database(s) that ensures accurate data management for surveillance.
8) Analyze surveillance data by appropriate statistical techniques.
9) Critically evaluate significance of findings of surveillance.
10) Report the surveillance findings to appropriate clients.
12) Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.

Programme management and evaluation

13) Develop the programme plan with measurable outcomes.
14) Periodically, e.g. annually, review the programme.
15) Assess the client needs on infection prevention and control programme during planning.
16) Incorporate the client needs into the programme plan.
17) Recommend appropriate resources for the proposed programme plan.
18) Communicate with clients on the objectives of the programme.
19) Communicate with clients on the value of the programme.
20) Communicate the necessary resources to administration/ management,
21) Modify the programme plan if needed after communicating the necessary resources to administration/ management.
22) Periodically evaluate the effectiveness of the infection prevention and control programme.
23) Integrate the evaluated findings during modification of the programme.
24) Evaluate client needs after implementing the infection prevention and control programme.
25) Evaluate client satisfaction after implementing the infection prevention and control programme.
26) Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.

Evidence based practice

27) Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.
28) Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.
29) Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.

Education

31) Periodically assess the educational needs of clients.
32) Develop educational objectives and strategies to meet the client needs.
33) Collaborate in the development of educational programmes/ tools that related to infection prevention and control.
34) Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.
35) Evaluate the educational programmes/ tools that related to infection prevention and control.
36) Disseminate the findings of the infection prevention and control programmes to concerned clients.
37) Disseminate the recommendations of the infection prevention and control programmes to concerned clients.
38) Disseminate the policies of the infection prevention and control programmes to concerned clients.
39) Continuously evaluate the effectiveness of educational programmes.

40) Continuously evaluate the learner outcomes of educational programmes.

Team and service management

41) Share knowledge and skills with other team members and clients.

42) Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members.

43) Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.

44) Seek opportunities to influence policymakers.

45) Consider clinical outcomes when initiating changes in practice.

48) Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.

49) Identify opportunities for service improvement.

50) Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.

51) Manage the expanded resources for infection prevention and control in the organization, e.g. infection control link systems.

Collaboration and partnership

52) Recruit other relevant parties to involve in the infection prevention and control programmes if necessary.

53) Participate in inter-departmental and organization’s infection prevention and control improvement activities.

Outbreak investigation and control

54) Recognize an outbreak through surveillance information and reporting channels.

55) Assess the extent of outbreak situation.

56) Use epidemiological knowledge to identify the risk factors during outbreak situations.

57) Collect the appropriate data during infection outbreak investigation.

58) Advise the control measures to the involved parties during outbreak situations.

59) Advise the investigations to the involved parties during outbreak situations.

60) Evaluate the effectiveness of the control measures during outbreak situations.

61) Share the findings of outbreak investigation to the relevant parties.

Research and development

62) Critically review the related research.

63) Incorporate the relevant published research findings into practice, including when providing consultation service.

64) Incorporate the relevant published research findings into education.

65) Share findings with other infection control practitioners from surveillance and other infection prevention and control activities.

66) Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control.

67) Publish or present the participated research findings to contribute in advancing the field of infection prevention and control.

Expert knowledge

68) Demonstrate knowledge in areas of patient care practices.

69) Demonstrate knowledge of microbiology.

70) Demonstrate knowledge of asepsis.

71) Demonstrate knowledge of decontamination.

72) Demonstrate knowledge of educational skills and tactics.

73) Demonstrate knowledge of educational methodologies.

74) Demonstrate knowledge of infectious diseases.

75) Demonstrate knowledge of communication skills.

76) Demonstrate knowledge of programme administration.

77) Demonstrate knowledge of epidemiology.

78) Demonstrate knowledge of biostatistics.

80) Act as expert resource in infection prevention and control in clinical and organizational level.

Continuing education and professional development

82) Advance the relevant knowledge and skills through educational programmes, peer

networking, internet access, published literature, and/ or professional meetings. 83) Advance the field of infection prevention and control through the involvement of related research.

Appendix 9- 23: Comparison between core competencies for infection control practices (Hong Kong vs. the United Kingdom)

Hong Kong	The United Kingdom (ICNA, 2004)
Surveillance	
1) Design a surveillance plan for the served population(s) using epidemiological principles.	1.6.2) Use relevant information technology to collect and interpret surveillance data.
	1.7.1) Formulate and implements a programme for improving the quality of care which takes into account priorities, objectives and available resources.
	1.7.7) Incorporate the principles of the Data Protection Act into methodology and data handling.
	1.9.1) Analyse the role of demographics relating to public health.
	1.9.2) Synthesise current population trends to inform decision making process a service development and provision to prevent and control infection.
2) Use standardized definitions to conduct surveillance.	1.7.3) Use appropriate epidemiological methods to collect or co-ordinate the collection of data and ensure reliable and reproducible results.
3) Select appropriate indicators to monitor internal trend of infection.	2.3.3) Select appropriate quality indicators or benchmarks.
4) Select appropriate indicators to benchmark externally.	2.3.3) Select appropriate quality indicators or benchmarks.
8) Analyze surveillance data by appropriate statistical techniques.	1.7.4) Analyse data using appropriate epidemiological measures and statistical tests, seeking expert advice where appropriate.
9) Critically evaluate significance of findings of surveillance.	1.6.1) Use relevant information technology to collect and interpret surveillance data.

Hong Kong	The United Kingdom (ICNA, 2004)
	1.6.3) Analyse epidemiological data and knowledge to formulate action plans relevant to local needs and inform future practice, and evaluate effectiveness of interventions.
	1.7.5) Interpret results, identify trends and adverse events, and assess the relationship to benchmarks.
	1.9.3) Analyse data to inform process and practice in relation to demographic shift.
	1.9.4) Deduce target populations for preventive interventions.
	1.9.5) Evaluate the risks to individuals' health and well being and seeks immediate assistance when there are serious concerns.
10) Report the surveillance findings to appropriate clients.	1.7.2) Establish and maintain dialogue with key professionals, both those who can use the results to inform practice and those who can provide expert advice and guidance.
	1.7.8) Interpret findings and produce logical, structured reports, appropriate in style and content for the intended reader.
	1.7.9) Disseminate results to relevant clinical and non-clinical staff in a timely manner.
12) Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.	1.6.2) Assess the suitability of surveillance methods, techniques and commercially available packages, and selects the most appropriate
5) Select a database(s) that matches internal/ external data structure of surveillance.	
7) Select a database(s) that ensures accurate data management for surveillance.	
Programme management and evaluation	

Hong Kong	The United Kingdom (ICNA, 2004)
13) Develop the programme plan with measurable outcomes.	2.3.1) Formulate and implement a programme for improving the quality of care which takes into account priorities, objectives and available resources.
	2.3.3) Select appropriate quality indicators or benchmarks.
	2.3.6) Distinguish target population and develop and use appropriate methodology and data collection tools.
	2.3.7) Appraise limitations of methods.
	2.3.8) Use systems to collect data, which will produce reliable and reproducible findings.
	2.3.9) Incorporate the principles of the Data Protection Act into methodology and data handling in line with the Caldicott Guidelines.
14) Periodically, e.g. annually, review the programme.	4.2.2) Review and evaluate the service strategy annually, taking into account relevant legislation and published professional guidelines, forming short, medium and long term objectives.
15) Assess the client needs on infection prevention and control programme during planning.	1.1.8) Formulate assessments of infection hazards; identify where and when they occur, the risks related to them, and the actions required eliminating or minimizing those risks.
	1.1.10) Explore social, economic and environmental influences in relation to inequalities in health and the impact this may have on infection.
	2.5.6) Use the principles of hazard analysis and ‘root cause analysis’ in relation to infection control practice/ incidents to inform future strategies.

Hong Kong	The United Kingdom (ICNA, 2004)
16) Incorporate the client needs into the programme plan.	4.2.1) Formulate an organization wide infection prevention and control programme with clearly defined objectives in collaboration with other members of the organization.
17) Recommend appropriate resources for the proposed programme plan.	4.2.3) Prioritize service provision taking into account varying demands and available resources.
18) Communicate with clients on the objectives of the programme.	4.2.1) Formulate an organization wide infection prevention and control programme with clearly defined objectives in collaboration with other members of the organization.
19) Communicate with clients on the value of the programme.	4.1.4) Inspire others with values and vision through support in daily activities.
20) Communicate the necessary resources to administration/ management	4.2.6) Negotiate resource allocation for infection prevention and control programmes.
21) Modify the programme plan if needed after communicating the necessary resources to administration/ management.	1.1.6) Undertake regular review and evaluation of the service and initiate changes where appropriate
22) Periodically evaluate the effectiveness of the infection prevention and control programme.	1.1.6) Undertake regular review and evaluation of the service and initiate changes where appropriate
	2.3.10) Use professional judgment in recognizing and challenging poor practice.
	2.3.11) Interpret findings and produce logical, structured reports, appropriate in style and content for the intended reader.
23) Integrate the evaluated findings during modification of the programme.	1.1.6) Undertake regular review and evaluation of the service and initiate changes where appropriate
24) Evaluate client needs after implementing the infection prevention and control programme.	1.1.2) Evaluate the measures used to prevent and control infection, taking into account the individual's nursing, social, physical and psychological needs.

Hong Kong	The United Kingdom (ICNA, 2004)
25) Evaluate client satisfaction after implementing the infection prevention and control programme.	1.1.6) Undertake regular review and evaluation of the service and initiate changes where appropriate
26) Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.	1.1.6) Undertake regular review and evaluation of the service and initiate changes where appropriate
Evidence-based practice	
27) Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	1.7.6) Formulate strategies to promote and facilitate the review of clinical and non-clinical practice in response to the results of surveillance.
	2.3.13) Formulate strategies to promote and facilitate the review of clinical and non-clinical practice in response to results of audit.
28) Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	1.1.3) Incorporate wider public health issues into guidance and advice given.
	1.1.4) Incorporate relevant legislation, and national and local guidelines, into guidance and advice given.
	1.1.5) Assess the effect of international, national and local, social, political and professional trends on infection prevention and control practice.
	1.1.11) Synthesise the mechanisms of antimicrobial resistance into infection prevention and control policies.
	1.2.5) Incorporate environmental and public health issues when formulating local decontamination strategies.
	1.5.1) Synthesise relevant legislation and guidelines (of vaccination) into practice.
	2.3.5) Incorporate national guidelines and legal requirements into local standards.

Hong Kong	The United Kingdom (ICNA, 2004)
	4.2.5) Devise, review and update policies, procedures and standards for the organization to prevent and control infection, in collaboration with other experts and specialists.
29) Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	1.1.1) Critically evaluate information and research and synthesise knowledge to formulate advice on the prevention and control of infection.
	1.5.2) Support individuals in the safe management and administration of vaccines.
	1.5.3) Analyse indicators and contra-indications (of immunisation) and any special risk groups and take action accordingly.
	1.5.5) Distinguish adverse reactions (of vaccination) and take appropriate action.
	1.5.6) Design immunization programmes in collaboration with key stakeholders.
	2.3.4) Construct standards that are agreed, achievable, measurable, objective, research based and user-friendly.
Education	
31) Periodically assess the educational needs of clients.	3.2.1) Help others to identify learning needs in relation to infection prevention and control.
	3.2.2) Encourage and support others to make realistic self-assessments of their current level of knowledge in relation to infection prevention and control.
	3.2.5) Alert managers to resource issues which affect learning, development and performance.
32) Develop educational objectives and strategies to meet the client	2.4.1) Work collaboratively to support patient and public involvement

Hong Kong	The United Kingdom (ICNA, 2004)
needs.	mechanisms and initiatives.
	3.2.6) Formulate and implement teaching and learning strategies for the identified groups or individuals.
33) Collaborate in the development of educational programmes/ tools that related to infection prevention and control.	2.4.1) Work collaboratively to support patient and public involvement mechanisms and initiatives.
	3.2.3) Seek and gain access to learning opportunities for others and support them in applying theory to practice.
34) Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.	3.2.7) Use a variety of methods to deliver appropriate information effectively.
35) Evaluate the educational programmes/ tools that related to infection prevention and control.	3.2.8) Evaluate the effectiveness of strategies used to facilitate the learning of others.
36) Disseminate the findings of the infection prevention and control programmes to concerned clients.	2.3.12) Disseminate results (of audits) to relevant clinical and non-clinical staff in a timely manner.
	2.5.8) Produce logical, structured reports, appropriate in style and content for the intended reader.
37) Disseminate the recommendations of the infection prevention and control programmes to concerned clients.	2.3.12) Disseminate results (of audits) to relevant clinical and non-clinical staff in a timely manner.
38) Disseminate the policies of the infection prevention and control programmes to concerned clients.	4.2.4) In collaboration with other members of the ICT keep key stakeholders informed through agreed feedback mechanisms.
39) Continuously evaluate the effectiveness of educational programmes.	3.2.8) Evaluate the effectiveness of strategies used to facilitate the learning of others.
40) Continuously evaluate the learner outcomes of educational programmes.	3.2.8) Evaluate the effectiveness of strategies used to facilitate the learning of others.
Team and service management	
41) Share knowledge and skills with other team members and	3.2.4) Contribute to the development of a learning and development

Hong Kong	The United Kingdom (ICNA, 2004)
clients.	culture in the workplace.
	4.1.6) Build and maintain optimal relationships within the infection control team.
42) Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members	3.2.3) Seek and gain access to learning opportunities for others and support them in applying theory to practice.
43) Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	1.1.4) Incorporate relevant legislation, and national and local guidelines, into guidance and advice given.
	1.1.5) Assess the effect of international, national and local, social, political and professional trends on infection prevention and control practice.
	1.2.3) Devise and review policies and procedures that reflect knowledge of the principles of decontamination and incorporate legislation, and national and local guidelines and strategies into practice.
	1.3.8) Incorporate relevant legislation and guidance (microbiology).
	1.5.1) Synthesise relevant legislation and guidelines into practice (epidemiology).
	1.5.2) Support individuals in the safe management and administration of vaccines.
	2.5.3) Formulate the initiate strategies to reduce risk, taking into account relevant legislation and published guidelines.
44) Seek opportunities to influence policymakers.	1.7.2) Establish and maintain dialogue with key professional, both those who can use the results to inform practice and those who can provide expert advice and guidance.
45) Consider clinical outcomes when initiating changes in practice.	1.1.6) Undertake regular review and evaluation of the service and

Hong Kong	The United Kingdom (ICNA, 2004)
	initiate changes where appropriate
48) Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.	4.2.7) Support the organisation's procurement process in cost effective purchasing.
49) Identify opportunities for service improvement.	1.1.6) Undertake regular review and evaluation of the service and initiate changes where appropriate.
	1.9.2) Synthesise current population trends to inform decision making process a service development and provision to prevent and control infection.
	4.1.5) Seek active contribution to service development activities, e.g. commissioning new buildings, contracting services, e.g. cleaning contracts, laundry contracts.
	4.1.12) Actively listen in seeking to understand other's opinion and position in communication.
	4.1.13) Analyse situations, examining, exploring and seeking diverse perspectives openly to achieve mutual benefit.
	4.1.7) Manage change by synthesizing knowledge and expertise.
	4.1.8) Recognise and resolve conflict.
	4.1.9) Ensure that the service provided is confidential and non-judgmental.
	4.1.10) Formulate and sustain the vision for the strategy for infection prevention and control embedding it within the organization.

Hong Kong	The United Kingdom (ICNA, 2004)
	4.1.11) Seek co-operation and mutual benefit in interactions with others.
	4.1.15) Enable others to understand their contribution, communicate their views, take an active part in process, and challenge behaviours.
	4.1.16) Accept joint responsibility for any arising problems and tensions within the team and use this to inform future practice.
	4.2.10) Organise ongoing audit of the infection prevention and control service, amending service provision in response.
	4.2.11) Delegate responsibility and authority to people who are capable of delivering the required outcomes.
	4.2.12) Agree clear and explicit targets which are consistent with objectives, personnel and organizational.
	4.1.13) In collaboration with other members of the ICT and trust management, negotiate allocations for infection control programmes.
	4.2.14) Analyse problems and possible solutions whilst maintaining autonomy.
	4.2.15) Evaluate work at appropriate interval revising arrangements as necessary.
50) Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.	
51) Manage the expanded resources for infection prevention and control in the organization, e.g. infection control link systems.	
Collaboration and partnership	
52) Recruit other relevant parties to involve in the infection prevention and control programmes if necessary.	1.1.7) Acknowledge personal limitations and seek advice from others with specific expertise when necessary.

Hong Kong	The United Kingdom (ICNA, 2004)
	1.2.4) Seek advice where necessary from those with appropriate expertise in the testing, monitoring and validation of decontamination processes.
	1.5.4) Seek advice where necessary from those with appropriate expertise in the testing, monitoring and validation of decontamination processes.
	1.6.4) Investigate, manage, document and report outbreaks, seeking advice from others with appropriate expertise where necessary.
	1.6.6) Establish a network between local infection control and health protection teams to assist in the control of infectious diseases and formulate strategic plans where necessary.
	1.7.2) Establish and maintain dialogue with key professionals, both those who can use the results to inform practice and those who can provide expert advice and guidance.
	1.8.1) Collaborate effectively with, and is knowledgeable of, multi-agency emergency teams, playing a key role as the nursing resource of the team.
	1.8.3) Recognise the distinct roles in any healthcare emergency situation and supports them in managing the incident.
	1.8.4) Develop and sustain appropriate relationships, partnerships and networks to influence and improve health outcomes.
	2.3.2) Establish links with key professionals, both those who can use the results to inform practice and those who can provide expert advices and guidance.

Hong Kong	The United Kingdom (ICNA, 2004)
	2.5.5) Work collaboratively with individuals and organization to assess and manage infection risks.
	4.1.1) Work autonomously and seek collaborative relationship with others across and within professional boundaries.
	4.1.2) Establish and maintain professional networks within healthcare organizations.
53) Participate in inter-departmental and organization's infection prevention and control improvement activities.	1.4.4) Support Occupational Health department in exclusion of staff with infections and exclusion or redeployment of staff identified as susceptible to infection.
	1.1.9) Work collaboratively with multi-agencies to assess health needs and activities that can influence health of individuals.
	2.5.1) Support the organisation in the prevention and control of infection.
	4.2.7) Support the organisation's procurement process in cost effective purchasing.
	4.2.8) Co-ordinate and deliver a proactive and reactive service.
	4.2.9) Communicate effectively at all levels, using available resources and ensuring full documentation in line with the national bodies' standard for record keeping.
Outbreak investigation and control	
54) Recognize an outbreak through surveillance information and reporting channels.	1.3.1) Seek and interpret microbiological data to assist in the prevention and control of infection.
	1.7.5) Interpret results, identify trends and adverse events, and assess the relationship to benchmarks.

Hong Kong	The United Kingdom (ICNA, 2004)
	2.5.2) Devise key indicators to provide early warning of risk related to infection prevention and control.
	2.5.4) Distinguish level of risk present by individuals, equipment and the environment.
55) Assess the extent of outbreak situation.	1.6.4) Investigate, manage, document and report outbreaks, seeking advice from others with appropriate expertise where necessary.
	1.6.5) Seek, assemble and interpret epidemiological data obtained through local, national and international surveillance to assist in the investigation, prevention and control of infection.
56) Use epidemiological knowledge to identify the risk factors during outbreak situations.	1.6.4) Investigate, manage, document and report outbreaks, seeking advice from others with appropriate expertise where necessary.
	1.6.5) Seek, assemble and interpret epidemiological data obtained through local, national and international surveillance to assist in the investigation, prevention and control of infection.
	1.8.2) Analyse the range of effects of the incident on the population and respond effectively to minimise risk.
	1.8.7) Analyse the factors that contribute to the problem and agree priorities for action.
57) Collect the appropriate data during infection outbreak investigation.	1.6.4) Investigate, manage, document and report outbreaks, seeking advice from others with appropriate expertise where necessary.
	1.6.5) Seek, assemble and interpret epidemiological data obtained through local, national and international surveillance to assist in the investigation, prevention and control of infection.
58) Advise the control measures to the involved parties during outbreak situations.	1.3.4) Distinguish between modes of transmission of micro-organisms and recommend appropriate methods of control.

Hong Kong	The United Kingdom (ICNA, 2004)
59) Advise the investigations to the involved parties during outbreak situations.	1.3.2) Support staff in procedures for specimen collection.
	1.6.4) Investigate, manage, document and report outbreaks, seeking advice from others with appropriate expertise where necessary.
60) Evaluate the effectiveness of the control measures during outbreak situations.	1.3.7) Review microbiological data to evaluate the efficacy of interventions.
	1.8.8) Critically evaluate performance under pressure and acknowledge limitations.
	1.8.9) Investigate with others, critical incidents and service failures, revise plans and update as appropriate to current information.
61) Share the findings of outbreak investigation to the relevant parties.	1.6.4) Investigate, manage, document and report outbreaks, seeking advice from others with appropriate expertise where necessary.
	1.8.10) Synthesise lessons learned into future practice and service development.
Research and development	
62) Critically review the related research.	2.1.2) Adopt a critical approach to the review of published literature.
	2.1.3) Select relevant published literature.
	2.1.5) Critically evaluate the reliability, validity and application to practice of the published literature.
	2.1.6) Integrate theoretical understanding with practical experience when determining and reflecting on professional practice.
63) Incorporate the relevant published research findings into practice, including when providing consultation service.	2.1.6) Integrate theoretical understanding with practical experience when determining and reflecting on professional practice.
	2.2.6) Critically interpret data and formulate proposal for action.
64) Incorporate the relevant published research findings into education.	2.2.7) Communicate research findings effectively in both verbal and non-verbal forms.

Hong Kong	The United Kingdom (ICNA, 2004)
65) Share findings with other infection control practitioners from surveillance and other infection prevention and control activities.	4.2.4) In collaboration with other members of the ICT keep key stakeholders informed through agreed feedback mechanisms.
66) Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control.	2.1.4) Differentiate between different research methodologies and choose correct method to achieve objectives.
	2.2.1) Identify research opportunities and formulate appropriate research questions.
	2.2.2) Access key personnel and sources of data to facilitate the research process.
	2.2.3) Appraise personal and organizational limitations in respect of ability to undertake research.
	2.2.4) Construct an appropriate proposal to address the research question, which takes into account ethical consideration.
	2.2.5) Define the data required, systems for collection and methods of analysis.
	2.2.6) Critically interpret data and formulate proposal for action.
67) Publish or present the participated research findings to contribute in advancing the field of infection prevention and control.	2.2.7) Communicate research findings effectively in both verbal and non-verbal forms.
Expert knowledge	

Hong Kong	The United Kingdom (ICNA, 2004)
68) Demonstrate knowledge in areas of patient care practices.	1.3.5) Assess patients, staff, visitors and relatives, environments and situations to estimate the risk of transfer of micro-organisms and the likely consequences of such transfer.
	1.3.6) Select and initiate appropriate actions to minimize the risk of transmission of infectious agents.
	1.4.3) Plan, advise and initiate appropriate patient care and other actions, taking immune status into account to minimize the risk of infection.
69) Demonstrate knowledge of microbiology.	1.3.1) Seek and interpret microbiological data to assist in the prevention and control of infection.
	1.3.2) Support staff in procedures for specimen collection.
70) Demonstrate knowledge of asepsis.	1.2) Application of the principles of cleaning, disinfection and sterilization to maintain safety of patients and healthcare staff
71) Demonstrate knowledge of decontamination.	1.2.1) Evaluate the level of risk of transmission of infection by individuals, medical devices and environments.
	1.2.2) Support staff in choosing appropriate methods of decontamination depending on the risk of transmission of infection.
	1.2.6) Support staff and organization on appropriate use of reusable, 'single use' and 'single patient use' medical devices.
72) Demonstrate knowledge of educational skills and tactics.	3.2) Use of effective strategies to help others learn about infection prevention and control.
73) Demonstrate knowledge of educational methodologies.	3.2) Use of effective strategies to help others learn about infection prevention and control.
74) Demonstrate knowledge of infectious diseases.	1.3.3) Assess the clinical relevance of microbiological information to patients' well and advise accordingly.

Hong Kong	The United Kingdom (ICNA, 2004)
	1.3.4) Distinguish between mode of transmission of micro-organisms and recommend appropriate methods of control.
	1.3.5) Assess patients, staff, visitors and relatives, environments and situations to estimate the risk of transfer of micro-organisms and the likely consequences of such transfer.
	1.4.1) Seek out and interpret immunological information to inform advice as necessary.
	1.4.2) Assess the susceptibility of individual patients, clients, staff members, relatives and others to infection.
	1.4.3) Plan, advise and initiate appropriate patient care and other actions, taking immune status into account to minimize the risk of infection.
75) Demonstrate knowledge of communication skills.	1.8.5) Communicate calmly and effectively with the multi-agency team.
	1.8.6) Champions the nursing contribution and distinguish roles of others.
	4.1.14) Recognise, communicate and reward the achievements of the team and individuals within the team and wider organization, e.g. link groups.
76) Demonstrate knowledge of programme administration.	4.2) Adopts a co-ordinated approach to ensure the service is managed effectively.
77) Demonstrate knowledge of epidemiology.	1.6.1) Use relevant information technology to collect and interpret surveillance data
	1.6.2) Assess the suitability of surveillance methods, techniques and commercially available packages, and selects the most appropriate

Hong Kong	The United Kingdom (ICNA, 2004)
	based on evaluation of situation and circumstances.
	1.6.3) Analyse epidemiological data and knowledge to formulate action plans relevant to local needs and inform future practice, and evaluate effectiveness of interventions.
	1.6.5) Seek, assemble and interpret epidemiological data obtained through local, national and international surveillance to assist in the investigation, prevention and control of infection.
78) Demonstrate knowledge of biostatistics.	2.2.5) Define the data required, systems for collection and methods of analysis
	2.2.6) Critically interpret data and formulate proposal for action.
80) Act as expert resource in infection prevention and control in clinical and organizational level.	2.5.7) Act as an expert resource in response to incidents, complaints and claims.
	4.1.3) Act as an expert resource in infection prevention and control at a clinical and organizational level.
Continuing education and professional development	
82) Advance the relevant knowledge and skills through educational programmes, peer networking, internet access, published literature, and/ or professional meetings.	2.1.1) Access a full range of resources to search the literature for relevant information to maintain and expand specialist knowledge.
	3.1.1) Fulfil The Professional Bodies' requirements for acting as a teacher and mentor.
	3.1.2) Use reflection to formulate and prioritise strategies for self development.
	3.1.3) Analyses own competence, analyses deficits and recognizes own strengths and limitations.
	3.1.4) Maintain a portfolio of evidence relating to own personal professional development.

Hong Kong	The United Kingdom (ICNA, 2004)
	3.1.5) Make effective use of learning opportunities within and outside the workplace.
	3.1.6) Update existing knowledge and skills in relation to worn role in the prevention and control of infection.
	3.1.7) Integrate own learning to the future development of infection prevention and control to meet the needs of the individual and the organization.
	3.1.8) Seek opportunities for development and devise personal objectives for own professional development.
83) Advance the field of infection prevention and control through the involvement of related research.	2.2.7) Communicate research findings effectively in both verbal and non-verbal forms.
Patient and public involvement (PPI)	
	2.4.1) Work collaboratively to support PPI mechanisms and initiatives.
	2.4.2) Support PPI forums.
	2.4.3) Create information resources and seek the views of patients/ public.
	2.4.4) Evaluate information resources in collaboration with patient/ public.
	2.4.5) Actively seek feedback from patients/ public in relation to their experience of infection and act on that information.
	2.4.6) Work collaboratively with the media officer/ communications department to promote infection prevention and control.

Difference between two competencies for infection control practices

Reference:
Infection Control Nurses Association. (2004). Core Competencies for Practitioners in Infection Prevention and Control (2nd Edition). Retrieved 4 September 2011 at http://www.ips.uk.net/icna/Admin/uploads/Competencies2ndeditionpdf.pdf

Appendix 9- 24: Major differences of 2008 APIC/ CHICA-Canada infection prevention, control and epidemiology: Professional and practice standards compared with 1999 version

Categories	**Items compared with 1999 version**
Professional accountability	More details than 1999 version
Qualification	● "experienced healthcare professional with a health sciences background" replaced "has a baccalaureate degree"
Professional development	● Tightened the completion of basic infection control training from 12 months to 6 months after joining the profession ● Knowledge area was moved here from "qualification" ● Specified "outbreak management" is included in the knowledge of "epidemiology" ● Extended the knowledge on " adult education" to "learning/ education principles" Additionally required to demonstrate the knowledge on occupational health, emergency preparedness, product evaluation, information technology, legislative issues/ policy making and research
Leadership	Added the followings: ● Provides direction and works collaboratively with others ● Mentors less experienced healthcare providers/ ancillary personnel ● Collaborates and/ or educates self with regard to the global infection prevention and control community
Ethics	More details than the 1999 version
Infection prevention and control practice	Added "Ensures that findings, recommendations, and policies of the programme are disseminated to appropriate groups or individuals"
Epidemiology	Similar to 1999 version

Categories	Items compared with 1999 version
Surveillance	Followings were added ● Integrates pertinent regulatory requirements ● Utilized information technology and systems applications ● Ensures requirements for communicable disease reporting are met
Education	Followings were added ● Utilizes learning principles appropriate to the target audience ● Utilizes appropriate information technology in educational design and delivery
Consultation	Followings were added: ● "patients/ families" were the included parties to support ● provides input into patient safety and healthcare quality initiatives ● collaborates with community health organization
Performance improvement	Followings were added: ● directs the organization's infection prevention and control improvement activities ● utilizes established measurement tools and techniques, e.g. outbreak investigation, root cause analysis, brainstorming and others
Programme administration and evaluation	Category modified from "programme management and evaluation" and added "assures that customer needs/ expectations are considered in the development and continuous improvement of processes, products and services
Fiscal responsibility	Similar with 1999 version with adjustment in wordings and item combination
Research	Removed "incorporates cost analysis into infection prevention and control research when possible"

Categories	Items compared with 1999 version
Occupational health	New category with the following indicators: ● participates in development/ review of occupational health policies and procedures related to infection prevention and control ● assists in the development of an immunization programme ● consults on post-exposure protocols and activities related to communicable diseases

References:

Friedman C, Curchoe R, Foster M, Hirji Z, Krystofiak S, Lark RL, Laxson L, Ruppert MJ, Spaulding L. (2008). APIC/CHICA-Canada infection prevention, control, and epidemiology: Professional and practice standards. America Journal of Infection Control, 36(6), 385-389.

Horan-Murphy E, Barnard B, Chenoweth C, Friedman C, Hazuka B, Russell B, Foster M, Goldman C, Bullock P, Docken L & McDonald L. APIC/CHICA-Canada infection control and epidemiology: Professional and practice standards. American Journal of Infection Control, 27(1), 47-51.

Appendix 9- 25: Comparison of core competency/ professional and practice standards for infection control practices (Hong Kong vs. North America)

Hong Kong	**North America (Friedman et al., 2008)**
Surveillance (including data management)	
1) Design a surveillance plan for the served population(s) using epidemiological principles.	Develop a surveillance plan based on the population(s) served, services provided and previous surveillance data
	Integrate pertinent regulatory requirements into surveillance design
2) Use standardized definitions to conduct surveillance.	Use standardize definitions for identification and classification of events, indicators or outcomes
	Use epidemiologic principles to conduct surveillance
3) Select appropriate indicators to monitor internal trend of infection.	Select indicators for surveillance
4) Select appropriate indicators to benchmark externally.	
5) Select a database(s) that matches internal/ external data structure of surveillance.	Utilize information technology and systems applications
7) Select a database(s) that ensures accurate data management for surveillance.	
8) Analyze surveillance data by appropriate statistical techniques.	Employ statistical techniques to describe the data, calculate risk-adjusted rates and benchmark
9) Critically evaluate significance of findings of surveillance.	Critically evaluate significance of findings
	Use epidemiologic principles to conduct surveillance and investigations
10) Report the surveillance findings to appropriate clients.	Reports epidemiologically significant findings to appropriate customers

Hong Kong	**North America (Friedman et al., 2008)**
12) Periodically evaluate the effectiveness of the surveillance plan and modify as necessary.	Periodically evaluate the effectiveness of the surveillance plan and modify as necessary
	Make recommendation for improvement based on surveillance findings
Programme management and evaluation	
13) Develop the programme plan with measurable outcomes.	Develop the programme goals and objectives
14) Periodically, e.g. annually, review the programme.	review the effectiveness of the programme goals and objectives
15) Assess the client needs on infection prevention and control programme during planning.	Assure that customer needs/ expectations are considered in the development and continuous improvement of processes, products and services
16) Incorporate the client needs into the programme plan.	
17) Recommend appropriate resources for the proposed programme plan.	Determine resource needs to accomplish the proposed goals and objectives
18) Communicate with clients on the objectives of the programme.	Provide knowledge on the function, role and value of the programme to customers
19) Communicate with clients on the value of the programme.	
20) Communicate the necessary resources to administration/ management	Communicate resource needs to administration based on goals and objectives
21) Modify the programme plan if needed after communicating the necessary resources to administration/ management.	review the effectiveness of the programme goals and objectives
22) Periodically evaluate the effectiveness of the infection prevention and control programme.	review the effectiveness of the programme goals and objectives
23) Integrate the evaluated findings during modification of the programme.	Develop the programme goals and objectives
24) Evaluate client needs after implementing the infection prevention and control programme.	Assure that customer needs/ expectations are considered in the development and continuous improvement of processes, products and services

Hong Kong	North America (Friedman et al., 2008)
25) Evaluate client satisfaction after implementing the infection prevention and control programme.	Assure that customer needs/ expectations are considered in the development and continuous improvement of processes, products and services
26) Modify the infection prevention and control programmes according to the evaluated client needs and satisfaction.	Assure that customer needs/ expectations are considered in the development and continuous improvement of processes, products and services
Evidence based practice	
27) Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	Integrate surveillance findings into formal plans for improvement of practice and patient outcomes in various healthcare settings
28) Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	Integrate pertinent regulatory requirements, accreditation standards and guidelines into practice, policies and procedures
	Incorporate research findings into practice and/ or consultation
29) Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	Develop and implement policies and procedures based on currently accepted infection prevention and control best practices
Evidence based practice (occupational health)	
	Participate in development/ review of occupational health policies and procedures related to infection prevention and control
	Assist in the development of an immunization programme
	Consult on post-exposure protocols and activities related to communicable diseases
Education	
31) Periodically assess the educational needs of clients.	Assess the needs of customers and develop educational objectives and

Hong Kong	North America (Friedman et al., 2008)
32) Develop educational objectives and strategies to meet the client needs.	strategies to meet hose needs
33) Collaborate in the development of educational programmes/ tools that related to infection prevention and control.	Utilize appropriate information technology in educational design Collaborate in the development of educational programmes and/ or tools that related to infection prevention, control and epidemiology
34) Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.	Utilize appropriate information technology in educational delivery Collaborate in the delivery of educational programmes that related to infection prevention, control and epidemiology
35) Evaluate the educational programmes/ tools that related to infection prevention and control.	
36) Disseminate the findings of the infection prevention and control programmes to concerned clients.	Ensure that findings of the programme are disseminated to appropriate groups or individuals
37) Disseminate the recommendations of the infection prevention and control programmes to concerned clients.	Ensure that recommendations of the programme are disseminated to appropriate groups or individuals
38) Disseminate the policies of the infection prevention and control programmes to concerned clients.	Ensure that policies of the programme are disseminated to appropriate groups or individuals
39) Continuously evaluate the effectiveness of educational programmes.	Evaluate the effectiveness of educational programmes
40) Continuously evaluate the learner outcomes of educational programmes.	Evaluate the effectiveness of learner outcomes
Team and service management	
41) Share knowledge and skills with other team members and clients.	Share knowledge and expertise
42) Facilitate conducting research related to infection prevention and control in workplace, e.g. encourage and support team members	Recognize and support the importance of research in shaping the practice of infection prevention, control and epidemiology

Hong Kong	**North America (Friedman et al., 2008)**
43) Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	Review, analyse and implement regulations, standards and/ or guidelines of applicable governmental agencies and professional organizations
	Integrate pertinent regulatory requirements, accreditation standards and guidelines into practice, policies and procedures
	Integrate relevant local national and global public health issues into practice
44) Seek opportunities to influence policymakers.	Seek opportunities to influence and educate policy making bodies
45) Consider clinical outcomes when initiating changes in practice.	Consider safety, and clinical outcomes when making recommendations, evaluating technology and products and developing policies and procedures
48) Integrate relevant cost information into the analysis of findings and recommendations, including document cost saving in the organization through infection prevention and control programmes activities, if any.	Incorporate fiscal assessments into programme evaluation and/ or reports, as applicable
49) Identify opportunities for service improvement.	Identify opportunities for improvement based on observations, process and outcome indicators and other findings
	Provide direction with others
	Seek opportunities to influence and educate the public
Team and service management (quality management)	
	Act as a change agent of change and participate in the change process

Hong Kong	North America (Friedman et al., 2008)
	Utilize established measurement tools and techniques, e.g. outbreak investigation, root cause analysis, brainstorming and others
	Contribute epidemiologic skills to improvement processes
Use of link person system	
50) Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.	
51) Manage the expanded resources for infection prevention and control in the organization, e.g. infection control link systems.	
Collaboration and partnership	
52) Recruit other relevant parties to involve in the infection prevention and control programmes if necessary.	Work collaboratively with others
53) Participate in inter-departmental and organization's infection prevention and control improvement activities.	Work collaboratively with others
	Collaborate with community health organizations
Outbreak investigation and control	
54) Recognize an outbreak through surveillance information and reporting channels.	
55) Assess the extent of outbreak situation.	
56) Use epidemiological knowledge to identify the risk factors during outbreak situations.	
57) Collect the appropriate data during infection outbreak investigation.	
58) Advise the control measures to the involved parties during outbreak situations.	

Hong Kong	**North America (Friedman et al., 2008)**
59) Advise the investigations to the involved parties during outbreak situations.	
60) Evaluate the effectiveness of the control measures during outbreak situations.	
Research and development	
61) Share the findings of outbreak investigation to the relevant parties.	Organize and share findings from outbreak investigations
62) Critically review the related research.	Critically evaluate published research and incorporate appropriate findings
63) Incorporate the relevant published research findings into practice, including when providing consultation service.	Analyse and apply pertinent information from current scientific literature and publications
64) Incorporate the relevant published research findings into education.	Incorporate and disseminate research findings into practice education, and/ or consultation
65) Share findings with other infection control practitioners from surveillance and other infection prevention and control activities.	Organize and share findings from surveillance activities and/ or outbreak investigations
66) Participate in infection prevention and control-related research to contribute in advancing the field of infection prevention and control.	Participate in infection prevention and control –related research independently or collaboratively
67) Publish or present the participated research findings to contribute in advancing the field of infection prevention and control.	Publish or present research findings to assist in advancing the field of infection prevention, control and epidemiology
	Incorporate with other professional organizations and academic entities to further the prevention of infection
	Incorporate cost analysis into infection prevention and control research when possible

Hong Kong	North America (Friedman et al., 2008)
Expert knowledge	
68) Demonstrate knowledge in areas of patient care practices.	Demonstrate knowledge of patient care practices
69) Demonstrate knowledge of microbiology.	Demonstrate knowledge of microbiology
70) Demonstrate knowledge of asepsis.	Demonstrate knowledge of asepsis
71) Demonstrate knowledge of decontamination.	Demonstrate knowledge of disinfection/ sterilization
72) Demonstrate knowledge of educational skills and tactics.	Demonstrate knowledge of learning/ education principles
73) Demonstrate knowledge of educational methodologies.	
74) Demonstrate knowledge of infectious diseases.	Demonstrate knowledge of infectious diseases
75) Demonstrate knowledge of communication skills.	Demonstrate knowledge of communication
76) Demonstrate knowledge of programme administration.	Demonstrate knowledge of programme administration
77) Demonstrate knowledge of epidemiology.	Demonstrate knowledge of epidemiology, including outbreak management
78) Demonstrate knowledge of biostatistics.	
80) Act as expert resource in infection prevention and control in clinical and organizational level.	Support patients/ families, administration, committees, healthcare providers and ancillary staff in infection prevention , control and epidemiology
	Provide input into patient safety and healthcare quality initiatives
	Direct the organization’s infection prevention and control improvement strategies
	Demonstrate knowledge of facility planning/ construction
	Demonstrate knowledge of occupational health
	Demonstrate knowledge of emergency preparedness
	Demonstrate knowledge of product evaluation
	Demonstrate knowledge of information technology

Hong Kong	**North America (Friedman et al., 2008)**
	Demonstrate knowledge of legislative issues/ policy making
	Demonstrate knowledge of research
Continuing education and professional development	
82) Advance the relevant knowledge and skills through educational programmes, peer networking, internet access, published literature, and/ or professional meetings.	Participates in professional organizations and networking opportunities
	Maintains current knowledge and functions well with electronic media, e.g. computers and handheld devices, with which to communicate in the IPC environment
	Collaborates and/ or educates self with regard to the global infection prevention and control community
	Stay current with developments in infection prevention, control and epidemiology
83) Advance the field of infection prevention and control through the involvement of related research.	
Financial management	
	Consider financial implications when making recommendations, evaluating technology and products and developing policies and procedures
	Develop and maintain a departmental budget, as appropriate

Difference between two competencies/ standards for infection control practices

Reference:

Friedman C, Curchoe R, Foster M, Hirji Z, Krystofiak S, Lark RL, Laxson L, Ruppert MJ, Spaulding L. (2008). APIC/CHICA-Canada infection prevention, control, and epidemiology: Professional and practice standards. America Journal of Infection Control, 36(6), 385-389.

Appendix 10- 1: Six experts' replies of Phase Three questionnaire

Expert	Cut-off rank (the most essential items)	Justifications and other comments
ICO_A	Rank 17/ 18 (25 items)	The most essential core competency items cannot be too many but they should be possessed by each and every functional ICN specialist; There are inextricably some overlapping among the items in different ranks, e.g. "demonstrate knowledge of infectious diseases" and demonstrate knowledge of microbiology", "advise the control measures to the involved parties during outbreak situation" and "share the findings of outbreak investigation to the relevant parties". Items ranked below 17 are, in my opinion, mostly team competency, rather than individual ability markers; More importantly, an objective measurement system should be established on the competency items for certification purpose. My previous comments are still applicable; Those features from rank number 18 and below, though not regarded as essential but still are desirable elements for a specialist ICN.
ICO_B	Rank 16/ 17 (23 items)	I am not sure how you define the specialist, all working ICNs or only those senior or in charge? I suppose this exercise is for all ICNs, not just the senior. Therefore, I would consider those elements that all ICNs must master as "essential". The others are important, but may not be essential for all ICNs. For those senior or in charge, some elements outside [ranks] 1-7 may also be "essential". I have tried to include those elements that a senior should have, however, I find that the described items are too specific and many items that are in same category fall in different ranking and it is very difficult to draw a line on them. Accepted till rank 16 after defined ICN specialist.
ICO_C	Rank 11/ 12 (13 items)	It's not easy to draw a cut-off line because some of the items that I consider important were placed in the last. I agree with most of you that the knowledge of infectious disease and outbreak investigation/ control should be the top priority. However, scientific basis of research and application of biostatistics is also important in managing the outbreak (which is listed in 40 and 41). For instance, when the outbreak of intestinal mucomycosis occurred at QMH in Jan 2009, the first step for us is to review the literature in order to get ourselves familiar with this rare disease, and the finding in literature review can definitely help us to plan our further investigation. When we measure the incidence of MRSA or MRAB in the clinical unit, basic knowledge of biostatistics is required to compare if there is any significant change over time.
ICN_D	Rank 29/ 30 (57 items)	I consider operational and knowledge competency is more important.
ICN_E	-	I find the list [is] too detailed. Many [competency items] are basic knowledge that a general nurse should know. One way to handle it is to aggregate by subject group [to separate them according to subject group]. I find it hard to separate the preferred or essential.

Expert	Cut-off rank (the most essential items)	Justifications and other comments
ICN_F	-	In my opinion, I would like to cut [out] the [ranks] 24-37 and keep the [ranks] 38 to 41. The first 2 pages [from rank 1 to rank 23] should be kept as it is the core business of the ICN such as outbreak management, educational skills and surveillance. For [ranks] 38 to 41, it is also the essential role that an ICN to review research with biostatistics knowledge.

Appendix 10- 2: Rescaled item measures for 76 items and 76 persons

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
1	348	75	99.68	6.39	1.17	1.1	1.02	.3	.46	68.0	76.4	74
45	347	75	97.86	6.35	1.23	1.5	1.07	.3	.50	73.3	75.9	57
22	344	75	92.53	6.25	1.22	1.5	1.04	.3	.55	73.3	75.3	60
16	340	75	85.64	6.16	1.11	.8	1.11	.4	.56	69.3	74.6	2
75	339	75	83.94	6.15	1.17	1.1	1.04	.3	.52	69.3	74.5	58
62	333	75	73.86	6.11	.70	-2.0	.57	-1.1	.67	81.3	74.9	55
25	332	75	72.18	6.11	1.18	1.1	3.30	3.8	.55	72.0	75.1	71
61	332	75	72.18	6.11	.94	-.3	.84	-.3	.64	76.0	75.1	54
29	331	75	70.51	6.11	1.21	1.2	1.19	.6	.57	69.3	75.3	70
2	330	75	68.84	6.11	.81	-1.2	.73	-.7	.63	76.0	75.5	20
24	329	75	67.16	6.11	.70	-1.9	.58	-1.2	.72	80.0	75.7	43
36	329	75	67.16	6.11	1.01	.1	1.01	.2	.66	72.0	75.7	75
13	324	74	66.26	6.18	1.25	1.4	2.96	3.7	.49	68.9	76.2	68
48	328	75	65.49	6.12	.83	-1.0	.73	-.7	.63	82.7	76.1	61
18	326	75	62.13	6.12	1.02	.2	1.00	.1	.60	74.7	76.8	15
79	326	75	62.13	6.12	.82	-1.0	.67	-1.0	.72	82.7	76.8	59
10	325	75	60.45	6.12	.96	-.2	.91	-.2	.61	76.0	77.1	27
15	325	75	60.45	6.12	1.14	.8	1.20	.7	.61	73.3	77.1	50
70	325	75	60.45	6.12	.66	-2.1	.55	-1.5	.71	84.0	77.1	29
57	324	75	58.77	6.12	.91	-.5	.83	-.4	.71	85.3	77.3	56
7	323	75	57.09	6.13	1.09	.5	1.18	.7	.59	74.7	77.5	77
44	323	75	57.09	6.13	1.00	.0	1.06	.3	.67	74.7	77.5	38
52	323	75	57.09	6.13	1.20	1.1	1.33	1.1	.58	69.3	77.5	72
19	322	75	55.41	6.12	1.06	.4	1.17	.6	.65	76.0	77.6	32
50	322	75	55.41	6.12	.77	-1.3	.71	-1.0	.73	86.7	77.6	80
32	321	75	53.73	6.12	1.04	.3	.93	-.1	.66	80.0	77.7	41
53	321	75	53.73	6.12	.69	-1.8	.61	-1.4	.73	84.0	77.7	22
76	321	75	53.73	6.12	.83	-.9	.75	-.8	.71	78.7	77.7	45
6	320	75	52.05	6.12	1.31	1.6	1.23	.8	.62	70.7	77.8	49
23	320	75	52.05	6.12	.53	-2.9	.49	-2.1	.76	90.7	77.8	33
26	320	75	52.05	6.12	.85	-.8	.76	-.8	.72	82.7	77.8	28
31	320	75	52.05	6.12	.99	.0	.94	-.1	.65	77.3	77.8	24
39	320	75	52.05	6.12	1.10	.6	1.17	.6	.63	77.3	77.8	10
78	320	75	52.05	6.12	.95	-.2	.85	-.4	.67	74.7	77.8	3
14	315	74	50.80	6.17	.86	-.7	.81	-.6	.67	82.4	77.9	34
35	318	75	48.70	6.11	.91	-.4	.79	-.7	.72	81.3	77.9	82
83	318	75	48.70	6.11	.67	-1.9	.63	-1.4	.70	86.7	77.9	35
49	317	75	47.03	6.10	1.25	1.3	1.14	.6	.67	78.7	77.9	8
20	316	75	45.37	6.09	1.26	1.3	1.17	.7	.59	73.3	77.8	16
60	316	75	45.37	6.09	.77	-1.2	.68	-1.2	.75	82.7	77.8	51
69	316	75	45.37	6.09	.60	-2.3	.52	-2.1	.74	88.0	77.8	53
72	316	75	45.37	6.09	.69	-1.7	.76	-.9	.74	85.3	77.8	9
82	315	75	43.71	6.08	.65	-2.0	.68	-1.3	.73	85.3	77.7	37
21	314	75	42.06	6.06	1.39	1.9	1.33	1.2	.56	68.0	77.6	69
17	313	75	40.41	6.05	1.33	1.6	1.38	1.4	.67	69.3	77.5	63
55	313	75	40.41	6.05	.66	-1.9	.66	-1.4	.72	85.3	77.5	36
68	313	75	40.41	6.05	.70	-1.7	.61	-1.7	.72	82.7	77.5	65
77	313	75	40.41	6.05	.91	-.4	.87	-.5	.70	77.3	77.5	13
33	312	75	38.78	6.03	1.27	1.4	1.28	1.1	.68	74.7	77.4	44
34	312	75	38.78	6.03	.77	-1.2	.67	-1.4	.74	84.0	77.4	4
42	312	75	38.78	6.03	.48	-3.3	.42	-2.9	.82	92.0	77.4	12
27	311	75	37.16	6.01	.66	-1.9	.63	-1.6	.72	85.3	77.3	14
30	311	75	37.16	6.01	1.33	1.6	1.34	1.3	.53	69.3	77.3	25
51	311	75	37.16	6.01	1.05	.3	1.00	.1	.66	85.3	77.3	26
9	310	75	35.54	5.99	.67	-1.9	.61	-1.7	.72	85.3	77.0	23
28	310	75	35.54	5.99	.81	-1.0	.79	-.8	.67	82.7	77.0	18
81	310	75	35.54	5.99	.61	-2.3	.56	-2.0	.74	88.0	77.0	39
4	309	75	33.94	5.97	1.04	.3	.96	-.1	.69	78.7	76.8	64
41	309	75	33.94	5.97	.78	-1.2	.69	-1.3	.70	77.3	76.8	42
74	308	75	32.35	5.94	1.04	.3	1.04	.3	.68	74.7	76.5	7
54	307	75	30.77	5.92	.72	-1.5	.65	-1.6	.69	84.0	76.3	40

ENTRY NUMBER	RAW SCORE	COUNT	MEASURE	MODEL S.E.	INFIT MNSQ	INFIT ZSTD	OUTFIT MNSQ	OUTFIT ZSTD	PTMEA CORR.	EXACT MATCH OBS%	EXACT MATCH EXP%	Item
67	302	74	29.41	5.93	.91	-.4	.86	-.5	.67	74.3	75.9	66
65	306	75	29.21	5.89	.70	-1.7	.66	-1.6	.73	78.7	75.9	21
37	305	75	27.66	5.87	.84	-.8	.78	-.9	.73	80.0	75.6	1
38	303	75	24.61	5.81	.56	-2.8	.49	-2.7	.75	82.7	74.9	17
58	303	75	24.61	5.81	1.02	.2	1.02	.2	.64	76.0	74.9	48
71	303	75	24.61	5.81	.85	-.8	.83	-.7	.71	77.3	74.9	83
46	302	75	23.10	5.78	1.32	1.7	1.75	2.8	.54	64.0	74.5	67
64	302	75	23.10	5.78	1.22	1.2	1.15	.7	.63	66.7	74.5	52
47	299	75	18.67	5.70	1.01	.1	.94	-.2	.71	77.3	73.7	76
56	298	75	17.22	5.67	1.05	.4	1.03	.2	.69	74.7	73.4	73
43	294	74	17.21	5.70	.83	-.9	.83	-.8	.74	73.0	73.2	5
3	296	75	14.37	5.62	1.31	1.7	1.39	1.7	.68	69.3	72.8	31
8	296	75	14.37	5.62	1.25	1.4	1.37	1.7	.63	66.7	72.8	19
66	296	75	14.37	5.62	.82	-1.1	.81	-.9	.74	74.7	72.8	62
80	289	75	4.79	5.44	1.17	1.0	1.23	1.2	.64	65.3	70.3	78
MEAN	316.7	74.9	47.37	6.03	.95	-.3	.97	-.2		77.5	76.4	
S.D.	12.2	.2	19.82	.17	.23	1.3	.45	1.3		6.5	1.6	

Appendix 10- 3: 35-item critical competency (safety margin as shaded)

Item	Rank	Description	Importance level (logit)
74	1	Demonstrate knowledge of infectious diseases.	-2.36
57	2	Collect the appropriate data during infection outbreak investigation.	-2.28
60	3	Evaluate the effectiveness of the control measures during outbreak situations.	-2.04
2	4	Use standardized definitions to conduct surveillance.	-1.73
58	5	Advise the control measures to the involved parties during outbreak situations.	-1.65
55	6	Assess the extent of outbreak situation.	-1.20
71	7	Demonstrate knowledge of decontamination.	-1.12
54	7	Recognize an outbreak through surveillance information and reporting channels.	-1.12
70	8	Demonstrate knowledge of asepsis.	-1.05
20	9	Communicate the necessary resources to administration/ management.	-0.97
43	10	Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	-0.90
75	10	Demonstrate knowledge of communication skills.	-0.90
68	11	Demonstrate knowledge in areas of patient care practices.	-0.86
61	12	Share the findings of outbreak investigation to the relevant parties.	-0.82
15	13	Assess the client needs on the infection prevention and control programme during planning.	-0.67
59	13	Advise the investigation to the involved parties during outbreak situations.	-0.67
27	14	Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	-0.60
50	14	Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.	-0.60
29	14	Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	-0.60
56	15	Use epidemiological knowledge to identify the risk factors during outbreak situations.	-0.52
77	16	Demonstrate knowledge of epidemiology.	-0.45
38	16	Disseminate the policies of the infection prevention and control programmes to concerned clients.	-0.45
72	16	Demonstrate knowledge of educational skills and tactics.	-0.45
32	17	Develop educational objectives and strategies to meet the client needs.	-0.37
80	17	Act as expert resource in infection prevention and control in clinical and organizational level.	-0.37
41	18	Share knowledge and skills with other team members and clients.	-0.30
22	18	Periodically evaluate the effectiveness of the infection prevention and control programme.	-0.30
45	18	Consider clinical outcomes when initiating changes in practice.	-0.30
49	19	Identify opportunities for service improvement.	-0.22
33	19	Collaborate in the development of educational programmes/ tools that related to infection prevention and control.	-0.22
28	19	Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	-0.22
24	19	Evaluate client needs after implementing the infection prevention and control programme.	-0.22

Item	Rank	Description	Importance level (logit)
10	19	Report the surveillance findings to appropriate clients.	-0.22
3	19	Select appropriate indicators to monitor internal trend of infection.	-0.22
34	20	Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.	-0.17

Appendix 10- 4: Critical competency items defined in the certification programme for infection control nurses of Hong Kong

Core Competency items in category
Surveillance
2) Use standardized definitions to conduct surveillance.
3) Select appropriate indicators to monitor internal trend of infection.
10) Report the surveillance findings to appropriate clients.
Programme management and evaluation
15) Assess the client needs on infection prevention and control programme during planning.
20) Communicate the necessary resources to administration/ management,
22) Periodically evaluate the effectiveness of the infection prevention and control programme.
24) Evaluate client needs after implementing the infection prevention and control programme.
Evidence based practice
27) Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.
28) Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.
29) Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.
Education
32) Develop educational objectives and strategies to meet the client needs.
33) Collaborate in the development of educational programmes/ tools that related to infection prevention and control.
34) Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.
38) Disseminate the policies of the infection prevention and control programmes to concerned clients.
Team and service management
41) Share knowledge and skills with other team members and clients.
43) Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.
45) Consider clinical outcomes when initiating changes in practice.
49) Identify opportunities for service improvement.
50) Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.
Outbreak investigation and control
54) Recognize an outbreak through surveillance information and reporting channels.
55) Assess the extent of outbreak situation.
56) Use epidemiological knowledge to identify the risk factors during outbreak situations.
57) Collect the appropriate data during infection outbreak investigation.
58) Advise the control measures to the involved parties during outbreak situations.
59) Advise the investigations to the involved parties during outbreak situations.
60) Evaluate the effectiveness of the control measures during outbreak situations.
61) Share the findings of outbreak investigation to the relevant parties.

Core Competency items in category
Expert knowledge
68) Demonstrate knowledge in areas of patient care practices.
70) Demonstrate knowledge of asepsis.
71) Demonstrate knowledge of decontamination.
72) Demonstrate knowledge of educational skills and tactics.
74) Demonstrate knowledge of infectious diseases.
75) Demonstrate knowledge of communication skills.
77) Demonstrate knowledge of epidemiology.
80) Act as expert resource in infection prevention and control in clinical and organizational level.

Appendix 10- 5: Weight calculation for 35 essential core competency items

Item	Description	Item Measure		Weight
		Original	Rescaled	
74	Demonstrate knowledge of infectious diseases.	-2.36	99.68	4.4%
57	Collect the appropriate data during infection outbreak investigation.	-2.28	97.86	4.3%
60	Evaluate the effectiveness of the control measures during outbreak situations.	-2.04	92.53	4.1%
2	Use standardized definitions to conduct surveillance.	-1.73	82.64	3.7%
58	Advise the control measures to the involved parties during outbreak situations.	-1.65	83.94	3.7%
55	Assess the extent of outbreak situation.	-1.20	73.86	3.3%
71	Demonstrate knowledge of decontamination.	-1.12	72.18	3.2%
54	Recognize an outbreak through surveillance information and reporting channels.	-1.12	72.18	3.2%
70	Demonstrate knowledge of asepsis.	-1.05	70.51	3.1%
20	Communicate the necessary resources to administration/ management.	-0.97	68.86	3.1%
43	Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	-0.90	67.16	3.0%
75	Demonstrate knowledge of communication skills.	-0.90	67.16	3.0%
68	Demonstrate knowledge in areas of patient care practices.	-0.86	66.26	2.9%
61	Share the findings of outbreak investigation to the relevant parties.	-0.82	65.49	2.9%
15	Assess the client needs on the infection prevention and control programme during planning.	-0.67	62.13	2.8%
59	Advise the investigation to the involved parties during outbreak situations.	-0.67	62.13	2.8%
27	Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	-0.60	60.45	2.7%
50	Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.	-0.60	60.45	2.7%
29	Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	-0.60	60.45	2.7%
56	Use epidemiological knowledge to identify the risk factors during outbreak situations.	-0.52	58.77	2.6%
77	Demonstrate knowledge of epidemiology.	-0.45	57.09	2.5%
38	Disseminate the policies of the infection prevention and control programmes to concerned clients.	-0.45	57.09	2.5%
72	Demonstrate knowledge o of educational skills and tactics.	-0.45	57.09	2.5%

Item	Description	Item Measure		Weight
		Original	Rescaled	
32	Develop educational objectives and strategies to meet the client needs.	-0.37	55.41	2.5%
80	Act as expert resource in infection prevention and control in clinical and organizational level.	-0.37	55.41	2.5%
41	Share knowledge and skills with other team members and clients.	-0.30	53.73	2.4%
22	Periodically evaluate the effectiveness of the infection prevention and control programme.	-0.30	53.73	2.4%
45	Consider clinical outcomes when initiating changes in practice.	-0.30	53.73	2.4%
49	Identify opportunities for service improvement.	-0.22	52.05	2.3%
33	Collaborate in the development of educational programmes/ tools that related to infection prevention and control.	-0.22	52.05	2.3%
28	Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	-0.22	52.05	2.3%
24	Evaluate client needs after implementing the infection prevention and control programme.	-0.22	52.05	2.3%
10	Report the surveillance findings to appropriate clients.	-0.22	52.05	2.3%
3	Select appropriate indicators to monitor internal trend of infection.	-0.22	52.05	2.3%
34	Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.	-0.17	50.80	2.3%
Total			2251.07	100.00 %

Appendix 10- 6: Content blueprint of certification programme for infection control nurses (ICNs) of Hong Kong

Core competency items for Hong Kong ICNs			Competency categories	
Item	**Description**	**Item weight**	**Category weight**	**Category**
54	Recognize an outbreak through surveillance information and reporting channels.	3.2%	27.0%	Outbreak investigation and control
55	Assess the extent of outbreak situation.	3.3%		
56	Use epidemiological knowledge to identify the risk factors during outbreak situations.	2.6%		
57	Collect the appropriate data during infection outbreak investigation.	4.3%		
58	Advise the control measures to the involved parties during outbreak situations.	3.7%		
59	Advise the investigation to the involved parties during outbreak situations.	2.8%		
60	Evaluate the effectiveness of the control measures during outbreak situations.	4.1%		
61	Share the findings of outbreak investigation to the relevant parties.	2.9%		
68	Demonstrate knowledge in areas of patient care practices.	2.9%	24.2%	Expert knowledge
70	Demonstrate knowledge of asepsis.	3.1%		
71	Demonstrate knowledge of decontamination.	3.2%		
72	Demonstrate knowledge o of educational skills and tactics.	2.5%		
74	Demonstrate knowledge of infectious diseases.	4.4%		
75	Demonstrate knowledge of communication skills.	3.0%		
77	Demonstrate knowledge of epidemiology.	2.5%		
80	Act as expert resource in infection prevention and control in clinical and organizational level.	2.5%		
41	Share knowledge and skills with other team members and clients.	2.4%	12.8%	Team and service management
43	Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures.	3.0%		
45	Consider clinical outcomes when initiating changes in practice.	2.4%		
49	Identify opportunities for service improvement.	2.3%		
50	Expand the resources for infection prevention and control in the organization, e.g. use of infection control link systems.	2.7%		
15	Assess the client needs on the infection prevention and control programme during planning.	2.8%	10.5%	Programme management and evaluation
20	Communicate the necessary resources to administration/ management.	3.1%		

Core competency items for Hong Kong ICNs			Competency categories	
Item	**Description**	**Item weight**	**Category weight**	**Category**
22	Periodically evaluate the effectiveness of the infection prevention and control programme.	2.4%		
24	Evaluate client needs after implementing the infection prevention and control programme.	2.3%		
32	Develop educational objectives and strategies to meet the client needs.	2.5%	9.6%	Education
33	Collaborate in the development of educational programmes/ tools that related to infection prevention and control.	2.3%		
34	Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control.	2.3%		
38	Disseminate the policies of the infection prevention and control programmes to concerned clients.	2.5%		
2	Use standardized definitions to conduct surveillance.	3.7%	8.3%	Surveillance
10	Report the surveillance findings to appropriate clients.	2.3%		
3	Select appropriate indicators to monitor internal trend of infection.	2.3%		
27	Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome.	2.7%	7.7%	Evidence based practice
28	Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme.	2.3%		
29	Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies.	2.7%		

Appendix 10- 7: Comparison of certification blueprint for infection control nurses between Hong Kong and CBIC (USA) (2010)

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
Surveillance	
Use standardized definitions to conduct surveillance	2B1) Use standardized definitions for the identification of outcomes and processes
	2B2) Use a systematic approach to record surveillance data
	2B4) Organize and manage data in preparation for analysis
	2B5) Determine the incidence or prevalence of infections
	2B6) Calculate specific infection rates
	2B7) Calculate risk stratified rates
	2B8) Incorporate post-discharge surveillance findings into calculation of rates
Report the surveillance findings to appropriate clients	2C7) Prepare and report findings of surveillance or epidemiologic investigations to customers, using analyzed data, tables, graphs or charts as appropriate
Select appropriate indicators to monitor internal trend of infection	2A4) Determine data needed to calculate specific rates
	2B3) Determine numerators, denominators, and constants for calculations of rates for outcomes and processes
Design of surveillance systems	
	2A1) Develop a surveillance plan based on the population served, services provided, and regulatory or other requirements
	2A2) Evaluate periodically the effectiveness of the surveillance plan and modify as necessary
	2A3) Identify appropriate critical/ significant lab results and implement a notification system
	2A5) Integrate surveillance activities within health care settings (e.g., ambulatory, home health, long term care, acute care)

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
	2A6) Establish mechanisms for identifying those with communicable diseases requiring follow-up and/ or isolation
Interpretation of surveillance data	
	2C1) Generate, analyze and validate surveillance data
	2C2) Use basic statistical techniques to describe data
	2C3) Recognize statistical significance of surveillance data
	2C4) Monitor and interpret antibiotic resistance patterns
Programme management and evaluation	
Assess the client needs on the infection prevention and control programme during planning	5A1) Conduct an infection risk assessment of the organization
Communicate the necessary resources to administration/ management	5A3) Recommend specific equipment, personnel, and resources for the infection prevention and control programme
Periodically evaluate the effectiveness of the infection prevention and control programme	5A2) Develop, evaluate, and revise a mission and vision statement, goals, measurable objectives, and action plans for the infection prevention and control programmes
Evaluate client needs after implementing the infection prevention and control programme	
Evidence based practice	
Integrate findings of surveillance and infection control programmes into organizational plan for improvement of practice and patient outcome	2C8) Develop and implement corrective action plans based on surveillance findings
Incorporate the regulations, standards and/ or guidelines of applicable professional organizations and governmental departments, current scientific literature and publications into own infection control programme	

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
Recommend new or revised practices in accordance to currently accepted, evidence-based infection prevention and control strategies	3C) Identify and implement infection prevention and control strategies related to hand hygiene, cleaning, disinfection and sterilization, specific direct and indirect care settings, infection risks associated with therapeutic and diagnostic procedures and devices, recall of potentially contaminated equipment and supplies, initiation and discontinuation of isolation/ barrier precautions when indicated, patient placement, transfer and discharge, environmental hazards, immunization programs for patients, construction and renovation in patient care settings, the influx of patients with communicable diseases
	5A5) Recommend changes in practice based on clinical outcomes and financial implications
Evidence based practice (employee/ occupational health)	
	4A) Review and/ or develop screening and immunization programmes
	4C) Assist with analysis and trending of occupational exposure incidents and information exchange between Occupational Health and Infection Prevention and Control departments
Education	
Develop educational objectives and strategies to meet the client needs	6A1) Assess needs, develop goals and measurable objectives and prepare lesson plans for educational offerings
Collaborate in the development of educational programmes/ tools that related to infection prevention and control	
Collaborate in the delivery of educational programmes/ tools that related to infection prevention and control	6A3) prepare, present, or coordinate educational workshops, lectures, discussion, or one-on-one instruction on a variety of infection and control topics

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
Disseminate the policies of the infection prevention and control programmes to concerned clients	5B1) Provide infection prevention and control findings, recommendations, annual reports, and policies and procedures to appropriate individuals, committees, departments and units
	6A4) evaluate the effectiveness of education and learner outcomes (e.g. behaviour modification, compliance rate)
	6A5) instruct patients, families and other visitors about methods to prevent and control infections
Team and service management	
Share knowledge and skills with other team members and clients	5B2) communicate with internal and external customers (e.g. related to infection prevention and control issues of continuity of care, reporting communicable diseases)
Integrate the pertinent regulations, standards, guidelines and current infection surveillance, prevention and control practice into policies and procedures	3A) Develop and review infection prevention and control policies and procedures
Consider clinical outcomes when initiating changes in practice	3C9) Identify and implement infection prevention and control strategies related to use of patient care products and medical equipment,
Identify opportunities for service improvement	5A4) Participate in cost benefit assessments, efficacy studies and product evaluations
	5B4) Evaluate accreditation/ regulatory issues and facilitate compliance
	5C1) participate in quality/ performance improvement and patient safety activities related to infection prevention and control
	5C2) Demonstrate quality/ performance improvement projects through the use of graphic tools (e.g. "fishbone" diagram, Pareto charts, flow charts)
Use of infection control link system	
Expand the resources for infection prevention and control in the organization, e.g. use of infection control link system	

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
Outbreak investigation and control	
Recognize an outbreak through surveillance information and reporting channels	2D1) Verify existence of outbreak
Assess the extent of outbreak situation	2D2) Collaborate with appropriate persons to establish the case definition, period of investigation, and care-finding methods
Use epidemiological knowledge to identify the risk factors during outbreak situations	2D3) Define the problem using time, place, person, and risk factors
Collect the appropriate data during infection outbreak investigation	
Advise the investigation to the involved parties during outbreak situations	
Advise the control measures to the involved parties during outbreak situations	2D5) Implement and evaluate control measures, including ongoing surveillance
Evaluate the effectiveness of the control measures during outbreak situations	
Share the findings of outbreak investigation to the relevant parties	2D6) Prepare and disseminate reports
	2D4) Formulate hypothesis on source and mode of transmission
Expert knowledge	
Demonstrate knowledge in areas of patient care practices	3C) Identify and implement infection prevention and control strategies related to hand hygiene, specific direct and indirect care settings, infection risks associated with therapeutic and diagnostic procedures and devices, recall of potentially contaminated equipment and supplies, patient placement, transfer and discharge, construction and renovation in patient care settings
Demonstrate knowledge of asepsis	3C) Identify and implement infection prevention and control strategies related to cleaning, disinfection and sterilization, recall of potentially contaminated equipment and supplies,

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
Demonstrate knowledge of decontamination	3C) Identify and implement infection prevention and control strategies related to cleaning, disinfection and sterilization, recall of potentially contaminated equipment and supplies
Demonstrate knowledge of education skills and tactics	6A2) Apply principles of adult learning to educational strategies and delivery of educational sessions
Demonstrate knowledge of infectious diseases	1) Identification of infectious disease processes
	3C) Identify and implement infection prevention and control strategies related to initiation and discontinuation of isolation/ barrier precautions when indicated, patient placement, transfer and discharge, environmental hazards, immunization programs for patients, the influx of patients with communicable diseases
	4B) Provide counseling, follow up, work restriction recommendations related to communicable diseases or following exposures
	4D) Assess risk of occupational exposure to infectious diseases (e.g. TB, bloodborne pathogens)
Demonstrate knowledge of communication skills	5B) Communication and feedback
Demonstrate knowledge of epidemiology	2C5) Recognize the need for an epidemiologic study to investigate a problem (e.g. case control, cohort studies)
	2C6) Compare surveillance results to published data or other benchmarks

Hong Kong	CBIC (USA) (Feltovich & Fabrey, 2010)
Act as expert resource in infection prevention and control in clinical and organizational level	3C) Identify and implement infection prevention and control strategies related to hand hygiene, cleaning, disinfection and sterilization, specific direct and indirect care settings, infection risks associated with therapeutic and diagnostic procedures and devices, recall of potentially contaminated equipment and supplies, initiation and discontinuation of isolation/ barrier precautions when indicated, patient placement, transfer and discharge, environmental hazards, immunization programs for patients, construction and renovation in patient care settings, the influx of patients with communicable diseases
Collaboration and partnership	
	3B) Collaborate with public health agencies in planning community responses to biological agents
	5B3) Collaborate with Risk Management/ Quality Management in the identification and review of adverse and sentinel events
Research and development	
	6B1) apply critical reading skills to evaluate research findings
	6B2) incorporate research findings into practice through education and consultation

Difference between two ICN competencies

Reference:

Feltovich F & Fabrey LJ. (2010). The current practice of infection prevention as demonstrated by the practice analysis survey of the Certification Board of Infection Control and Epidemiology, Inc. American Journal of Infection Control, 38, 784-788.

Appendix 11- 1: Response probabilities of five importance levels

Item label	Measure (logits)	Response category			
		Not important	Neutral	Important	Very important
78	1.90	0.00	0.29	0.55	0.16
31	1.47	0.01	0.24	0.53	0.22
19	1.47	0.00	0.24	0.57	0.20
62	1.47	0.00	0.21	0.62	0.17
73	1.34	0.01	0.17	0.63	0.18
5	1.34	0.00	0.20	0.61	0.18
76	1.28	0.03	0.13	0.66	0.18
52	1.08	0.00	0.17	0.62	0.21
67	1.08	0.00	0.16	0.64	0.20
83	1.01	0.00	0.14	0.66	0.20
48	1.01	0.00	0.14	0.66	0.20
17	1.01	0.00	0.11	0.74	0.16
1	0.87	0.00	0.14	0.63	0.22
21	0.80	0.00	0.11	0.70	0.20
66	0.79	0.00	0.11	0.68	0.20
40	0.73	0.00	0.08	0.74	0.18
7	0.66	0.00	0.13	0.62	0.25
42	0.59	0.00	0.08	0.71	0.21
64	0.59	0.01	0.09	0.64	0.25
39	0.52	0.00	0.07	0.72	0.21
18	0.52	0.00	0.01	0.70	0.22
23	0.52	0.00	0.07	0.72	0.21
26	0.45	0.03	0.03	0.71	0.24
25	0.45	0.00	0.09	0.66	0.25
14	0.45	0.00	0.07	0.71	0.22
12	0.37	0.00	0.08	0.67	0.25
4	0.37	0.00	0.09	0.64	0.26
44	0.37	0.01	0.11	0.58	0.30
13	0.30	0.00	0.09	0.63	0.28
65	0.30	0.00	0.05	0.71	0.24
36	0.30	0.00	0.05	0.71	0.24
63	0.30	0.00	0.14	0.53	0.33
69	0.23	0.00	0.11	0.59	0.30
37	0.15	0.00	0.05	0.68	0.26
9	0.08	0.00	0.07	0.64	0.29
53	0.08	0.00	0.04	0.70	0.26
51	0.08	0.00	0.08	0.62	0.30
16	0.08	0.00	0.08	0.62	0.30
8	0.00	0.01	0.08	0.57	0.34
35	-0.07	0.00	0.03	0.70	0.28
82	-0.07	0.00	0.09	0.57	0.34
34	-0.17	0.00	0.04	0.64	0.30
3	-0.22	0.00	0.05	0.62	0.33
10	-0.22	0.00	0.07	0.59	0.34
24	-0.22	0.00	0.05	0.62	0.33
28	-0.22	0.00	0.07	0.59	0.34
33	-0.22	0.00	0.03	0.67	0.30
49	-0.22	0.01	0.05	0.58	0.36
45	-0.30	0.00	0.05	0.61	0.34
22	-0.30	0.00	0.04	0.63	0.33
41	-0.30	0.00	0.07	0.58	0.36
80	-0.37	0.00	0.05	0.59	0.36

Item label	Measure (logits)	Response category			
		Not important	Neutral	Important	Very important
32	-0.37	0.00	0.07	0.57	0.37
72	-0.45	0.00	0.05	0.58	0.37
38	-0.45	0.00	0.07	0.55	0.38
77	-0.45	0.00	0.04	0.61	0.36
56	-0.52	0.01	0.03	0.58	0.38
29	-0.60	0.00	0.01	0.63	0.36
50	-0.60	0.00	0.05	0.55	0.39
27	-0.60	0.00	0.03	0.61	0.37
59	-0.67	0.00	0.05	0.54	0.41
15	-0.67	0.00	0.03	0.59	0.38
61	-0.82	0.00	0.00	0.62	0.38
68	-0.86	0.00	0.03	0.55	0.41
75	-0.90	0.00	0.05	0.50	0.45
43	-0.90	0.00	0.03	0.55	0.42
20	-0.97	0.00	0.00	0.59	0.41
70	-1.05	0.00	0.04	0.50	0.45
71	-1.12	0.00	0.04	0.49	0.47
54	-1.12	0.00	0.03	0.51	0.46
55	-1.20	0.00	0.00	0.55	0.45
58	-1.65	0.00	0.01	0.45	0.54
2	-1.73	0.00	0.03	0.41	0.57
60	-2.04	0.00	0.04	0.33	0.63
57	-2.28	0.00	0.03	0.32	0.66
74	-2.36	0.00	0.00	0.36	0.64

Appendix 11- 2: Summary of outcome competences (Performance indicators) for advanced level practitioners in infection prevention and control, the United Kingdom (2011)

Domain 1: Clinical practice
1) Improve quality and safety by developing and implementing robust, high-quality policies and guidelines that prevent and control infection 2) Collate, analyse and communicate data relating to preventing and controlling infection for surveillance purposes 3) Manage incidents and outbreaks 4) Improve quality and safety through the application of improvement methodologies 5) Advise on the design, construction and modification of facilities to prevent and control infection in the built environment **6)** Evaluate, monitor and review the effectiveness of decontamination processes for equipment and environment
Domain 2: Education
7) Develop own knowledge, skills and practice 8) Lead the development of the knowledge, skills and practice of the infection prevention and control team 9) Develop and implement learning and development opportunities and solutions to improve infection prevention and control 10) Work with others to develop, implement, evaluate and embed infection prevention and control within workforce development strategies
Domain 3: Research
11) Access, appraise and apply robust evidence of all types, and from a range of research and other sources, to the domains of the role 12) Build the evidence and knowledge base to improve and develop infection prevention and control strategies and practices through participation in, or completing research and other related activities, including audit **13)** Share best practice through the dissemination of evidence and knowledge
Domain 4: Leadership and management

14)	Improve quality and safety through networking, influence, proactivity and challenge
15)	Improve quality and safety through the design, planning, monitoring and development of services
16)	Lead high quality infection prevention and control services
17)	Lead and manage the work of the infection prevention and control team to achieve objectives

Reference:

Infection Prevention Society and Competency Steering Group. (2011). Outcome competences for practitioners in infection prevention and control. Journal of Infection Prevention, 12(2), 67-90.