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EFFECT OF ULTRA VIOLET HAND WASHING TRAINING ON
THE PERFORMANCE OF HAND WASHING FOR
NON-PROFESSIONAL FRONTLINE CARE WORKERS
IN RESIDENTIAL CARE HOMES FOR THE ELDERLY

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2012
ACKNOWLEDGEMENTS

Firstly, I would like to express my deepest appreciation for the guidance from my supervisors, Dr. Meyrick Chow (SN) and Dr. Lawrence Chan (HTI), throughout the study. Dr. Chow provided me the backbone of this study and he showed the greatest support when I encountered difficulties. Dr. Chan showed his expertise in imaging analysis and gave technical advice in processing all photos taken in this research.

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After this research, I understood more about my strengths and limitations and I am sure this will enhance my problem solving skills in the future.
Abstract of dissertation entitled:

Effect of Ultra Violet Hand Washing Training on the Performance of Hand Washing for Non-professional Frontline Care Workers in Residential Care Homes for the Elderly

Submitted by

CHAN KIT FAN

For the degree of MSc in Health Care (Infection Control)

At The Hong Kong Polytechnic University in December, 2012
Abstract

Background

As infection risks in residential care homes increase while residents become frailer and multi drug resistant organisms emerge, hand washing performance by non-professional front line workers is important to control the transmission of diseases and prevent outbreaks. Effective hand washing training and its lasting effects are crucial to promote the hand hygiene for care workers and infection control in RCHEs especially when they encounter the difficulties arising from limited resources to provide a high level of care to the elderly in the homes.

Objectives:

The objective of the study is to evaluate ultra violet (UV) hand washing training the effects on improving hand washing techniques for non-professional frontline care workers in residential care homes for the elderly during a period of three months.

Methods:

An experimental study was conducted to explore the effect of hand washing training on improving hand washing techniques for non-professional frontline care workers in residential care homes for the elderly for a period of three months. A total of 126 subjects were recruited in the study with 62 in a control group and 64 in an experimental group. A hand washing training program without UV intervention was conducted for control group in the first training. A UV Glow germ was used as the
intervention for the experimental group to allow visualization UV germ coverage on hands after incomplete coverage by hand washing. After three months, both participants in the control and experimental groups received UV hand washing training and had photos taken under flash and UV light to check for differences. Imaging analysis followed with evaluation of the proportion of residual fluorescence staining of hands by Santec/Tudor Dicom Viewer Version Software. All data and variables were analyzed by SPSS software.

**Results:**
A parametric two samples independent T-test was designed to test the effect of the UV hand washing training program. The proportion of residual fluorescence stain on the hands of the groups in the second training was found to be similar. Association between the variables of working experience, educational level and previous hand washing training without UV intervention for non-professional front line workers was found to be insignificant.

**Conclusion:**
The findings concluded the effect of the UV hand washing training program on performance of non-professional front line workers in RCHEs. The UV hand washing training program allowed direct visualization of the neglected area on hands after incomplete coverage by proper hand washing. From the outcome of this research, I would recommend the introduction of UV hand washing training for front line care
workers in the RCHEs and other health care setting in the community
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List of Abbreviations

CA    Care Assistant
C &A  Care and attention Home for the elderly
C&SD  Census and Statistics Department
CHP   Center for Health and Protection
CW    Care Worker
HCA   Health care assistant
RA    Rehabilitation Assistant
SPSS  Statistical Package for the Social Sciences
SWD   Social Welfare Department
UV    Ultra violet

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Chapter 1 Introduction

1.1 Background of the study

1.1.1 Aging Population in Hong Kong

In view of the rapid growth of the population in Hong Kong as reported by the Census and Statistics Department (C&SD) in 2011, Hong Kong’s mid-year population reached 7.067 million in 2010 (C&SD, 2011) and is projected to reach 8.16 million in 2031 and 8.47 million in 2041. The proportion of the population aged 65 and above will increase from 13% in 2011 to 27% in 2031, followed by 30% in 2041. The decline of the mortality rate in Hong Kong during 1991 to 2011 led to an increase of life expectancy in the aged group. Provisional life expectancy at birth was 80.5 years for males and 86.7 years for females in 2011. In 2041, the life expectancy is projected to rise to 84.4 years for males and 90.8 years for females (C&SD, 2012).

1.1.2 Residential care homes for the elderly (RCHEs) in Hong Kong

RCHEs in Hong Kong aim to provide residential care and facilities for the elderly aged 65 or above who cannot adequately live independently at home. In 2009, there were 58,300 elderly people living in various types of residential care institutions including private elderly homes, hostels for the elderly, homes for the aged, care and attention homes (C&A Homes), nursing homes and infirmaries (C&SD, 2009). Since “Aging in place” policy was
adopted in 2003, the Social Welfare Department (SWD) has ceased to accept applications for the hostels for the elderly and Homes for the aged. Self-care hostels and homes for the aged will gradually be phased out and converted to C&A Homes to provide a continuum of care. Nursing homes and C&A Homes for the elderly aim to provide residential care, meals, personal care, as well as regular basic medical and nursing care in nursing homes and limited caring service in C&A Homes for elders suffering from poor health, or physical or mental impairment (SWD, 2005).

Nursing homes and C&A Homes should provide 24 hours residential home care with personal care services, including assistance with activities of daily living, therapeutic exercise and treatment in form of group or individual intervention, to maintain or improve the functioning of residents (SWD, 2005).

1.1.3 Non-professional care workers in RCHEs

Care workers in RCHEs refer to persons who are responsible for the daily and personal care services provided to the residents according to the personal care schedule designed by a nurse or health worker (SWD, 2005). Various posts of personal care workers, care workers, care assistants, rehabilitation assistants, health care assistants, etc. are created for task allocations in most of the sub-vented RCHEs for better quality of service, staff training and monitoring. Care workers and care assistants provide personal care services and rehabilitation assistants and health care assistants provide rehabilitation services and assistance in the form of personal care for residents in the homes for the elderly.
Staffing in RCHEs includes Home Manager, nurse or health workers, care workers and ancillary workers. The minimum staff requirements in a 100 to 250 capacity sub-vented C&A Home for non-professional frontline care workers are 1 to 5 residents and 1 to 4 residents at a private RCHE under the “Bought Placement Scheme” (SWD 2002). Around 45% of the care workers interviewed attained lower secondary education, 28.8% attained primary education and 2.5% had no formal education (SWD 2002). Also, 52.5% of the interviewed care workers received their education in Mainland China and 35% were educated in Hong Kong (Audit Commission, 2002).

1.1.4 **Hand washing**

Normal human skin is colonized by resident flora (resident microbiota) organisms under the superficial layers of the stratum corneum of the skin. They are of low pathogenic potential that seldom penetrate into body tissues unless as a result of trauma or medical devices such as intravenous catheters. Transient flora (transient microbiota) are colonized on the superficial layer of the skin and are easily removed by hand washing. Transient micro-organisms do not usually multiply on the skin but cause most hospital infections due to cross transmission (WHO Guidelines on Hand Hygiene in Health Care, 2009). Transient micro-organisms (bacteria, yeast, moulds, viruses and parasites of any type that the body has contacted) are commonly found on the palms of the hands, fingertips, and under the fingernails (Mcbride et al., 1976).

Hand washing is an act of cleaning the hands with or without the use of water or some other liquid aiming to remove soil, dirt and/or micro-organisms. Hand washing is one
of the most effective ways to prevent infection outbreak (WHO Guidelines on Hand Hygiene in Health Care, 2009). No transient pathogens can recover after hand rubbing (Kac et al., 2005). Ring wearing leads to an increase of the frequency of hand contamination and artificial fingernails result in the hands retaining pathogens after hand rubbing or hand washing (Trick et al., 2003).

1.1.5 History of Glo Germ

Glo Germ was invented by Dean Luxton in 1968 and was sold for educational purpose in the medical field in the 1980’s. It is sold in the form of invisible, harmless, non-toxic particles containing proven safe ingredients both in powder or liquid-based form. It is formulated to be 5 microns in size, the same size as bacteria. With the use of a UV light, it simulates the spread of germs. Glo Germ has played a major role in the training of patients and staff in major hospitals throughout the United States. It is now exported to Canada, Australia, New Zealand and many European countries. Its applications are reported to be 25% educational, 25% medical, and 50% industrial (including restaurants and consumer based industries). Glo Germ is used in hand washing training program, surface cleaning, food contamination, and also bio-terrorism and the use of PPE training. Hand washing training, Glow Germ allows direct visualization of UV particles which mimic germ with touch transmission on characteristics like micro-organisms and contaminants. They allow safe deposition onto the hands and most surfaces and clothing. The program aims at revealing neglected areas after hand washing and improves hand washing techniques for
infection control (Glo Germ Company, 2012).

1.1.6 Hand washing training program

The Center for Heath Protection sets up guidelines and designs posters and demonstrates hand hygiene techniques with all steps of the rub-in technique for staff in all health care setting including RCHEs (CHP, 2008). If hands are visibly dirty or soiled with blood or other body fluids, or after using the toilet or if it is strongly suspected or proven that pathogens are present, including outbreaks of Clostridium Difficile, hand washing with water and soap is preferred. If hands are not seen to be soiled or water and soap is not available, 70-80% alcohol should be used for hand disinfection (CHP, 2007).
Hand hygiene compliance with the recommended guidelines was estimated to be unacceptably low, lesser than 50% (Pittet, 2001). Promotion of hand hygiene is a major challenge to for infection control professionals (Larson., 1999). In-service training, distribution of information leaflets, workshops and lectures were found to produce only transient improvements in compliance rate (Tibballs, 1996). There is no guarantee for any hand washing behavior improvements to be maintained when the activities or intervention is withdrawn from the setting (Luby et al., 2009).

1.2 Objective of the study

The objective of the study was to evaluate ultra violet (UV) hand washing training its effect on improving hand washing technique for non-professional frontline care workers in residential care homes for the elderly for a period of three months.

1.3 Research questions

1.3.1 Does UV hand washing training program enable both groups to achieve adequate removal of UV germ lotion after hand washing?

(Two groups of attendants participated in the 1st and 2nd Parts of the UV hand washing training over a period of three months, the first group underwent UV intervention only in the 2nd Part of the training, while another group received UV intervention in both parts of the training)
1.3.2 Do non-professional frontline care workers with more work experiences perform better than those who have less?

1.3.3 Do non-professional frontline care workers with higher educational level perform better than others?

1.3.4 Do non-professional frontline care workers having undergone more recent hand washing training perform better than those who received training a longer time before the study?

### 1.4 Research hypotheses

1.4.1 UV hand washing training program enables both groups to achieve adequate removal of UV germ lotion after hand washing.

(Two groups of attendants participated in the 1\textsuperscript{st} and 2\textsuperscript{nd} Parts of the UV hand washing training over a period of three months, the first group underwent UV intervention only in the 2\textsuperscript{nd} Part of the training, while another group received UV intervention in both parts of the training)

1.4.2 Non-professional frontline care workers with more working experiences perform better than those who have less.

1.4.2 Non-professional frontline care workers with higher educational level perform better than the others.

1.4.3 Non-professional frontline care workers having undergone more recent hand washing training perform better than those who received training a longer time before the study.
1.5 Significance of the study

The significance of this study is to demonstrate the UV hand washing training program to be a great interactive way to allow frontline non-professional care workers to witness personally, how germs on their hands. The program enables participants to visualize the neglected areas after an incomplete coverage by hand washing.

The result of the study demonstrated the effectiveness of the training in the promotion of hand washing technique in RCHEs especially when homes encounter a shortage of manpower to allow staff to attend an hour long hand washing training program or in a more frequently. The study also showed the lasting effect of the program for a period of three months.
Chapter 2  Literature Review

2.1 Introduction

This chapter will discuss the infection risks in RCHEs in Hong Kong. Hand hygiene performance is important to control the transmission of pathogens and infection outbreaks in the RCHEs. Studies show the importance of a feasible and effective hand washing program in helping to modify one’s behavior to improve hand washing technique in RCHEs.

2.2 Infection risks of RCHEs in Hong Kong

2.2.1 Low health status and self-care capability of the elderly in RCHEs

In a survey conducted by the Census and Statistics Department in 2008, among 58,300 institutional elderly inmates in Hong Kong, around 46% were aged 80 to 89 and 22.3% were aged 90 and over. The proportion of female residents (67.4%) was significantly higher than males (32.6%). Nearly half of the females were aged 80 and above. About 19,500 residents had been admitted to hospital during the previous twelve months, accounting for 33.5% of the institutional elderly residents and nearly 40% of them had been admitted to hospital on more than one occasion (20.9% twice, 10% three times and 7.4% with 4 times or above) (C&SD, 2009). About 60% of the elderly residents had a higher level of impairment in the activities of daily living (ADL) with
more than three ADL activities capable of being performed independently. More than 50% of the institutional elderly residents suffered from more than three kinds of chronic diseases (22.1% with three kinds and 33.1% with four kinds). Furthermore, 51.9% had fecal incontinence and 54.1% had urinary incontinence. Around 30% of residents received rehabilitation and nursing care services (20.1% physiotherapy, 11.2% nursing care services and 5.4 % occupational therapy) (C&SD, 2009). In Chen’s study in 2006, more than 60% of 1626 elderly residents in 43 RCHEs in Hong Kong could not walk independently (11% bed-bound, 26.2% wheel chair-bound and 24.5% need walking aids) and 24.7% suffered from dementia (Chen et al., 2008).

2.2.2 High prevalence of infections in RCHEs in Hong Kong

In Chan M’s study, the estimated prevalence rate of active tuberculosis in 2243 residents from 15 old age homes was 669 per 100,000 with a significantly higher proportion of men than in women (1,101 per 100,000 vs 530 per 100,000). The rate of active tuberculosis in old age homes in Hong Kong is still high as treatment for latent tuberculosis may cause a high risk of liver dysfunction in frail elders (Chan et al. 2006). In Chen’s study, the overall estimated prevalence in residents interviewed was 5.8% (95/1626). The common types of infection at the institutional elderly suffered were upper respiratory infection, followed by skin and soft tissue infection, urinary tract infection and lower respiratory tract infection (Chen et al., 2008).

In Lin’s study, the outbreak rate of Norovirus outbreaks in homes for the elderly was 12.2 per 100 homes-years. Elderly homes with a larger capacity, a higher staff to
resident ratio and better wheelchair accessibility were found to have an increased norovirus outbreak rate. Those with partitions between beds had lower rate (Lin et al., 2011).

2.2.3 Emergence of Multi-drug Resistant Organisms (MDROs) in Hong Kong

MDRO are micro-organisms which are resistant to the commonly used antibiotics which are mainly spread by contact transmission by contaminated hands, inanimate surfaces and equipments. As a wide range of health-care associated infections such as pneumonia, urinary tract infection, wound infection and bacteremia can result when infection cannot be controlled by first line antibiotics (Ho, 2011).

In Cheng’s study, vancomycin resistant Enterococcus faecium positive cases had a significantly longer cumulative length of stay (P<0.001), a higher proportion with chronic cerebral and cardiopulmonary conditions (P=0.001), underlying malignancies (P < 0.001), presence of urinary catheter (P<0001), wound or ulcer (P < 0.001), and a greater proportion receiving antibiotics when compared with the controls. Extensive contact tracing and screening with a “search-and-confine” strategy was important to control outbreak of MDROs in health care settings (Cheng et al., 2012).

In Cheng’s study, the provision of single room isolation and promotion of hand hygiene practice was stated to be important to control the spread of MDROs in health care setting. However, infection control measures rely largely on personal commitment which will be increased when the infection rate is high or personal safety is threatened (Cheng et al., 2006).
Hong Kong’s situation is now complicated by a multitude of antibiotic-resistance bacteria including methicillin resistant Staphylococcus Aureus (MRSA), vancomycin resistant Enterococcus (VRE), and carbapenems resistant Enterobacteriaceae (CRE) including New Delhi Metallo Betalactamase (NDM-1) and multidrug resistant Pseudomonas aeruginosa (MRPA). The outbreak of VRE cases in hospitals has markedly increased in the recent few years, from 24 confirmed specimens in 2010 rose up to 110 specimens in 2011, and 160 specimens until 2012 September (CHP laboratory surveillance report, 2012).

2.2.4 Discharge of MDRO colonized residents to RCHEs from hospital

The Centre for Health Protection (CHP) adopted the policy of discharging residents colonized by MDROs to RCHEs in 2010. Patients with active emerging MDRO infection undergo treatment and isolation in hospital. Patients treated with MDROs or documented to be clear of MDRO infection can be discharged to RCHEs. Patients from RCHEs with prolonged colonization longer than eight weeks undergo joint assessment by hospital infection control team, Chief Infection Officer’s Office of Hospital Authority and Infection Control Branch of the CHP before discharge to RCHEs.

Information sheet and discharge advice for patients with MDRO infection or colonization are distributed to all RCHEs in the community (SWD, 2011). Additional infection control measures for MDRO carriers living in RCHEs are suggested to reduce the risk of MDRO outbreaks in the home. Residents who have no symptoms and are
ADL independent are suggested to participate in social activities with non-MDRO residents. Residents who are colonized by and high a risk of MDRO bacterial shedding e.g. presence of wound, use of indwelling devices and uncontrolled bowel opening, are suggested to be placed in a single room preferably, or cohort in a room with the same MDRO type of residents. Standard precautions such as a basic level of infection control measures, with proper hand washing and use of protective personal equipments should be implemented. Besides, “Modified contact precautions” are advised to be carried out in the homes to lessen the risk of MDRO infection transmitted to other elderly residents including appropriate signage to remind staff of the status of the colonized residents but a confidential manner. Increased frequency of environmental cleaning to at least three times per day, and dedicated specific use of non-critical items such as wheelchairs and blood pressure cuffs, etc. are also suggested to reduce the risks of MDRO transmission in the homes (CHP, 2011).

As the minimum area per resident in a C&A Home required by the government is 6.5 square metres or above (SWD, 2005), the limited spaces and shared room settings in RCHEs precipitate the risk of MDRO infection in a home. Colonization by MRSA was found by Cimiotti et al. (2004) and occurred after a short exposure time to the hospital environment. Transmission of staphylococcal infections may result from the shedding of seeds to the environment and lead to sporadic infection (Beggs et al., 2008). Standard and contact precautions are strongly suggested by the government so as to prevent transmission of MDRO infection in RCHEs (Chen, 2010)
2.3 Staffing for RCHEs in Hong Kong

2.3.1 Staffing ratio in RCHEs

According to staff requirements documented in the Code of Practice of SWD, a staffing ratio should be assigned according to three shifts of duty (morning session between 7a.m. and 3p.m., afternoon session between 3p.m. and 10p.m., and overnight session between 10p.m. and 7a.m.). The staffing ratio for non-professional care workers to residents should be 1 to 20 in the morning shift, 1 to 40 in the afternoon shift and 1 to 60 in the night shift. The staffing ratio for health workers who have completed an approved course of health care training with a licence issued by the SWD, should be 1 to 30 unless a nurse is present. The staffing ratio for nursing professional staff to residents between 7a.m. and 6p.m. should be 1 to 60 (SWD, 2005).

2.3.2 Shortage of manpower

In a consultancy study in 2011, the shortage of nurses and occupational therapists / physiotherapists already extended to care workers in RCHEs, day care centres for the elderly and home care workers. Most of the workers in the informal interviews revealed that many of the care workers preferred to enter self-employed jobs, rather than working in non-governmental organizations for flexibility of work time, less workload and less stress. Young people after taking training such as the Vocational Training Council’s courses drop out due to the unattractiveness of the working conditions and career prospect (The University of Hong Kong, 2011). Low job satisfaction and high
turnover has led to a decrease of the quality of care and an increase in the cost of service. A significant association was found between job satisfaction and work pressure and the intention to leave the post (Chen et al., 2006). Due to the launch of the Minimum Wage Policy since 2011 (SWD, 2011), the high wastage rate and turnover rate of care workers in the field reflect the shortage of manpower and difficulties encountered by RCHEs to maintain quality services for residents.

2.3.3 Low education levels in non-professional frontline care workers in RCHEs

From an audit in 2002, 45% of the care workers interviewed attained lower secondary education, 28.8% attained primary education and 2.5% had no formal education (SWD 2002). Education and motivation in health care workers are important to modify hand hygiene behaviour (Dubbert et al., 1990).

2.4 Hand hygiene performance in health care settings

2.4.1 Low hand washing compliances

Infection control is important in the carrying out of nursing procedures. Hand hygiene is considered to be an important measure to lessen the transmission of hospital acquired pathogens (Pittet, 2003). Good hand hygiene compliance led to low contamination rates of MRSA, Pseudomonas Aeruginosa and Acinetobacter Baumannii on ward computer interlace (LU et al., 2009). However, the association between hand washing non-compliance and intensity of care suggests that understaffing may lead to a decrease
in the quality of services and patient care (Pittet et al., 1999). Meanwhile, high workload will cause a significant barrier to good hand hygiene compliance (Visscher, 2009).

2.4.2 Hand hygiene program

Structural training program with on-site training are effective in enhancing knowledge of the staff in private RCHEs (Chan et al., 2004). Following a simulated UV germ contamination and a simple educational intervention, performance of hand washing was evaluated for 55 personnel working in an orthopaedic ward in England. An average missed area of 7.8% was reduced to 2.3% (P<0.001). The researcher suggested that a simple educational intervention in the form of a UV training program is effective in improving hand washing performance (Macdonald et al., 2006).

Introduction of simulated fluorescence Glo Germ for experimental groups of school children showed statistically significant improvement in a total population of 492 children in that a sustainable increase in hand hygiene in elementary school aged children was indicated (Snow, 2007).

A study in Chicago of 60 children of all ages and their parents while they were waiting to see pediatrician in 2011 were asked to use Glo Germ applied onto the hands and washed with soap and water before placing the hands under ultra violet light. Most of the children were evaluated one month after and were found to have improvement in hand washing technique. But their parents did not have hand hygiene significantly improved (Glow germ Co. 2012)
2.5 Conclusion

All findings and theories of the studies in the literature review demonstrate the significance of adopting a practical and effective hand washing programme in a RCHE. The hand washing training programme should have a good effect on the participants as they can see the inadequacy of their hand washing performance and enable them to improve their technique in order to lessen the risks of infection outbreak in RCHEs.

Chapter 3 Methodology

3.1 Research Design

A parametric two samples independent T-test was designed to test the effect of a UV hand washing training program.

G Power, a statistical power analysis tool, was used for sample size calculation. Difference between two independent groups in t-test and a priori (compute required sample size) were chosen. Parametric data of effect size d 0.5 and power size at 0.80 were chosen. A medium level of estimated magnitude was predicted for the result of the study in light of a few studies on hand hygiene compliance in long term care facilities and professional staff e.g. doctors and nurses (Yeung, 2007; Macdonald 2006). A total sample size of 128 subjects with a 1 to 1 control group to experimental group ratio of 64 persons in the control group (Group 1) and 64 persons in the experimental group (Group 2) was formulated.
Sample size calculation: G Power (statistical power analysis)

**t tests - Means: Difference between two independent means (two groups)**

**Analysis:** A priori: Compute required sample size

- **Input:**
  - Tail(s) = Two
  - Effect size d = 0.5
  - α err prob = 0.05
  - Power (1-β err prob) = 0.80
  - Allocation ratio N2/N1 = 1

- **Output:** Noncentrality parameter δ = 2.8284271
  - Critical t = 1.9789706
  - Df = 126
  - Sample size group 1 = 64
  - Sample size group 2 = 64
  - Total sample size = 128
  - Actual power = 0.8014596

---

**Figure 1.** Sample size calculation: G power (statistical power analysis)
3.2 Research setting

The study was designed to consist of a hand washing training program with two parts for non-professional frontline care workers in four residential care homes of a non-governmental organization conducted over a period of three months. The two parts of the hand washing training program were conducted by the same trainer in the research.

The first part of the program aimed at providing experience for the experimental group by having UV germ intervention in the hand washing training program but not the control group. The second part of the program aimed at evaluating the effect of residual fluorescence stain on hands in the control group and experimental group before and after hand washing, and their variances.

3.3 Inclusion and Exclusion Criteria of the study

3.3.1 Inclusion criteria:

Care workers who worked in RCHE for at least one month having received orientation in hand washing techniques and had completed assessment were recruited.

3.3.2 Exclusion criteria:

Care workers who had open wounds or skin problems, e.g. dermatitis, or care workers who were sensitive or allergic to fluorescent solution were excluded from the study.
3.4 Study Population

The study was held at four RCHEs of a non-governmental organization (NGO). All non-professional frontline care workers who were newcomers to this NGO were required to learn hand hygiene techniques as documented by the CHP guidelines. They had to pass a hand washing assessment before they could commence their work. Every participant should have a basic knowledge of hand hygiene technique in caring for the elderly.

A randomized control trial method with a one to one ratio was designed to assign participants equally to the control and experimental group to reduce allocation bias and balance possible factors that were known to both groups. A total number of 142 non-frontline care workers including care workers, care assistants, rehabilitation assistants and health care assistants in these four RCHEs were recruited. One hundred and twenty-six care workers met the inclusion criteria of the study with work experience of not less than one month and who had attended an orientation in hand washing techniques or had completed a hand washing assessment. Two persons were excluded from the study due to open wounds. Eight persons dropped out of the study because they resigned from work during the study period and six persons could not attend the training due to limited manpower in the dormitory. Throughout the study, there was no subject excluded from the study due to allergic reaction to the UV germ lotion used in the study.
3.5 Development of Instrument

An information sheet, consent form and demographic data questionnaire for the study were prepared on 15th August 2011. All documents were explained and distributed on the site 15 minutes before each training session in the first part of the study for the control group in September 2011 and experimental group in October 2011.

3.5.1 Information sheet

The information sheet provided participants the details of the study including purpose of the study, methodology, training hours required, allergy test for UV medium used, confidentiality in relation to all data collected during and six months after the study and the complaint channel. Participants had the right to withdraw from the study before the study commenced or after without penalty of any kind (Appendices 2 and 3).

3.5.2 Consent form

A consent form was designed to confirm that the participants understand the purpose of and method used in the study. They had the right to raise questions or withdraw from the study without any penalty (Appendices 4 and 5).

3.5.3 Demographic data questionnaire

A demographic data questionnaire was designed to assure the confidentiality of all data
collected in the study. Data collected from participants included staff name, staff number, gender and post held. Also, work experience, education level and hand washing training or assessment received before the study were collected. Work experience was categorized as less than one month, one to six months, six months to one year, one to three years, three to five years and more than five years. Education level, i.e. below Form three, above Form three and lower than Form Five and above Form Five as well as the period of previous hand washing training or assessment received before the study were collected (Appendices 6 and 7).

3.6 Ethics consideration

Ethics approval for the study proposal was reviewed and approved by the School Research Committee, School of Nursing of the Hong Kong Polytechnic University in September 2011 (Appendix 1).

Subjects gave their consent by signing before the study. They had the right to withdraw before or after the study without penalty of any kind.

A skin allergy test for UV germ medium on each of the participants was carried out before its use in the study.

All subjects were assured that their information would be kept strictly confidential and be destroyed six months after the study was completed.
3.7 Procedure of the Study

3.7.1 First part of the study

The first part of the study was held in September and October 2011 since ethics approval was granted for a total of 12 classes provided to four RCHE target groups.

3.7.1.1 Introduction of the study

The information sheet, consent form and data collection were explained and distributed. Inclusion and exclusion criteria for the targeted groups for the study were reinforced. Staff who did not meet the criteria were excluded from the study.

3.7.1.2 Hand washing training for the control groups in the First Part of the study

Hand washing training for control groups were held before experimental group in each of the four RCHEs. Training of Hand hygiene technique in accordance to the guidelines of CHP was demonstrated in the program. Each of the participants was asked to follow hand rub-in technique shown in CHP poster. Every participant was trained to learn application and all steps of hand hygiene technique. Ultra violet germ was not used in any of the sessions for the control groups in this round. Subjects of the control group therefore had no idea about neglected areas after hand washing.
3.7.1.3  Hand washing training for the experimental groups in the First part of the study

Hand washing training for the experimental group was held in the four RCHEs when the classes for the control group were completed. Inclusion and exclusion criteria were rechecked to confirm the reliability of the study.

Allergy test for ultra violet germ was performed to check for allergic reaction e.g. skin redness, itching much more than a mosquito bite sensed. The participant with allergic reaction would be excluded from the study.

After brief introduction of hand washing significance, all participants had UV germ lotion applied onto both parts of their hands. Everyone visualized UV simulated germ lotion on their hands under UV light before hand washing and checked for any residue UV germ lotion remained on hands after hand washing. All participants discussed among groups the reasons for the neglected area after hand washing.

3.7.2  Second part of the study

3.7.2.1  Introduction

The second part of the study was held in December 2011 and January 2012 with a total of 12 classes for four RCHEs. All target subjects were arranged to attend one of the UV hand washing training classes conducted in the RCHE in which they worked during the period.
3.7.2.2 Procedure for the second part of the program

Control group members who did not have UV germ intervention in the hand washing program underwent a UV germ allergy test before the program started. The allergy testing method was the same as carried out for the experimental group in the first part of the training program. Any persons who were sensitive to the UV germ would be excluded from the study.

After brief reminders of the significance of hand washing in caring services, all participants of the control and experimental groups had UV germ lotion applied onto their hands and were shown the coverage of simulated UV germs before hand washing.

(UV Germ Lotion)

Photos were taken at this time of both the dorsal and ventral parts of right and left hands of each participant under flash and UV light in a Glow Box. A digital Panasonic Lumix Camera with auto flash setting and an Ultra violet Hand Held Fluorescent or Ultra Violet (UV) Black light were used for photo taking.
Participants then performed hand washing and rechecked the residue of fluorescence stain UV germ on their hands after hand washing. Participants were allowed to witness the difference of residual fluorescence stain coverage on their hands before and after hand washing.

Meanwhile, another set of photos of the dorsal and ventral parts of each part of their hands was taken under flash and UV light. The hand hygiene technique following the CHP guidelines was introduced and participants were reminded of the rubbing technique.

All photos taken were uploaded for image analysis to check the percentage of residual fluorescence stain on participants’ hands before and after hand washing.
An example of photo taken for a participant in experimental group in the second training uploaded into software for images analysis – Left Hand (dorsal part)

**Photo taken before hand washing**

<table>
<thead>
<tr>
<th>With flash</th>
<th>Under UV</th>
<th>Lotion covered</th>
<th>Proportion of UV germ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Photo taken before hand washing](image1)

**Photo taken after hand washing**

<table>
<thead>
<tr>
<th>With flash</th>
<th>Under UV</th>
<th>Lotion covered</th>
<th>Proportion of UV germ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Photo taken after hand washing](image2)
An example of photo taken for a participant in experimental group in the second training uploaded into software for images analysis – Right Hand (ventral part)

**Photo taken before hand washing**

<table>
<thead>
<tr>
<th>With flash</th>
<th>Under UV</th>
<th>Proportion of UV germ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Under UV lotion covered 99.41%</td>
</tr>
</tbody>
</table>

**Photo taken after hand washing**

<table>
<thead>
<tr>
<th>With flash</th>
<th>Under UV</th>
<th>Proportion of UV germ</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Under UV lotion covered (0.05%)</td>
</tr>
</tbody>
</table>
3.8 Statistical Package for the Social Science (SPSS) Software

The software SPSS Version 19.0 for Windows was used to analyze data collected in the study.

Various statistical tests were used for data analysis and the statistical significance level was set at $P < 0.05$. An independent two sample T-test was used to ascertain the statistically significant difference between the control and experimental groups. One way ANOVA was used to compare the means of residual fluorescence stain on four different areas of hands, including left dorsal (LD), left ventral (LV), right dorsal (RD) and right ventral (RV) between the control and experimental groups and within the groups.
Chapter 4  Results

4.1  Demographic Data

4.1.1  Total number of non-professional frontline workers recruited in the study

In the study, there were a total of 142 non-professional frontline caring workers recruited, 1 male (0.7%) and 141 females (99.3%). However, 16 subjects were excluded from the study due to wounds on hands, resignation and staff being on duty and could not be released from the dormitory during the study.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Control n (%)</th>
<th>Experimental n (%)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Target subjects recruited</td>
<td>66 (46.5)</td>
<td>76 (53.5)</td>
<td>142 (100)</td>
</tr>
<tr>
<td>Subjects excluded from study</td>
<td>4 (2.8)</td>
<td>12 (8.4)</td>
<td>16 (11.2)</td>
</tr>
<tr>
<td>- Allergy to fluorescence</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>- Wounds on hands</td>
<td>0 (0.0)</td>
<td>2 (12.5)</td>
<td>2 (12.5)</td>
</tr>
<tr>
<td>- Dermatitis</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>- Resigned</td>
<td>4 (25.0)</td>
<td>4 (25.0)</td>
<td>8 (50.0)</td>
</tr>
<tr>
<td>- On duty</td>
<td>0 (0.0)</td>
<td>6 (37.5)</td>
<td>6 (37.5)</td>
</tr>
<tr>
<td>Total number of subjects completed in the study</td>
<td>62 (43.6)</td>
<td>64 (45.1)</td>
<td>126 (88.7)</td>
</tr>
</tbody>
</table>

Table 1  Demographic data for subjects recruited and excluded from the study (N=142)
4.1.2 **Total number of non-professional frontline workers in the study**

Until the second part of the hand washing training programme in the four RCHEs, there were a total of 126 staff (88.7%) retained and who completed the study.

Among the 126 participants, there were one male (0.8%) and 125 females (99.2%). There were 113 care workers in total (CW)(89.7%), three care assistants (CA)(2.4%), nine rehabilitation assistants (RA)(7.1%) and one health service assistant (HSA) (0.8%).

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control n(%)</th>
<th>Experimental n(%)</th>
<th>Total n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>1 (0.8)</td>
<td>0 (0.0)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td>Female</td>
<td>61 (48.4)</td>
<td>64 (50.8)</td>
<td>125 (99.2)</td>
</tr>
<tr>
<td><strong>Rank</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Care Worker</td>
<td>55 (43.7)</td>
<td>58 (46.0)</td>
<td>113 (89.7)</td>
</tr>
<tr>
<td>Care Assistant</td>
<td>1 (0.8)</td>
<td>2 (1.6)</td>
<td>3 (2.4)</td>
</tr>
<tr>
<td>Rehab Assistant</td>
<td>5 (3.9)</td>
<td>4 (3.2)</td>
<td>9 (7.1)</td>
</tr>
<tr>
<td>Health Service Assistant</td>
<td>1 (0.8)</td>
<td>0 (0.0)</td>
<td>1 (0.8)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>62 (49.2)</td>
<td>64 (50.8)</td>
<td>126 (100)</td>
</tr>
</tbody>
</table>

Table 2 Demographic data of subjects who participated in the study (N=126)
4.1.3 Work experience of the subjects participating in the study

Among the recruited population in the control group, there were 20 subjects (15.8%) had been working in the present post for less than 3 year and 42 subjects (33.3%) working in the existing post for 3 years and above. There were 2 subjects (1.6%) working for less than 1 month, 11 subjects (8.7%) within 1 to 6 months, 1 subject (0.8%) within 6 to 12 months, 6 subjects (4.7%) within 1 to 3 years, 12 subjects (9.5%) within 3 to 5 years and 30 subjects (23.8%) for working 5 years or above.

As for the experimental group, there were 19 subjects (15.1%) had been working in the present post for less than 3 year and 45 subjects (35.7%) working in the existing post for 3 years and above. There were 1 subjects (0.8%) working for less than 1 month, 1 subject (0.8%) within 1 to 6 months, 5 subjects (3.9%) within 6 to 12 months, 12 subjects (9.5%) within 1 to 3 years, 14 subjects (11.1%) within 3 to 5 years and 31 subjects (24.6%) for working 5 years or above.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control n(%)</th>
<th>Experimental n(%)</th>
<th>Total n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working period for Present post</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 month</td>
<td>2 (1.6)</td>
<td>1 (0.8)</td>
<td>3 (2.3)</td>
</tr>
<tr>
<td>For 1 to 6 months</td>
<td>11 (8.7)</td>
<td>1 (0.8)</td>
<td>12 (9.5)</td>
</tr>
<tr>
<td>For 6 to 12 months</td>
<td>1 (0.8)</td>
<td>5 (3.9)</td>
<td>6 (4.7)</td>
</tr>
<tr>
<td>For 1 to 3 years</td>
<td>6 (4.7)</td>
<td>12(9.5)</td>
<td>18 (14.2)</td>
</tr>
<tr>
<td>For 3 to 5 years</td>
<td>12 (9.5)</td>
<td>14 (11.1)</td>
<td>26 (20.6)</td>
</tr>
<tr>
<td>5 years or above</td>
<td>30 (23.8)</td>
<td>31 (24.6)</td>
<td>61 (48.4)</td>
</tr>
<tr>
<td>Total</td>
<td>62 (49.2)</td>
<td>64 (50.8)</td>
<td>126 (100)</td>
</tr>
</tbody>
</table>

Table 3 Demographic data for subjects working in their existing post during the study (N=126)
4.1.4 Educational level of subjects who participated in the study

Among the subjects who participated in the study, 21 subjects (16.6%) received education below Form 3 and 41 subjects (32.5%) achieved Form 3 or above in the control group. Twenty-one subjects (16.6%) attained below Form 3 level, 39 subjects (30.9%) attained Form 3 to Form 5 educational level and two subjects (1.6%) achieved Form 5 or above education.

In the experimental group, there were 21 subjects (16.6%) below Form 3 and 43 subjects (34.1%) from Form 3 to 5.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control n(%)</th>
<th>Experimental n(%)</th>
<th>Total n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Educational Level</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below Form 3</td>
<td>21 (16.6)</td>
<td>21 (16.6)</td>
<td>42 (33.3)</td>
</tr>
<tr>
<td>From Form 3 to 5</td>
<td>39 (30.9)</td>
<td>43 (34.1)</td>
<td>82 (65.1)</td>
</tr>
<tr>
<td>Form 5 or above</td>
<td>2 (1.6)</td>
<td>0 (0.0)</td>
<td>2 (1.6)</td>
</tr>
<tr>
<td>Total</td>
<td>62 (49.2)</td>
<td>64 (50.8)</td>
<td>126 (100)</td>
</tr>
</tbody>
</table>

Table 4 Demographic data for subjects educational level achieved in the study (N=126)
4.1. 5 Time when subjects undertook hand washing training before the study

In the control group, there were 31 subjects (24.6%) who had undergone hand washing training within 6 months before the study and 31 subjects (24.6%) who had undergone training 6 months or longer before the study. There were 11 subjects (8.7%) who had undergone training less than 1 month before the study, 20 subjects (15.8%) who had undergone training 1 to 6 months before, 25 subjects (19.8%) who had undergone training 6 to 12 months before, one subject (0.8%) who had undergone training 2 years and five subjects (3.9%) who had undergone training 2 years or more before.

As for the experimental group, there were 30 subjects (23.8%) who had undergone hand washing training within 6 months before the study and 34 subjects (26.9%) who had undergone the training 6 months or more before the study. There were 10 subjects (7.9%) who had undergone training less than 1 month before the study, 20 subjects (15.8%) who had undergone training 1 to 6 months before, 28 subjects (22.2%) who had undergone training 6 to 12 months before, four subjects (3.2%) who had undergone training 1 to 2 years before and two subjects (1.6%) who had undergone training 2 years before the study.
<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Control n(%)</th>
<th>Experimental n(%)</th>
<th>Total n(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time for Hand washing training taken</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than 1 month</td>
<td>11 (8.7)</td>
<td>10 (7.9)</td>
<td>21 (16.6)</td>
</tr>
<tr>
<td>1 to 6 months before</td>
<td>20 (15.8)</td>
<td>20 (15.8)</td>
<td>40 (31.7)</td>
</tr>
<tr>
<td>6 to 12 months before</td>
<td>25 (19.8)</td>
<td>28 (22.2)</td>
<td>53 (42.1)</td>
</tr>
<tr>
<td>1 to 2 years before</td>
<td>1 (0.8)</td>
<td>4 (3.2)</td>
<td>5 (3.9)</td>
</tr>
<tr>
<td>2 years or above</td>
<td>5 (3.9)</td>
<td>2 (1.6)</td>
<td>7 (5.5)</td>
</tr>
<tr>
<td>Total</td>
<td>62 (49.2)</td>
<td>64 (50.8)</td>
<td>126 (100)</td>
</tr>
</tbody>
</table>

Table 5 Demographic data of subjects who had hand washing training before the study (N=126)

4.2 Comparison of pre- and post- hand washing log$_{10}$ FS (Fluorescence stain) result on hands

The target groups in four RCHEs were non-professional care workers who had received hand washing training and assessment, and worked in the RCHEs for at least one month. Hence, the study group had the basic knowledge of hand hygiene and hand washing technique. Fluorescence stain used in the study enabled participants to see the deposition of simulated germs on their hands before and after hand washing under UV light. It was expected that the variations between the control and experimental groups exercised in the second part of the training programme would result in only a slight difference. The pre- and post-hand washing log$_{10}$FS (Fluorescence stain) was employed to enlarge and check for the variation difference between the values of the area with residual fluorescence stain on hands between the control and experimental
groups, as well as the difference within their groups.

As the ratio of the area covered by fluorescence stain on hands after hand washing to the area before hand washing was smaller than 0, the outcomes of the mean values of coverage area should be negative. When the mean values were closer to 0, they were be bigger in value, implying that the areas of residue fluorescence stain covered on hands were larger than the other which were further away from 0.

4.2.1 Comparison of residual fluorescence stain coverage on hands after hand washing in the control and experimental groups

Table 6 reflects the mean score differences between the control and experimental groups by using the independent sample t-tests. It suggests that there were no statistical significant differences for all residual fluorescence coverage on hands between the control and experimental groups.

In the second part of the training, every subject in both groups had UV fluorescence stain applied to their hands after hand hygiene reminders. Every participant saw the residual fluorescence on their hands under UV after hand washing. The mean values of residual fluorescence stain covering hands in the control and experimental groups on different parts of their hands were: (control)-1.482894914 and (experimental) -1.415698542 on the left dorsal, (control) -0.1535481115 and (experimental) -0.1427464260 on the left ventral, (control) -0.1689871669 and (experimental) -0.1376256092 on the right dorsal, and also (control)
-1.457086593 and (experimental) -1.490898149 on the right ventral. P values for residual fluorescence stain on the hands in both groups were nearly the same: 0.478 on the left dorsal, 0.550 on the left ventral, 0.663 on the right dorsal and 0.202 on the right ventral.

<table>
<thead>
<tr>
<th>Areas of hand</th>
<th>Groups Compared</th>
<th>N</th>
<th>Mean Log_{10} FS</th>
<th>P values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left dorsal part (LD)</td>
<td>Control</td>
<td>62</td>
<td>-1.482894914</td>
<td>0.478</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>64</td>
<td>-1.415698542</td>
<td></td>
</tr>
<tr>
<td>Left ventral part (LV)</td>
<td>Control</td>
<td>62</td>
<td>-0.1535481115</td>
<td>0.550</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>64</td>
<td>-0.142746426</td>
<td></td>
</tr>
<tr>
<td>Right dorsal part (RD)</td>
<td>Control</td>
<td>62</td>
<td>-0.1689871669</td>
<td>0.663</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>64</td>
<td>-0.1376256092</td>
<td></td>
</tr>
<tr>
<td>Right ventral part (RV)</td>
<td>Control</td>
<td>62</td>
<td>-1.457086593</td>
<td>0.202</td>
</tr>
<tr>
<td></td>
<td>Experimental</td>
<td>64</td>
<td>-1.490898149</td>
<td></td>
</tr>
</tbody>
</table>

Table 6 Comparison of residual fluorescence stain on hands before and after hand washing in control and experimental group (N=126)

4.2.2 **Comparison of fluorescence stain coverage area on hands between the groups and within the control and experimental groups**

In Table 7, one way ANOVA was used to compare the residual fluorescence stain coverage on hands after hand washing in the groups, between the control and experimental groups, as well as the performance within the control or experimental groups.

The mean values of fluorescence coverage on the hands in the control and experimental groups were compared. The mean value of residual fluorescence stain coverage on
the left dorsal part of the hands between the control and experimental groups was 0.142
while within the control or experimental groups it was 2.392 (P-value 0.808). The
mean value of residual fluorescence stain coverage on the left ventral part of the hands
between the control and experimental groups was 0.367 while within the control and
experimental groups it was 2.736 (P-value 0.715). The mean value of residual
fluorescence stain coverage on the right dorsal part of the hands between the control and
experimental groups was 3.097 while within the control and experimental groups it was
2.576 (P-value 0.275). The mean value of residual fluorescence stain coverage on the
right ventral part of the hands between the control and experimental groups was 0.036
while within the control and experimental groups it was 2.191 (P-value 0.898). As the
mean value of fluorescence stain on the right ventral part was 3.097 between the groups
and 2.576 within the groups and was the greatest among all areas, the result implied that
more residual fluorescence stain was found on the right ventral part.

In the table, as all P values for the comparison of residual fluorescence stain on hands
“between groups” and “within groups” were greater than 0.05, the table showed that the
difference in residual fluorescence stain on the hands in both groups was statistically
insignificant.
Table 7 Comparison of residual fluorescence stain coverage on the hands between groups and within groups of the control and experimental groups (N=126)

<table>
<thead>
<tr>
<th>Areas of hand</th>
<th>Groups Compared</th>
<th>Mean Value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Left dorsal part (LD)</td>
<td>Between groups</td>
<td>0.142</td>
<td>0.808</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>2.392</td>
<td></td>
</tr>
<tr>
<td>Left ventral part (LV)</td>
<td>Between groups</td>
<td>0.367</td>
<td>0.715</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>2.736</td>
<td></td>
</tr>
<tr>
<td>Right dorsal part (RD)</td>
<td>Between groups</td>
<td>3.097</td>
<td>0.275</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>2.576</td>
<td></td>
</tr>
<tr>
<td>Right ventral part (RV)</td>
<td>Between groups</td>
<td>0.036</td>
<td>0.898</td>
</tr>
<tr>
<td></td>
<td>Within groups</td>
<td>2.191</td>
<td></td>
</tr>
</tbody>
</table>

4.2.3 Association between variables

4.2.3.1 Comparison of removal of residual fluorescence stain on hands after hand washing in control and experimental groups in relation to working experience

In Table 8, it showed the mean variables for the removal of residual fluorescence stain on hands in the control group were 99.0567 (for those who has been working for less than 3 years) and 99.3970 (for those who has been working for 3 years or above) and the P value was 0.140. As for the experimental group, the mean variables for those
who has been working for less than 3 years was 99.3066 and for those who has been working for 3 years or above was 99.5011 (with P value 0.4.18).
The result showed that subjects who worked for more than 3 years or above 99.3970 in control group and 99.5011 in experimental group had a higher percentage in the removal of fluorescence stain than those who worked less than 3 years (99.0567 in control group and 99.3066 in experimental group). The result also showed that the mean value of experimental group working for 3 years or above 99.5011 was higher than the one in control group 99.3970. P value for experimental group 0.418 was greater than the one in control group 0.140 although they were all greater than 0.05 showing insignificant statistics for the association of working experience to the intervention of ultra violet hand washing training and removal of fluorescence stain on hands in the study.

<table>
<thead>
<tr>
<th>Association factors</th>
<th>Removal of fluorescence stain on hands after hand washing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Control group</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>Working experiences (time for working in the present post)</td>
<td>Less than 3 years</td>
</tr>
<tr>
<td></td>
<td>3 years or above</td>
</tr>
</tbody>
</table>

Table 8 Comparison of removal of fluorescence stain on hands after hand washing in control and experimental groups in relation to working experience
4.2.3.2 Comparison of the removal of residual fluorescence stain on hands after hand washing in the control and experimental groups in relation to educational level

Table 9 reflects that the mean variables for the removal of residual fluorescence stain on hands in the control group were 99.1260 (below Form 3 level), and 99.3699 (Form 3 or above), and the P value was 0.182. As for the experimental group, the mean variables were 99.4063 (below Form 3) and 99.4856 (Form 3 or above), and the P value was 0.441.

The result showed that the mean value for participants in the experimental group who had Form 3 or above educational level (99.4856) was higher than that in the control group of the same education level (99.3699). Moreover, the result also showed that the mean variables for subjects in the experimental group below Form 3 (99.4063) and subjects with Form 3 or above educational level (99.4856) were higher than that of the control group (99.1260 and 99.3699). The P value for the experimental group of 0.441 was greater than that in the control group of 0.182 although they were all greater than 0.05 showing an insignificant statistical result for the association between educational level and intervention of UV hand washing training and removal of fluorescence stain on hands in the study.
Table 9 Comparison of removal of fluorescence stain on hands after hand washing in control and experimental groups in relation to educational level

<table>
<thead>
<tr>
<th>Association factors</th>
<th>Control group</th>
<th>Experimental group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>P value</td>
</tr>
<tr>
<td>Education level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Below Form 3</td>
<td>99.1260</td>
<td>0.182</td>
</tr>
<tr>
<td>Form 3 or above</td>
<td>99.3699</td>
<td></td>
</tr>
</tbody>
</table>

4.2.3.3 Comparison of the removal of residual fluorescence stain on hands in the control and experimental groups in relation to the time when participants had hand washing training before the study

Table 10 refects that the mean variables for the removal of residual fluorescence stain on hands in the control group were 99.2795 (subjects had hand washing training less than 6 months before the study) and 99.2960 (subjects had hand washing training 6 months or more than 6 months before the study), and the P value was 0.879. As for the experimental group, the mean variables were 99.3608 (less than 6 months before the study) and 99.5612 (6 months or more than 6 months before the study), and the P value was 0.468.

The result showed that the mean value for participants in the control group who had undergone hand washing training 6 months or more before the study of 99.2960 was higher than for those who had training less than 6 months before (99.2795). The P value for the control group of 0.879 was greater than that in the experimental group of 0.468. As both P values were greater than 0.05, this reflected an insignificant statistic.
for the association of the time when hand washing training was taken before the study with the intervention of UV hand washing training and removal of fluorescence stain on hands in the study.

<table>
<thead>
<tr>
<th>Association factors</th>
<th>Removal of fluorescence stain on hands after hand washing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control group</td>
<td>Experimental group</td>
</tr>
<tr>
<td>Mean</td>
<td>P value</td>
</tr>
<tr>
<td>Hand washing (HW) training taken before study</td>
<td>less than 6 months before study</td>
</tr>
<tr>
<td>(Time for each participant had HW training taken before this study)</td>
<td>6 months or more before study</td>
</tr>
</tbody>
</table>

Table 10 Comparison of the removal of residual fluorescence stain on hands in the control and experimental groups in relation to time when hand washing training was undertaken before the study

4.3.3 Other findings - sites for UV coverage on hands after hand washing

Table 11 shows the frequency of residual fluorescence stain covered on various parts of the hands in the control and experimental groups after hand washing in the second part of the study. Of the participants, 48.02% had no UV germs on their hands after hand washing. More than 50% of the participants had UV germs remaining on the thumbs, fingers, spaces between fingers, fingertips, central portion and sites of ring wearing.

It was found that the common sites where UV germ was traced and deposited were the fingertips. 48/126 participants had UV germ left on the right dorsal and 58/126 participants had UV germ remaining on the left ventral. The mean percentile for UV coverage on the fingertips after hand washing was 26.59.

The next position where UV germ was often found on hands after hand washing was the central portion. 31/126 participants had UV germ left on the right dorsal and 22/126
participants had UV germ left on the left ventral. The mean percentage for UV coverage on the central portion after hand washing was 10.91.

The third finding was the thumb on the left ventral part of the hand. 29/126 participants had UV germ left after hand washing. The mean percentage for UV covered on thumbs after hand washing was 9.72.

Lastly, the frequency for the subjects who wore rings with UV fluorescence stain coverage was 1.79%. Fluorescence stains were found on the four views of the hands (left dorsal, left ventral, right dorsal and right ventral).

<table>
<thead>
<tr>
<th>Hand sites with residual fluorescence stain covered on hands after hand washing</th>
<th>Frequency %</th>
<th>Left dorsal</th>
<th>Left ventral</th>
<th>Right dorsal</th>
<th>Right ventral</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>48.02%</td>
<td>62%</td>
<td>63%</td>
<td>62%</td>
<td>55%</td>
</tr>
<tr>
<td>thumbs</td>
<td>9.72%</td>
<td>12%</td>
<td>6%</td>
<td>2%</td>
<td>29%</td>
</tr>
<tr>
<td>fingers</td>
<td>1.98%</td>
<td>1%</td>
<td>3%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>spaces between fingers</td>
<td>0.99%</td>
<td>1%</td>
<td>3%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>finger tips</td>
<td>26.59%</td>
<td>48%</td>
<td>16%</td>
<td>58%</td>
<td>12%</td>
</tr>
<tr>
<td>central portion</td>
<td>10.91%</td>
<td>0%</td>
<td>31%</td>
<td>2%</td>
<td>22%</td>
</tr>
<tr>
<td>Site with ring-wearing</td>
<td>1.79%</td>
<td>2%</td>
<td>4%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>126%</td>
<td>125%</td>
<td>126%</td>
<td>126%</td>
</tr>
</tbody>
</table>

Table 11 Frequency for residual fluorescence stain found on various sites of hands (Left Dorsal, Left Ventral, Right Dorsal and Right Ventral) after hand washing
Chapter 5 Discussion

5.1 Effect of UV hand washing training

Effect of UV hand washing training

In view of the results of the study, it was found that the mean score for the coverage of residual fluorescence stain (UV germs) on hands after hand washing in the control group were of nearly the same. Mean $\log_{10}$FS (fluorescence stain) on the left dorsal part of hands in the control and experimental groups were: -1.482894914 and -1.415698542. The mean $\log_{10}$FS (fluorescence stain) on the left ventral part of hands in the control and experimental groups were -0.1535481115 and -0.1427464260. The mean $\log_{10}$FS (fluorescence stain) on the right dorsal part of hands in the control and experimental groups were -0.1689871669 and -0.1376256092. The mean $\log_{10}$FS (fluorescence stain) on the right ventral part of hands in the control and experimental groups were -1.457086593 and -1.490898149. However, it is found that the mean values for the residual fluorescence stain on hands in control groups were nearly all greater than the mean in experimental group except the mean UV coverage on the right ventral part of hands. The results explained the effect of UV germ intervention in the first training for the experimental group. The greater mean values of experimental group than control group may in somehow explain the lasting effect of UV hand washing training.

P values of both groups on the left dorsal part were 0.478, left ventral part was 0.550, right dorsal part was 0.663 and right ventral part was 0.202. As all P values were
greater than 0.05, the findings showed statistically insignificant result.

5.2 Association factors regarding the effect of UV hand washing training

In the study, the association of various factors (work experience, educational level and time when hand washing training was undertaken before the study) were evaluated to check for the relation of these factors with the effect of the UV hand washing training program.

It was found that the mean percentage for the removal of residual fluorescence stain on hands in the control group of 99.3970 for those who had been working for 3 years or more, was slightly greater than those who had worked for less than 3 years 99.0567. The mean percentage of the subjects in the experimental group of 99.5011 for those who had been working for 3 years or more was also slightly greater than 99.3066 for those who had worked less than 3 years. The P value for comparing the working experience of the experimental group of 0.418 was slightly greater than that of the control group. As the P values in both groups with different work experience were greater than 0.05, showing insignificant differences, the effect of the UV germ (fluorescence stain) intervention was found to have a mildly greater effect in the experimental group than the control group.

The same was found for the association factor of educational level in participants of both groups. The mean percentage for the removal of residual fluorescence stain on hands in the control group of 99.3699 (for those with Form 3 or above education) was
slightly greater than 99.1260 (for those who had below Form 3 education). The mean percentage of the subjects in the experimental group of 99.4856 (with Form 3 or above educational level) was also slightly greater than that of 99.4063 (below Form 3 educational level). The P value of 0.441 (for comparing educational level in the experimental group) was slightly greater than 0.182 in the control group.

As the P values in both groups with different educational level were greater than 0.05, showing insignificant differences, the effect of the UV germ (fluorescence stain) intervention was found to have a mildly greater effect in the experimental group than the control group.

The mean percentage of the subjects in experimental group 99.5162 (who had hand washing training taken 6 months or more before study) was greater than 99.2795 (who had hand washing training taken less than 6 months before the study. However, it was understood that a more recent hand washing training in a recent period of time was expected to have a fresher memory than those taken training in a longer period of time. As P values in both groups with hand washing training taken in earlier or later period of time were greater than 0.05, the result showed an insignificant differences for both groups. Hence the factors for working experiences, educational level and time for hand washing training taken before study did not show association with the intervention of UV germ (fluorescence stain) in the ultra violet hand washing training.

Regarding the association factor of the period having undertaken hand washing training
before the study, the mean percentage for the removal of residual fluorescence stain on hands in the control group of 99.2960 (for those who had the training 6 months or more before the study) was slightly greater than that of 99.2795 (for those who had training less than 6 months before the study).

5.3 Mean scoring of hand washing performance in control and experimental groups

In the result, it was found that participants in the study from 4 RCHEs, both in the control and experimental group, had a mean score of more than 99% in the removal of fluorescence in the Second part of the study. Mean score for both control and experimental group were of nearly the same variables and all P values were greater than 0.05. Effect of fluorescence stain intervened in both control and experimental groups enabled them generally to remove 99% of ultra violet germ on hands after hand washing.

In the study of Macdonald 2006, improvement of an average of fluorescence stain on hands was found in 55 personnel working in an orthopaedic department. Statistically significance was found in the health care professions with an improvement of an average of 7.8% to 2.3% area missed (P < 0.001) in a post-test after 7 days. As the findings are different in various studies, it is suggested to have further studies of different background or personnel in different setting to see the effect of UV hand washing for improvement of hand washing technique.
5.4 Site for deposition of UV germ on hands after hand washing

In the study, it was also found that more than 50% of the participants had UV germ deposited on the left dorsal, left ventral, right dorsal and right ventral parts of the hands. Although all of the participants in the study satisfied the inclusion criteria of having received hand washing training before the study, it was found that UV germ was deposited on the commonly neglected areas of the fingertips, thumbs and central parts of the hands.

<table>
<thead>
<tr>
<th>Hand sites with residual fluorescence stain covered on hands after hand washing</th>
<th>Frequency</th>
<th>Left dorsal</th>
<th>Left ventral</th>
<th>Right dorsal</th>
<th>Right ventral</th>
</tr>
</thead>
<tbody>
<tr>
<td>none</td>
<td>48.02%</td>
<td>62%</td>
<td>63%</td>
<td>62%</td>
<td>55%</td>
</tr>
<tr>
<td>thumbs</td>
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<td>fingers</td>
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<td>1%</td>
<td>3%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>spaces between fingers</td>
<td>0.99%</td>
<td>1%</td>
<td>3%</td>
<td>0%</td>
<td>1%</td>
</tr>
<tr>
<td>finger tips</td>
<td>26.59%</td>
<td>48%</td>
<td>16%</td>
<td>58%</td>
<td>12%</td>
</tr>
<tr>
<td>central portion</td>
<td>10.91%</td>
<td>0%</td>
<td>31%</td>
<td>2%</td>
<td>22%</td>
</tr>
<tr>
<td>Site with ring wearing</td>
<td>1.79%</td>
<td>2%</td>
<td>4%</td>
<td>1%</td>
<td>2%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>126%</td>
<td>126%</td>
<td>126%</td>
<td>126%</td>
</tr>
</tbody>
</table>

Table 12 Frequency for various hand sites found with residual fluorescence stain on hands after hand washing

Referring to the hand rubbing technique shown in the hand washing guidelines of the Centre of Health and Protection of the Hong Kong Special Administrative Region, the length of time required for proper hand washing is over 20 seconds. In view of the results of the study, the fingertips, thumbs and central portions of the right ventral are
areas in frequent contact with the environment, further study concerning the commonly neglected areas in hand washing is recommended to provide suggestions for the training in hand washing techniques.
Chapter 6 Conclusion

6.1 Limitation of this study

As the only researcher of this study, I am going to sum up the limitations found while carrying out this research.

Performance of hand washing techniques might be affected by the participants seeing their hands after washing under UV light with photos taken. The hand washing technique of each subject during the program was not checked due to limited manpower and support. The study required a lot of technical support for image analysis of all photos taken and time to analyze the proportion of UV germ coverage on hands.

All this made the study not capable of being refined and nor was prevention of possible confounding bias possible.

6.2 Effect of UV hand washing training

In view of all the results derived from the study, hand washing performance in the control and experimental groups was similar over the period of three months. Participants who attended the UV hand washing training the first time displayed a similar performance to that of the subjects in the experimental group in the second part of the study. This showed that the effect of UV hand washing training was as strong as for the first and second training.
6.3 Recommendation

In accordance with the commonly neglected area found in the study, a third training session with the use of fluorescence stain is recommended to study the areas that are missed commonly in hand washing. Suggestions can be made to improve the hand washing technique in hand hygiene practice.
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MEMO

To: CHOW Chun Ming Meyrick, School of Nursing
From: KWONG Wai Yung, Chairman, Departmental Research Committee, School of Nursing

Ethical Review of Research Project Involving Human Subjects

I write to inform you that approval has been given to your application for human subjects ethics review of the following research project for a period from 27/09/2011 to 14/04/2012:

Project Title: Effect of UV hand washing training on performance of hand washing: a longitudinal comparative study

Department: School of Nursing

Principal Investigator: CHOW Chun Ming Meyrick

Please note that you will be held responsible for the ethical approval granted for the project and the ethical conduct of the research personnel involved in the project. In the case the Co-PI has also obtained ethical approval for the project, the Co-PI will also assume the responsibility in respect of the ethical approval (in relation to the areas of expertise of respective Co-PI in accordance with the stipulations given by the approving authority).

You are responsible for informing the Departmental Research Committee School of Nursing in advance of any changes in the research proposal or procedures which may affect the validity of this ethical approval.

You will receive separate notification should you be required to obtain fresh approval.

KWONG Wai Yung
Chairman
Departmental Research Committee
School of Nursing
INFORMATION SHEET

Effect of UV hand washing training on performance of hand washing for Non-professional frontline care workers in Residential Care Homes for the Elderly

You are invited to participate in a study supervised by Dr. Merrick CHOW and conducted by Ms. CHAN Kit Fan, who is student of the School of Nursing in The Hong Kong Polytechnic University.

This study aims to improve hand washing technique in training program. The training includes theoretical and practical session of hand washing technique. Every participant will attend first and second Part of the training with an interval of three months interval for a total of four training hours. As fluorescence stain will be intervened in some part of the study, every participant will have a skin allergy test before use in the study. Participant who presented with redness or allergy reaction to fluorescence stain, he or she will not continue the study.

You have every right to withdraw from the study before or during the measurement without penalty of any kind. All information related to you will remain confidential, and will be identifiable by codes known only to the researcher.

If you have any complaints about the conduct of this research study, please do not hesitate to contact Ms. Kath Lui, Secretary of the Human Subjects Ethics Sub-Committee of The Hong Kong Polytechnic University in person or in writing (c/o Research Office in Room M502 of the University).

If you would like more information about this study, please contact Ms. CHAN Kit Fan at telephone number 2177- or supervisor Dr. Merrick CHOW at telephone number 27666547.

Thank you for your interest in participating in this study.

Principal Investigator
Ms CHAN Kit Fan.
Appendix 3

Effect of UV hand washing training on performance of hand washing for Non-professional frontline care workers in Residential Care Homes for the Elderly

紫外光顯影對安老院舍前線非專業護理員工應用於手部清潔技巧教學的效能

香港理工大學
護理學院
School of Nursing

Effect of UV hand washing training on performance of hand washing for Non-professional frontline care workers in Residential Care Homes for the Elderly

紫外光顯影對安老院舍前線非專業護理員工應用於手部清潔技巧教學的效能

現誠邀閣下機構內四間安老院舍前線護理照顧員工參加周湛明助理教授負責監督，陳潔芬負責執行的研究計劃。她是在香港理工大學護理學院學生。

這項研究的目的是確定有效提升清潔雙手技巧的教學方法。方法是透過兩種的教學方法給參與者在現場實習，並於三個月後再實習示範與以比較，參與者需要花費的時間為四小時，出席兩次每次兩小時的「手部清潔」培訓活動。由於該研究的過程中參與者可能會使用和接觸營光劑的用品實習，參與者將接受皮膚敏感測試，如出現紅疹等敏感反應，將不會被安排參與研究，以確定研究不會引起參與研究者任何不適。

參加者享有充分的權利在研究開始之前或之後決定退出這項研究，而不會受到任何對不正常的待遇或被追究責任。凡有關參加者的資料將會保密，一切資料的編碼只有研究人員獲悉。

如果閣下對這項研究有任何的不滿，可隨時與香港理工大學人類實驗對象守護小組委員會秘書呂小姐聯絡 (地址：香港理工大學研究事務處M502室轉交)。

如果閣下想獲得更多有關這項研究的資料，請與陳潔芬聯絡，電話2177-或聯絡她們的導師周湛明，電話2766-6547。

謝謝閣下有關安老院舍前線護理照顧員工有興趣參與這項研究。

主要研究員 (PI)

陳潔芬
CONSENT TO PARTICIPATE

1. Effect of UV hand washing training on performance of hand washing for Non-professional frontline care workers in Residential Care Homes for the Elderly

I, hereby consent to participate in the captioned research conducted by Ms CHAN Kit Fan.

I understand that information obtained from this research may be used in future research and published. However, my right to privacy will be retained, i.e. my personal details will not be revealed.

The procedure as set out in the attached information sheet has been fully explained. I understand the benefits and risks involved. My participation in the project is voluntary.

I acknowledge that I have the right to question any part of the procedure and can withdraw at any time without penalty of any kind.

Name of participant
Signature of participant
Name of Parent or Guardian (if applicable)
Signature of Parent or Guardian (if applicable)
Name of researcher ———- Ms CHAN Kit Fan
Signature of researcher
Date

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參與研究同意書

Effect of UV hand washing training on performance of hand washing for Non-professional frontline care workers in Residential Care Homes for the Elderly

紫外光顯影對安老院舍前線非專業護理員工應用於手部清潔技巧教學的效能

本人________________同意參加由陳潔芬負責執行的研究項目。

我理解此研究所獲得的資料可用於未來的研究和學術交流。然而我有權保護自己的隱私，我的個人資料將不能洩漏。

我對所附資料的有關步驟已經得到充分的解釋。我理解可能會出現的風險。我是自願參與這項研究。

我理解我有權在研究過程中提出問題，並在任何時候決定退出研究而不會受到任何不正常的待遇或責任追究。

參加者姓名__________________________________________。
參加者簽名______________________________________________。

研究人員姓名_________________陳潔芬__________________。
研究人員簽字__________________________________________。
日期__________________________________________________。
Appendix 6

THE HONG KONG POLYTECHNIC UNIVERSITY

Demographic data collection for participants in the study

Effect of UV hand-washing training on performance of hand washing for Non-professional frontline care workers in Residential Care Homes for the Elderly

Dear all,

Thank you for your participation in this hand washing training study. You are cordially invited to fill in particulars of the details listed below. All information provided is restricted to statistical and analytical purposes. All personal data collected should be kept with strict confidentiality and be destroyed after six months when the study completed.

Personal Particulars

1. Name: _______________________________ (Staff Number: ______________________)
2. Sex: □ Male □ Female
3. Rank: □ Care Worker □ Care Assistant □ Others (Remarks): ______________________
4. Working period for the present post:
   - Within one month □
   - One to six months □
   - Half year to one year □
   - One to three years □
   - Three to five years □
   - More than five years □
5. Educational level:
   - Below Form 3 □
   - Form 3 to Form 5 □
   - Form 5 or above □

6. Time for hand washing training taken before the study:
   - Within one month □
   - One to six months □
   - Half year to one year □
   - One to two years □
   - Two years or above □

-- Thank you.

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你好！多謝閣下參與是項手部清潔的研究。現誠邀閣下填寫以下簡單問卷，以作統計和分析之用。閣下提供的私人資料，將為保密以保護私隱和不會洩漏，有關的資料將於是項研究完結六個月後銷毀。

個人資料

1. 姓名： ____________________（職員編號： ________）

2. 性別： 男 ☐ 女 ☐

3. 職級： 照顧員 ☐ 復康助理 ☐ 其他（請備註）： ________

4. 入職該職位時間：
   一個月內 ☐ 一至六個月內 ☐ 半年至一年內 ☐
   一年至三年內 ☐ 三年至五年內 ☐ 五年以上 ☐

5. 學歷程度：
   中三以下 ☐ 中三至中五 ☐ 中五以上 ☐

6. 最近出席有關手部清潔技巧培訓時間
   一個月內 ☐ 一至六個月內 ☐ 半年至一年內 ☐
   一年至兩年內 ☐ 兩年以上 ☐

——致謝——