THE IMPACT OF AN INTERNATIONAL CLASSIFICATION OF FUNCTIONING, DISABILITY AND HEALTH (ICF)-BASED POST-STROKE REHABILITATION PROGRAM IN PROMOTING PATIENTS' COMMUNITY REINTEGRATION

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The Impact of An International Classification of Functioning, Disability And Health (ICF)-Based Post-Stroke Rehabilitation Program in Promoting Patients' Community Reintegration

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CERTIFICATE OF ORIGINALITY

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_____________________________ (Signed)

Wong Ngai Kiu (Name of student)

Abstract

This thesis investigates the application of the International Classification of Functioning, Disability and Health (ICF) model in the design of a new post-stroke rehabilitation program (i.e., the ICF-PSRP) to promote community reintegration of post-stroke patients. The first part of the thesis presents a narrative review that examined the extent to which the ICF model has been applied in post-stroke patient assessments and rehabilitation interventions. The second part reports a qualitative study that explored how use of the ICF model influenced the rehabilitation processes, program delivery and outcomes of the ICF-PSRP. The third part presents an outcome study that examined the effectiveness of the ICF-PSRP in enhancing outcomes in a group of post-stroke patients.

In the narrative review, the design and delivery of rehabilitation for post-stroke patients in the ICF model was explored as stipulated in the UK Stroke Guideline (hereinafter "the Guideline"). In the 36 ICF studies related to post-stroke rehabilitation, 151 clinical assessments were identified and these addressed more than two thirds of the topics covered by the Guideline. However, only four ICF-related clinical assessments had exact content matches to the Guideline's cognition, mobility (i.e., weakness and ataxia) and sensation topics. More than two thirds of the ICF-related assessments were categorized into either the Activity domain alone or the Activity and Participation (ICF-A&P) domains with no clear distinction. Environmental factors (EF) were also not emphasized in the ICF-related assessments. The Participation domain and EF comprise the core content required to promote independent living and community integration after stroke, so emphasis should be placed on these domains. Furthermore, 14 ICF-related post-stroke interventions were found in 25 studies, addressing only approximately one third of the intervention topics covered by the Guideline. Nine of these 14 ICF-related interventions showed exact content matches to those in the Guideline, such as arm function, communication (i.e., aphasia and activities of daily

living), extended activities of daily living and mobility (i.e., balance). This narrow scope highlights the need for researchers to explore, design and test novel post-stroke interventions. In addition, these interventions did not comply with the ICF-based neurorehabilitation process, as they did not incorporate goal-setting for intervention personalization. It is recommended that future studies of ICF-based interventions incorporate the Participation domain and EF by incorporating goal-setting into interventions.

In the qualitative study, feedback from patients and other stakeholders was collected on the extent to which the use of the ICF model influenced the rehabilitation processes, program delivery and outcomes of the ICF-PSRP. Thirty-three patients participated in intake and pre-discharge semi-structured interviews. Three case therapists and five clinical experts conducted a one-time semi-structured interview. The goals set by the patients and their caregivers showed a broadening of treatment concerns from intake to pre-discharge interviews. Their concerns focused on stroke problems related to the Body Function (ICF-BF) and Activity domains and on problems related to the Participation domain and EF. Patient–therapist interactions increased from intake to pre-discharge during the goal-setting and evaluation processes. The participants reflected on the importance of goal-setting, particularly when these goals guided the design and delivery of treatment content. The therapists and experts interviewed emphasized the importance of promoting the ICF concepts to patients, beginning with the goal-setting process. Tailoring treatment content to these goals further enhanced the patients' exposure to their living environments and thus helped to prepare them for reintegration into the community. Future studies should therefore further explore how patient–therapist interactions, exposure to EF and personalized interventions maximize the benefits of applying the ICF model to the community reintegration of post-stroke patients.

The quantitative study tested the impact of the ICF-PSRP in enhancing community reintegration of post-stroke patients. Fifty-two post-stroke patients who joined the ICF-PSRP were recruited. The ICF-PSRP uses a multidisciplinary approach of physiotherapy, occupational therapy and speech therapy to improve patient performance in the ICF-A&P domains. A quasi-experimental within-subjects design was used to assess the patients' primary outcomes in the ICF-BF domain (e.g., cognition and muscle strength) and in the ICF-A&P domains (e.g., mobility and instrumental activities of daily living) and secondary outcomes based on their perceived improvements in ability (e.g., quality of life). Comparisons of primary outcomes at intake with those at pre-discharge showed significant improvements in areas under the ICF-BF and ICF-A&P domains, with the exception of cognitive function under the ICF-BF domain. Path analyses were conducted to test the relationships between improvements in the ICF-BF and ICF-A&P domains to enable the prediction of secondary outcomes. One important finding was that the ICP-BF domain (i.e., improvements in expressive and receptive functions) was mediated by the ICF-A&P domains (i.e., improvements in everyday language) and predicted the secondary outcome of satisfaction with quality of life related to language. Another important finding was that the ICF-BF domain (i.e., improvements in upper extremity function) was mediated by the ICF-A&P domains (i.e., improvements in lower extremity mobility) and predicted the secondary outcome of satisfaction with quality of life related to work and productivity. Other less important findings were that the ICF-BF domain was mediated by some ICF-A&P domains and that that there were some reciprocal relationships, i.e., some ICF-A&P domains were mediated by the ICF-BF domain. Content analyses helped explain the relationships between the ICF-BF and ICF-A&P domains, showing that most treatment program content combined both types of intervention modules. The combined or integrated approach involved patients engaged in both types of training either within or across treatment sessions. These integrated arrangements are common in lower extremity training and language-related training. Moreover, these arrangements reflected that the content of the treatment was largely personalized with respect to the patients' goals set at the start of the program. However, the results of upper extremity training showed that the integrated approach tended to shift to the ICF-BF domain in the latter part of the program. This may be because the recovery period required for the upper extremities is quite long, whereas the duration of the ICF-PSRP was limited to 8–12 weeks. Future studies should use a randomized controlled trial design to explore the efficacy of the ICF-PSRP for post-stroke patients.

In summary, the ICF-PSRP is effective in promoting the functional recovery of post-stroke patients to enable their life role resumption and community reintegration. The findings of this thesis reveal several features and advantages unique to the design of rehabilitation programs based on the ICF model, namely goal-setting conducted by patients and case therapists, personalized treatment content, interventions based on the ICF-BF or ICF-A&P domains and integration of ICF-BF and ICF-A&P intervention modules. The main limitations of this study include its having been single-group design and not a randomized controlled trial, not having covered all ICF components and not having explored the relationship between all ICF domains in post-stroke rehabilitation.

Publications arising from the thesis

Published article

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Articles under review/preparation

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Conference presentations

Wong, M. N. K., & Chan, C. C. H. (2022, November 11). *Effect of ICF-based Program for Promoting Rehabilitation Outcomes of Post-stroke Patients*. Paper presented at Symposium on International Classification of Functioning, Disability and Health

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Chapter 1

General Introduction

1.1 Background

Stroke is a neurological disease which is regarded as one of the leading causes of adult mortality and disability (Yi et al., 2020). Limitations in daily living activities, cognitive impairment and poorer quality of life are often observed as the sequelae of stroke (Beal, 2010; Broussy et al., 2019). Early rehabilitation under medical stable condition for post-stroke patients is of importance to improve physical, mental and social functions (Dworzynski et al., 2015; Ru et al., 2017), and also independence after stroke (Alsubiheen et al., 2022).

In recent years, clinical guidelines have been formulated to shape the practices of post-stroke rehabilitation (Stinear et al., 2020; Winstein et al., 2016). These guidelines were designed according to stroke recovery stages (Bernhardt et al., 2017b). The acute stage lasts for one to seven days; the subacute phase lasts for seven days to six months after stroke, respectively. In these two phases, post-stroke patients would be inpatients receiving intensive rehabilitation for functional recovery (Bernhardt et al., 2017a). The intensive inpatient rehabilitation targets on enhancing body functioning and health-related functions (Carroll et al., 2020; Cott et al., 2007), such as upper and lower extremity functions (Pollock et al., 2014; Thieme et al., 2018), and expressive and receptive languages (Godecke et al., 2016). Beyond the subacute stage is the chronic stage which is six months after and outpatient rehabilitation programs are the key service that post-stroke patients would receive. These services further enhance or maintain the patients' recovery gained from inpatient rehabilitation (Rice et al., 2016), and facilitate independent living (Carroll et al., 2020; Lynch et al., 2017; Walker et al., 2013).

Previous studies indicated that post-stroke patients often exhibit social and environmental barriers after being discharged from hospitals and returning to home as well as the community (Mulligan et al., 2012). One plausible reason is that hospitals' main roles focus on disease management and improving functional abilities (Cott et al., 2007). As a result, less attention is placed on facilitating patients to regain their former roles after discharge (Dworzynski et al., 2015). It would be more effective for outpatient rehabilitation to play the role of maximizing patients' adaptation and participation in the home and community settings (Steihaug, 2015). Besides, the acute and subacute stages are usually short in duration and delivering intensive rehabilitation would be unrealistic and challenging (Kuipers et al., 2019). Therefore, outpatient rehabilitation beyond subacute stages is a continuation of the inpatient treatment to empower patients to control their own well-being (Carroll et al., 2020; Mas & Inzitari, 2015), promote functional dependence and community reintegration.

Existing literature described the service models to be applied in rehabilitation for community integration. For example, the Community-based Rehabilitation Matrix (CBRM; World Health Organisation, 2008), the Disability Creation Process (DCP) Model (Fougeyrollas et al., 2019; Vincent et al., 2007), the Model of Community Integration (CI; Liu et al., 2014; McColl et al., 1998), and the Person-Environment-Occupation-Performance (PEOP) Model (Baum & Christiansen, 2015). However, the flexibility of the CBRM to tailor the matrix's components varies across contexts and is difficult compare (Bowers et al., 2015); the uncorrelation between the environmental factors and personal factors in the DCP model may hinder the understanding of post-stroke patients' life habits (Bouffioulx et al., 2011); the exclusion of environmental factors in the CI may not be ideal to in post-stroke rehabilitation for returning to the community (Liu et al., 2014; McColl et al., 1998); and the PEOP showed difficulties to transfer functioning skills across similar environmental conditions (Wong & Fisher, 2015).

The International Classification of Functioning, Disability and Health (ICF) conceptualizes an individual's functioning and disability as a dynamic interaction among different events (Kuipers et al., 2019; World Health Organization, 2002). The domains of Body function (ICF-BF), Body structure (ICF-BS), Activity, and Participation are interconnected to impact on individual's health conditions, which can be a disorder, disease or disability. Contextual factors, including Environmental (EF) and Personal factors (PF), are also considered influencing the aforementioned ICF domains. The ICF model has been applied in different age groups, such as children and youth (Adolfsson et al., 2018), as well as different populations with mental disorders (Chao & Chen, 2019), neurological disorders (Pfaller et al., 2020) and cancer (Shen et al., 2019).

In terms of post-stroke ICF-based rehabilitation, a four-step neurorehabilitation process was suggested by Lexell and Brogårdh (2015). These steps include baseline assessment to understand patients' health conditions, goal-setting process with patients to formulate short-term or long-term rehabilitation plans, treatment contents which are tailored from assessment results and goals, and lastly outcome measurements to evaluate the level of changes. Other research and application of ICF in post-stroke rehabilitation cover the feasibility of using the Core Set for Stroke in outpatient rehabilitation (Han et al., 2015), mapping intervention contents with ICF domains (Evans et al., 2017), and exploring stroke training exercises with ICF domains (Van Puymbroeck et al., 2014).

1.2 Knowledge gaps

Although studies have been conducted regarding different aspects of ICF post-stroke rehabilitation, only three post-stroke programs up to date documented the application of ICF in the complete rehabilitation process as suggested by Lexell and Brogårdh (2015). Two of them are case studies (Abarghuei et al., 2018; Begum & Haque, 2019), and one of them is a small-scale randomized controlled trial with 15 patients in the experimental group and another 15 patients in the control group (Mehraban et al., 2022). The small sample size in these studies may limit the understanding and exploring the effectiveness of ICF in post-stroke rehabilitation. Therefore, a new outpatient ICF-based post-stroke rehabilitation program (ICF-PSRP) is proposed in this study to examine the effectiveness of ICF in post-stroke rehabilitation, particularly in promoting community reintegration and resuming patients' life roles.

1.3 Study aims

Aim 1: Conducting a narrative review to explore the coverage of post-stroke ICF rehabilitation in terms of assessments and interventions to inform its readiness to apply in the design and delivery of rehabilitation

Aim 2: Using a qualitative method, we interview post-stroke patients, clinical staff and institutional governance to explore the relevance and challenges of adopting the ICF as the service model to deliver a new ICF-PSRP. We also investigate the values and attitudes of these interviewees in adopting the process and delivering the program.

Aim 3: Using a quantitative method, we test the impact of the ICF-PSRP for post-stroke patients using a pre- and post-treatment design. We further focus on the relationship between Activity and Participation (ICF-A&P) and ICF-BF embedded in the treatments to formulate patients' subjective satisfaction with the treatment outcomes.

Chapter 2

Current research on the ICF-based assessments and interventions for the design and delivery of post-stroke rehabilitation: A narrative review

2.1 Introduction

Stroke is a neurological condition that damages neural systems (Harris et al., 2022) and can lead to motor, cognitive, and emotional sequelae (Shi et al., 2017; Stoodley et al., 2016). Immediate treatment and intensive rehabilitation have been found to be effective in enhancing the physical, mental, and social recovery of patients with stroke (Dworzynski et al., 2015; Ru et al., 2017).

The stroke rehabilitation process is guided by a number of service models and concepts. The International Classification of Functioning, Disability and Health (ICF) model, developed by the World Health Organization in 2001 (World Health Organization, 2002), describes the effects of dynamic interactions between events on an individual's health conditions (Kuipers et al., 2019). The ICF model describes the relationships between patients' health conditions, in terms of "functioning" and "disability," and a set of domains: Body Functions (ICF-BF), Body Structures (ICF-BS), and Activities and Participation (ICF-A&P). The model also includes Environmental Factors (EF) and Personal Factors (PF), which influence all other components simultaneously. The ICF Core Set (CS) for stroke was developed by selecting appropriate ICF categories to represent stroke symptoms (Geyh et al., 2004). More than two thirds of the CS categories have been reported to be consistent with post-stroke patients' problems, and the EF and PF have been found to be appropriate for clinical use (Glässel et al., 2012; Glässel et al., 2011; Glässel et al., 2010).

In the past two decades, the application of the ICF model in stroke rehabilitation has been extensively researched. For instance, the ICF-based categorical profile has been employed to document patients' conditions (Han et al., 2015; Paanalahti et al., 2013; Santana & Chun, 2017), and the contents of commonly used clinical assessments have been mapped onto the CS categories to supplement the ICF-based assessment (Beninato et al., 2009; Dong et al., 2016; Salter et al., 2005). Evidence has been gathered on the validity of the CS categories in different cultural contexts (Algurén et al., 2010; Vongsirinavarat & Jitaree, 2019; Wang et al., 2014), and ICF-based assessments have also been used to evaluate treatment outcomes (Abarghuei et al., 2018; Begum & Haque, 2019). These studies have demonstrated the effectiveness of the ICF model in various aspects of the design and delivery of rehabilitation programs for post-stroke patients.

Nevertheless, as the application of the ICF model has a relatively young history, other studies have reported problems and concerns related to gaps in its full applicability to post-stroke rehabilitation. For example, frontline clinicians have reported that a lack of consensus on the definition and contents of the "Activity" and "Participation" factors makes them difficult to be deployed in daily practice (Playford, 2020). The shortcomings of the PF category may prevent clinicians from applying the ICF model to describe patients' social background and lifestyle habits (Grotkamp et al., 2012). Therefore, a comprehensive review of the ICF literature is necessary to elucidate how effectively the ICF-based assessments and interventions can fulfill the rehabilitation needs of post-stroke patients and the extent to which they can inform effective delivery of rehabilitation services.

This review was compiled to examine the current state of research into the applicability of ICF-based assessments and interventions for the design and delivery of post-stroke rehabilitation. The review was structured based on published consensual clinical guidelines on post-stroke rehabilitation. The ICF literature was organized according to the rehabilitation stages stipulated in the guidelines. One advantage of adopting this structure is that it enables us to align the evidence on the ICF model with the recovery patterns in the injured brain and patients' functionality post-stroke, based on which the guidelines were written (Bernhardt et al., 2017b). Another advantage is that it enables this review to identify potential research gaps in the ICF literature. Among the small number of commonly used guidelines, we selected the United Kingdom (UK)'s National Clinical Guideline for Stroke (Royal College of Physicians, 2016; Rudd et al., 2017), henceforth "the UK Guideline." The contents of the UK Guideline are not as detailed as those of its United States counterpart in terms of defining the clinical assessments and interventions for each stage of rehabilitation (Winstein et al., 2016). However, as the UK Guideline was developed in the context of a public healthcare system, its contents should be applicable in countries or jurisdictions with similar systems, such as those of European countries (e.g., Italy; see [Signorelli et al., 2020] and Canada (Martin et al., 2018).

2.2 Methods

2.2.1 Design

This narrative review followed the Scale for the Assessment of Narrative Review Articles (SANRA; Baethge et al., 2019). SANRA stipulates six aspects to be covered in a narrative review: the rationale of the review, concrete research questions, literature search description, the use of references to support statements, scientific presentation, and the use of data to support evidence.

2.2.2 Defining stroke stages

There is no consensus on the division among or the duration of stroke recovery stages. Therefore, the terminology and the stage durations might vary to some extent across studies.

In this review, we followed the timeline used by Bernhardt et al. (2017b), i.e., the hyperacute stage (0 to 24 hours), acute stage (1 to 7 days), early subacute stage (7 days to 3 months), late subacute stage (3 to 6 months), and chronic stage (beyond 6 months). The review focuses on post-stroke rehabilitation, which begins at the early subacute stage and encompasses subsequent stages.

2.2.3 Search strategies and study selection

PubMed, CINAHL, and Google Scholar were used to search for articles published up to December 2022. The keywords were “ICF,” “ICF in stroke rehabilitation application,” “ICF in stroke management,” “stroke guidelines,” “stroke management,” “stroke ICF assessments,” and “stroke ICF interventions.” The search was restricted to studies written in English or Chinese. Studies were included if they focused on the application of ICF-based assessments or interventions for post-stroke rehabilitation. Studies were excluded if they were protocols; if they focused on economic evaluation of interventions or the use of interventions such as medication, or brain stimulation; or if no full text was found.

2.2.4 Methodological quality of the studies

The Grading of Recommendations, Assessment, Development, and Evaluations (GRADE) framework was chosen to evaluate the quality of evidence for the articles included in this narrative review. This framework consisted of four levels of evidence, namely very low (i.e. the true effect was largely different from the estimated effect), low (i.e. the true effect was different from the estimated effect), moderate (i.e. the true effect was close to the estimated effect), and high (i.e., the true effect was very similar to the estimated effect). The label with the level of evidence of the articles reviewed would contribute to the reliability of the results of the narrative review.

2.2.5 Data analysis

First, according to the topics listed in the UK Guideline, data on ICF-based clinical assessments and interventions were extracted from the included papers. Terms and concepts similar to those mentioned in the UK Guideline's topics (e.g., "Personal activities of daily living" under the UK Guideline's "Independence in daily living" topic) were also extracted. Information extracted from the identified ICF-based post-stroke rehabilitation literature included the clinical assessments and/or interventions mentioned, the ICF domains or factors, and the ICF codes. The contents of the ICF literature were collated and grouped under each UK Guideline topic. The ICF literature contents were then mapped according to the level of content similarity under the UK Guideline topics and their terms or concepts.

2.3 Results

2.3.1 The UK stroke guideline

The fifth edition of the UK Guideline was published by the Royal College of Physicians Intercollegiate Stroke Working Party in 2016 to encourage service quality improvement in stroke care (Royal College of Physicians, 2016; Rudd et al., 2017). The UK Guideline adopts an evidence-based approach and covers the entire recovery pathway and corresponding interventions from acute care to longer-term management over three chapters. Other chapters cover the guideline development processes, stroke service types and providers in the UK, and secondary prevention of stroke. Given our focus on post-stroke rehabilitation, this review is structured according to the topics in Chapter 4 of the UK Guideline ("Recovery and Rehabilitation").

2.3.2 Methodological quality of the studies

Regarding the methodological quality of the studies in mapping clinical assessment with the GRADE framework, 16 studies were identified as of high level of evidence, seven were at the moderate level, and four were at the low level. Nine studies could not be categorized by the GRADE, as mapping with clinical assessments was done by professional judgements: seven studies performed systematic literature searches, one study was a single study, and one study was a case report.

For mapping clinical interventions with ICF with outcome measures, seven studies were identified as of high level of evidence, four were at the moderate level, and four were at the low level. Two studies with systematic literature searches could not be categorized by the GRADE, and the mapping was completed by professional judgements. For mapping with intervention contents, three studies were identified by the GRADE as moderate level, one study was of high level of evidence, and one study was at a low level. Three studies could not be identified, as the systematic literature search approach was used and mapping was completed by professionals.

2.3.3 Concepts and assessments mapped with ICF domains

All 17 topics in Chapter 4 of the UK Guideline relate to the management of patients' loss of function and the limitations of post-stroke rehabilitation (Table 2.1). In addition to these topics, there are 41 concepts. Five topics stipulate types of clinical assessment: "Cognition," "Mobility – Weakness and ataxia," "Mood and well-being – Anxiety, depression and psychological distress," "Sensation," and "Swallowing." For these five topics, content mapping of the clinical assessments was conducted between the UK Guideline and the ICF literature. For all other topics, the clinical assessments mentioned in the ICF literature were listed under each topic but content mapping was not conducted.

Table 2.1 presents the results of content mapping for each UK Guideline topic. The contents of the ICF literature were compared with each UK Guideline topic at the ICF domain level and the ICF code level. For example, under the topic "Activities of daily living – Independence of daily living" and the concept "Personal activities of daily living," a mapping was established between "Eating and drinking" and the ICF code "d4108 Changing basic body position." A total of 151 clinical instruments were mentioned in the 36 ICF-related studies. Among these clinical instruments, 84 (56.4%) were associated with ICF domains (e.g., ICF-BF or A&P domains), and the rest (43.6%) were associated with ICF codes (e.g., "d4108 Changing basic body position").

Among the 17 UK Guideline topics, the ICF domains of the clinical assessments stipulated in the ICF literature were mapped to 12 topics (70.6%). Four clinical assessments showed exact matches with the UK Guideline: the Montreal Cognitive Assessment in "Cognition"; the Motricity Index *and* the Scale for the Assessment and Rating of Ataxia in "Mobility – Weakness and ataxia"; and the Nottingham Sensory Assessment in "Sensation." The 151 clinical assessments mentioned in the ICF literature, including the four exact matches, were mapped as follows to the 12 topics. Thirty-seven assessments (24.5%) were classified into the ICF-BF domain, and eight assessments (5.3%) were classified into the ICF-BS domain. Twenty-two assessments (14.6%) were classified into both the ICF-BF and BS domains. Most of these clinical assessments were mapped under three UK Guideline topics, namely, "Arm function," "Mobility – Weakness and ataxia," and "Sensation." In contrast, 49

(32.5%) and 12 (7.9%) assessments were classified into the “Activities” and “Participation” domains of ICF-A&P, respectively. Forty-seven assessments (31.1%) were classified into both the ICF-A&P domains. Most of these assessments that mapped to both A&P domains were grouped and mapped under the “Mobility – walking” UK Guideline topic. Substantially fewer assessments were classified under the contextual factors: six assessments (4%) were classified as EF and none as PF. The UK Guideline topics to which these six assessments were mapped were “Communication – Aphasia,” “Mobility,” and “Swallowing.”

The UK Guideline’s “Mobility – walking” topic was mapped to the largest number of assessments (49) in the ICF literature, the majority of which (40; 81.6%) concurrently covered both ICF-A&P domains. The UK Guideline topic to which the second largest number of assessments in the ICF literature was mapped was “Arm function,” with 40 matches. Fifteen assessments (37.5%) were classified under only the Activities domain, and six assessments (15%) were classified under the ICF-BF domain. In contrast, the UK Guideline topics to which the fewest assessments were mapped were “Fatigue,” “Pain,” “Spasticity and contractures,” and “Vision,” each being mapped to only one assessment.

Table 2.1. Content mapping of the ICF-based literature on the concepts and clinical assessments in the UK Stroke Guideline (Note: A, activity; BF, body function; BS, body structure; CF, contextual factors; EF, environmental factors; P, participation.) (* The contents of the clinical assessments mentioned in the ICF literature are deemed comparable to the assessments or share similar concepts in the UK Guideline. # The clinical assessments are not specific to measurement of Body function or Body structure, or Activity or Participation domain.

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
Activities of daily living – Independence in daily living	• Also known as personal activities of daily living (PADL) • Range of basic activities such as washing, dressing, bathing, going to the toilet, eating and drinking	N/A	Stroke Impact Scale (SIS) – ADL subscale (Lee et al., 2019)	✓#	✓#	✓			✓	
			Barthel Index (BI; Hao et al., 2022; Schepers et al., 2007; Veerbeek et al., 2017)	✓		✓#	✓#			✓
			Modified BI (Hao et al., 2022)			✓			✓	
			Abilhand and Activlim questionnaires (Dehem et al., 2019)			✓			✓	
			Modified Rankin Scale (Veerbeek et al., 2017)			✓				✓
			Functional Independence Measure (FIM; da Silva et al., 2020; Fréz et al., 2013; Hao et al., 2022; Jaafar et al., 2021; Silva et al., 2020; Veerbeek et al., 2017)			✓#	✓#			✓
			The Self-Care subscale in the Stroke-Specific Quality of Life (SSQoL; Silva et al., 2015; Silva et al., 2013; Teixeira-Salmela et al., 2009; Wu et al., 2020)			✓#	✓#			✓
			A mapping conducted by Campos et al. (2019) with the PADL activities and ICF domains (e.g. “eating and drinking” is mapped with “ d4108 Changing basic body position”)			✓#	✓#			✓

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
			The Social Roles subscale in the SSQoL (Lee et al., 2019; Silva et al., 2015; Silva et al., 2013; Teixeira-Salmela et al., 2009; Wu et al., 2020)			✓#	✓#			✓
			Daily Experiences of Pleasure, Productivity and Restoration Profile (Atler et al., 2015)				✓		✓	
			Nottingham Extended ADL Scale (Lee et al., 2019)				✓		✓	
Activities of daily living – Extended activities of daily living (EADL)	• Encompass both domestic and community activities such as shopping, cooking and housework that allow complete or virtually complete independence • EADL activities enable community and social participation	N/A	A mapping conducted by Campos et al. (2019) with the EADL together with social ADL activities and ICF domains			✓#	✓#			✓
			London Handicap Scale (de Souza et al., 2017)				✓			✓
			Frenchay Activities Index (de Souza et al., 2017; Lee et al., 2019)				✓			✓
			The Family Roles subscale in the SSQoL (Lee et al., 2019)				✓		✓	
			Daily Experiences of Pleasure, Productivity and Restoration Profile (Atler et al., 2015)				✓		✓	
			SIS (Dehem et al., 2019; Doumas et al., 2021; Lee et al., 2019)				✓		✓	
			Extended ADL Scale (Lee et al., 2019)				✓		✓	
			Normal Living Index (Lee et al., 2019)				✓		✓	
			Physical Activity Scale for Individuals with Physical Disabilities (Lee et al., 2019)				✓		✓	
			Participation strategies self-efficacy scale (Lee et al., 2019)				✓		✓	

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
Activities of daily living – Work and leisure	• Productive work (paid or voluntary) • Return to work • Leisure activities	N/A	The Work/productivity subscale from SSQoL (Lee et al., 2019; Silva et al., 2013; Teixeira-Salmela et al., 2009; Wu et al., 2020)			✓#	✓#			✓
			SIS-3.0 (Cawood et al., 2016)				✓		✓	
			Nottingham Leisure Questionnaire (Lee et al., 2019)				✓		✓	
			Utrecht Scale for Evaluation of Rehabilitation – Participation restriction (Lee et al., 2019)				✓		✓	
Arm function	• Unilateral functional activities • Limb movement	N/A	Grip strength (da Silva et al., 2020; Hao et al., 2022; Silva et al., 2015; Yilmazer et al., 2019)	✓	✓				✓	
			Range of movement (da Silva et al., 2020; Yilmazer et al., 2019)	✓	✓				✓	
			Modified Motor Assessment Scale – Upper Arm Function component (Hao et al., 2022; Yilmazer et al., 2019)	✓	✓				✓	
			Brunnstrom stage for arm and hand (Yilmazer et al., 2019)	✓	✓				✓	
			Fugl-Meyer Assessment – Upper Extremity (Atler et al., 2015; da Silva et al., 2020; Doumas et al., 2021; Hao et al., 2022; Jaafar et al., 2021; Krakauer et al., 2021; Lee et al., 2019; Rozevink et al., 2021; Subramanian et al., 2020; Veerbeek et al., 2017; Wu et al., 2020; Yilmazer et al., 2019)	✓	✓					✓
			Shoulder flexion in active range of motion (AROM; Lee et al., 2019)	✓#	✓#				✓	
			Elbow extension in AROM (Lee et al., 2019)	✓#	✓#				✓	

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
			Shoulder flexor/elbow dynamometry (Lee et al., 2019)	✓#	✓#				✓	
			Wrist flexion and extension (Yilmazer et al., 2019)	✓#	✓#				✓	
			Temporal Coordination Index (Lee et al., 2019)	✓#	✓#				✓	
			Digital reaction time (Yilmazer et al., 2019)	✓#	✓#				✓	
			Purdue Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Three assessments categorized by Lemmens et al. (2012) under the ICF-BF and Activity domains for post-stroke patients (e.g. Functional Test for the Hemiplegic Upper Extremity)^	✓		✓			✓	
			Wolf Motor Function Test (Atler et al., 2015; da Silva et al., 2020; Dehem et al., 2019; Doumas et al., 2021; Lee et al., 2019; Rozevink et al., 2021; Veerbeek et al., 2017; Yilmazer et al., 2019)	✓		✓				✓
			Twelve assessments categorized by Lemmens et al. (2012) under the Activity domain for post-stroke patients (e.g Frenchay Arm Test)^			✓			✓	
			Action Research Arm Test (Doumas et al., 2021; Hao et al., 2022; Krakauer et al., 2021; Lee et al., 2019; Rozevink et al., 2021; Veerbeek et al., 2017)			✓				✓
			Box and Block Test (da Silva et al., 2020; Doumas et al., 2021; Hao et al., 2022; Jaafar et al., 2021; Lee et al., 2019)			✓				✓

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
			Arm Motor Ability Test (da Silva et al., 2020; Jaafar et al., 2021; Veerbeek et al., 2017; Yilmazer et al., 2019)			✓				✓
			Nine-Hole Peg Test (da Silva et al., 2020)			✓				✓
			Chedoke Arm and Hand Activity Inventory (da Silva et al., 2020)			✓				✓
			Jebsen-Taylor Hand Function Test (da Silva et al., 2020; Jaafar et al., 2021)			✓				✓
			SIS – upper limb items (Hao et al., 2022; Lee et al., 2019)			✓			✓	
			Manual Function Test (Hao et al., 2022)			✓			✓	
			The ABILHAND questionnaire (Jaafar et al., 2021)			✓			✓	
			Upper Extremity Performance Test (Lee et al., 2019)			✓			✓	
			Motor Activity Log (Atler et al., 2015; da Silva et al., 2020; Hao et al., 2022; Jaafar et al., 2021; Rozevink et al., 2021; Yilmazer et al., 2019)			✓	✓		✓	
			The Upper Extremity Function subscale in the SSQoL (Silva et al., 2013; Teixeira-Salmela et al., 2009)			✓#	✓#			✓
Cognition	• Cognitive losses • Perception • Attention • Memory	• Montreal Cognitive Assessment (MoCA)*	MoCA (Dong et al., 2016; Hao et al., 2022)*	✓						✓
			Mini-Mental State Examination (Dong et al., 2016; Hao et al., 2022; Salter et al., 2005; Zhang et al., 2018)	✓						✓

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
		• Oxford Cognitive Screen	Loewenstein Occupational Therapy Cognitive Assessment (Cawood et al., 2016)	✓					✓	
			Computerized neuropsychological test, including forward and backward digit span tests, and verbal learning test (Hao et al., 2022)	✓#	✓#				✓	
			CogState Groton Maze Learning and Set Shift Tasks (Hao et al., 2022)	✓#	✓#				✓	
			Kinesthetic and Visual Imagery Questionnaire (Yilmazer et al., 2019)	✓#	✓#				✓	
Communication – Aphasia	• Impairment of language function • Problems with communication • Affected abilities include speaking, understanding, reading and writing	N/A	Western Aphasia Battery (Simmons-Mackie & Kagan, 2007)	✓					✓	
			Psycholinguistic Assessment of Language Processing in Aphasia (Simmons-Mackie & Kagan, 2007),	✓					✓	
			FIM (Fréz et al., 2013; Silva et al., 2020)	✓		✓#	✓#			✓
			The Language subscale in the SSQoL (Silva et al., 2015; Teixeira-Salmela et al., 2009; Wu et al., 2020)	✓		✓#	✓#	✓ (EF)		✓
			The American Speech-Language-Hearing Association Functional Assessment of Communication Skills (Simmons-Mackie & Kagan, 2007),			✓			✓	
Fatigue	• A lack of energy • An increased need to rest	N/A	The Energy subscale in the SSQoL (Silva et al., 2015; Teixeira-Salmela et al., 2009)	✓						✓
Mobility	• Affected abilities	N/A	Stroke Rehabilitation Assessment of Movement (Kegelmeyer et al., 2014)	✓		✓			✓	

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
	include balance, falls, and walking		The Mobility subscale in the SSQoL (Silva et al., 2015; Silva et al., 2013; Teixeira-Salmela et al., 2009; Wu et al., 2020)	✓		✓	✓	✓ (EF)		✓
			SIS – Mobility subscale (Lee et al., 2019)			✓			✓	
			FIM (Fréz et al., 2013; Silva et al., 2020)			✓[#]	✓[#]	✓ (EF)		✓
Mobility – Weakness and ataxia	• Lack of coordination of movement • Loss of selective movement	• Motricity Index* • Scale for the Assessment and Rating of Ataxia (SARA)*	Motricity Index (Geroin et al., 2013)*	✓						✓
			SARA (Ahmedy et al., 2020; Reoli et al., 2021)*	✓					✓	
			Fugl-Meyer Assessment – Lower Extremity (FMA-LE; Kegelmeyer et al., 2014)	✓					✓	
			Motor Power Scale (Veerbeek et al., 2017)	✓						✓
			Manual Muscle Testing scale (Hao et al., 2022; Yilmazer et al., 2019)	✓[#]	✓[#]				✓	
			SIS – Strength subscale (Lee et al., 2019)			✓			✓	
Mobility – Balance	• Dynamic balance	N/A	FMA-LE (de Paula Oliveira et al., 2015)	✓					✓	
			Trunk Impairment Scale (Kegelmeyer et al., 2014)	✓					✓	
			Clinical Test of Sensory Integration and Balance (Kegelmeyer et al., 2014)	✓					✓	
			FMA – Balance (Zhang et al., 2018).	✓	✓	✓			✓	

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
			Berg Balance Scale (Beninato et al., 2009; Hao et al., 2022; Kegelmeyer et al., 2014; Schepers et al., 2007)			✓				✓
			Postural Assessment Scale for Stroke Patient (Hao et al., 2022; Kegelmeyer et al., 2014)			✓			✓	
			Functional Reach Test (Hao et al., 2022; Kegelmeyer et al., 2014)			✓			✓	
			Five Times Sit-to-Stand Test (Kegelmeyer et al., 2014)			✓			✓	
			Timed Up and Go test (TUG; Kegelmeyer et al., 2014; Rosa et al., 2015)			✓			✓	
			Balance Evaluation Systems (BESTest; de Paula Oliveira et al., 2015)			✓			✓	
			Sitting Balance Test (Hao et al., 2022)			✓			✓	
			Step Test (Hao et al., 2022)			✓			✓	
Mobility – Falls and fear of falling	• Balance deficits • Reduced postural stability • High incidence of falls	N/A	Fall Efficacy Scale (Rosa et al., 2015)			✓[#]	✓[#]			✓
Mobility – Walking	• Walk independently	N/A	Two assessments that categorized by Mudge and Stott (2007) under the ICF-BF domain (e.g. Hemiplegic Gait Analysis Form)^	✓						✓

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
			Three assessments that categorized by Mudge and Stott (2007) under the ICF-BF and ICF-A&P domains (e.g. Wisconsin Gait Scale, and Rivermead Visual Gait Assessment)^	✓		✓#	✓#			✓
			10-Meter Walk Test (Kegelmeyer et al., 2014; Silva et al., 2015)			✓			✓	
			TUG (Hao et al., 2022; Kegelmeyer et al., 2014; Rosa et al., 2015)			✓				✓
			6-Minute Walk Test (Kegelmeyer et al., 2014; Meng et al., 2022)			✓			✓	
			Dynamic Gait Index (Kegelmeyer et al., 2014)			✓			✓	
			BESTest (de Paula Oliveira et al., 2015)			✓			✓	
			Functional Ambulation Category (Meng et al., 2022)			✓			✓	
			5-meter walk test (Rosa et al., 2015)			✓#	✓#		✓	
			Thirty six assessments that categorized by Mudge and Stott (2007) under the ICF-A&P domains (e.g. Sickness Impact Profile, and Falls Efficacy Scale)^			✓#	✓#			✓
Mood and well-being	• Emotional problems	N/A	The Mood subscale in the SSQoL (Silva et al., 2015; Teixeira-Salmela et al., 2009)	✓						✓
Mood and well-being – Anxiety, depression and	• Mood disturbance	• Stroke Aphasic Depressio n	The Hospital Anxiety and Depression Scale (Hao et al., 2022; Viktorisson et al., 2022)	✓					✓	
			Beck Depression Inventory (Barak & Duncan, 2006)	✓					✓	

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
psychological distress		Questionnaire • Depression Intensity Scale Circles • Behavioural Outcomes of Anxiety scale	Center for Epidemiologic Studies Depression (Barak & Duncan, 2006)	✓					✓	
			Geriatric Depression Scale (Barak & Duncan, 2006)	✓					✓	
Pain	• Include neuropathic pain, musculoskeletal pain, shoulder pain as well as shoulder subluxation	N/A	Nottingham Health Profile (Silva et al., 2013)			✓#	✓#			✓
Sensation	• Sensory loss • Somatic sensations	• Nottingham Sensory Assessment*	Revised Nottingham Sensory Assessment (da Silva et al., 2020; Jaafar et al., 2021; Yilmazer et al., 2019)*	✓#	✓#				✓	
			Sensory Integration Praxis Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Byl-Cheney-Boczai Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Fabric Matching Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Tactile Discrimination Test (Yilmazer et al., 2019)	✓#	✓#				✓	

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
			Wrist Position Sense Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Finger Position Sense Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Functional Tactile Object Recognition Test (Yilmazer et al., 2019)	✓#	✓#				✓	
			Weinstein Enhanced Sensory Test – hand monofilaments (Yilmazer et al., 2019)	✓#	✓#				✓	
Spasticity and contractures	• Contractures - shortening of surrounding tissues leading to restricted movement of joints	N/A	The Original and Modified Ashworth's Scale (da Silva et al., 2020; Rosa et al., 2015; Salter et al., 2005; Veerbeek et al., 2017; Yilmazer et al., 2019)	✓#	✓#				✓	
Swallowing	• Dysphagia • Swallowing difficulty	• A water intake test of 10 teaspoons • A lingual motor test	Frenchay dysarthria evaluation (Dong et al., 2016)	✓				✓ (EF)		✓
			Repetitive saliva swallowing test (Dong et al., 2016)	✓	✓			✓ (EF)		✓
			Kubota Water Swallowing Test (Dong et al., 2016)	✓	✓	✓#	✓#	✓ (EF)		✓
Vision	• Visual problems • Visual impairments • Central visual loss	• N/A	The Vision subscale in the SSQoL (Silva et al., 2015; Teixeira-Salmela et al., 2009)	✓						✓

Guideline Topics	Guideline Concepts	Guideline Clinical Assessments	ICF Literature Assessments	BF	BS	A	P	CF	ICF domains	ICF codes
	• Problems include altered acuity, field loss such as hemianopia and disruption of eye movements causing diplopia, nystagmus, blurred vision and loss of depth perception • Central visual loss									

Note: *Clinical assessments mentioned in the UK guideline are identical to the clinical assessments or share a similar concept mentioned in other literature. #Clinical assessments are non-specified to the Body function or Body structure, or Activity or Participation domain. A, Activity; BF, Body function; BS, Body structure; CF, Contextual factors; EF, Environmental factors; P, Participation.

2.3.4 Interventions mapped with mapped with ICF domains

There were only seven UK Guideline topics stipulating clinical interventions for post-stroke patients: "Activities of daily living – Extended activities of daily living (EADL)," "Arm function," "Cognition," "Communication – Aphasia," "Mobility – Balance," "Mobility – Walking", and "Sensation." Three of the interventions stipulated under these topics had defined treatment contents and relevant outcome measures (Table 2.2). The other 11 interventions had defined outcome measures but lacked clear descriptions of the treatment contents (Table 2.3).

The three ICF-based interventions with defined treatment contents and relevant outcome measures, namely, virtual reality (VR), hands-on physiotherapy, and aphasia, were mapped to interventions mentioned in the UK Guideline (Table 2.2). The VR interventions were classified under "Arm function" (Doumas et al., 2021; Hao et al., 2022; Merians & Fluet, 2014; Rozevink et al., 2021; Subramanian et al., 2020), while the aphasia interventions reported in Simmons-Mackie and Kagan (2007) and Cherney and Carpenter (2022) were classified under "Communication – Aphasia." The hands-on physiotherapy interventions were classified under "Arm function" and "Mobility – Walking" (Table 2.2). The ICF-based VR interventions had a direct content match with the VR intervention and interactive video games mentioned under the "Arm function" topic of the UK Guideline and were classified under the ICF-BF, ICF-BS, and Activities domains in the literature (Table 2.2). Another exact content match mapped the multimodality language stimulation, semantic therapy, compensatory, and communication partner training interventions in the ICF literature with the communication/conversation therapy and communication partner training interventions mentioned in the UK Guideline. The communication interventions in the ICF literature were classified under all ICF domains except ICF-BS (Table 2.2).

The 11 interventions with defined outcome measures but without clear descriptions of the treatment contents mentioned in the UK Guideline were classified under the "Arm function" and "Mobility – Balance" topics (Table 2.3). Five of these interventions were classified under the "Arm function" topic, namely, constraint-induced movement therapy (CIMT; Atler et al., 2015; da Silva et al., 2020; Kwakkel et al., 2015; Pain et al., 2015), upper-limb robot-assisted therapy (Dehem et al., 2019; Veerbeek et al., 2017; Wu et al., 2020), mirror therapy (da Silva et al., 2020; Jaafar et al., 2021), neuroanimation therapy (Krakauer et al., 2021), and upper-limb somatosensory interventions (Yilmazer et al., 2019). Three of the 11 interventions were classified under the topic of walking abilities, namely, body weight-supported treadmill training and overground walking training (Combs-Miller et al., 2014), robot-assisted gait training (Geroin et al., 2013; Meng et al., 2022), and dance therapies (Ares-Benitez et al., 2022). The remaining three of the 11 interventions were classified under the four topics of "Balance abilities," "EADL," "Cognition," and "Sensation," respectively. One exact content match was between a community participation intervention to improve outdoor mobility under the "EADL" topic of the UK Guideline and a community participation intervention in the ICF literature. All community participation interventions in the ICF literature were classified under the ICF-A&P domains. Another exact content match was between a mirror therapy intervention under the "Arm function" topic of the UK Guideline and an identically named intervention mentioned in the ICF literature. All mirror therapy interventions in the ICF literature were classified under the ICF-BF and Activities domains. Other interventions mentioned under the "Arm function" topic in the UK Guideline, such as CIMT, were mapped to the trunk resistance training mentioned in the ICF literature. The interactive video games and robot-mediated treatment mentioned in the UK Guideline were mapped to the upper-limb robot-assisted therapy mentioned in the ICF literature. All of the interventions mentioned in the ICF literature were classified under the

ICF-BF and ICF-A&P domains. A video gaming intervention under the “Balance” topic in the UK Guideline was mapped to VR balance training in the ICF literature and was classified under the ICF-BF and A&P domains.

Table 2.2. Content mapping of the ICF-based literature on the interventions based on their contents in the UK Stroke Guideline (Note: A, activity; BF, body function; BS, body structure; CF, contextual factors; EF, environmental factors; P, participation.) (* The contents of the interventions mentioned in the ICF literature are deemed comparable to the assessments or share similar concepts in the UK Guideline. # The intervention contents are not specific to measurement of Body function or Body structure, or Activity or Participation domain.

Guideline Topics	Guideline Clinical Interventions	ICF Literature Interventions	Brief Intervention Content and Relevant Outcome Measures Descriptions	BF	BS	A	P	CF	ICF domains	ICF codes
Arm function	• Intensive, repetitive, task-orientated and task-specific training • Constraint-induced movement therapy (CIMT) • Mental practice with motor imagery • Virtual reality (VR)* • Interactive video games* • Robot-mediated treatment • Mirror therapy	VR interventions (Doumas et al., 2021; Hao et al., 2022; Merians & Fluet, 2014; Rozevink et al., 2021; Subramanian et al., 2020)*	• Interventions target on patient's ICF-BF and ICF-BS improvements. Some interventions also target on transfer of skills to living environments via using and grasping activity of daily living objects in virtual environments • Outcome measures target on ICF-BF (e.g. measured by the Fugl-Meyer Assessment and grip strength), Activity (e.g. measured by the Wolf Motor Function Test and Barthel Index), and participation (e.g. measured by the Stroke Impact Scale) domains	✓	✓	✓			✓	
		Hands-on physiotherapy interventions mentioned in de Almeida et al. (2015)	• It involves therapists touching the patients to treat injury, disability and musculoskeletal pains. Concepts cover the Bobath concept and proprioceptive neuromuscular facilitation • Intervention contents and outcome measures are connected with ICF codes, including the ICF-BF (e.g., "b260 Proprioceptive functions" and "b740 Muscle endurance functions" and ICF-A&P (e.g., "d415 Maintaining body position" and "d420 Transferring oneself")	✓	✓	✓#	✓#			✓

Guideline Topics	Guideline Clinical Interventions	ICF Literature Interventions	Brief Intervention Content and Relevant Outcome Measures Descriptions	BF	BS	A	P	CF	ICF domains	ICF codes
Communication – Aphasia	• Cognitive-linguistic therapy • Communication/ conversation therapy* • Constraint-induced speech and language therapy • Computerized speech and language therapy • Communication partner training*	Interventions mentioned in Simmons-Mackie and Kagan (2007) and Cherney and Carpenter (2022)*	• Interventions targeting on ICF-BF such as multimodality language stimulation to improve language process, and semantic therapy to improve word finding. Corresponding ICF-BF outcome measures are suggested such as the Western Aphasia Battery and the Psycholinguistic Assessment of Language Processing in Aphasia • Interventions targeting on ICF-A&P such as compensatory training on engaging in communicative interactions, and conversation therapy on improving conversation. Corresponding ICF-A&P outcome measures are suggested such as the American Speech-Language-Hearing Association Functional Assessment of Communication Skills • Interventions targeting on contextual factors such as training communication partners on facilitating and supporting communication, and personal factors include aphasia groups	✓		✓#	✓#	✓	✓	
Mobility – Walking	• Task-specific, walking orientated leg exercises	Refer to hands-on physiotherapy intervention mentioned in the "Arm function" topic								

Note: *Intervention contents mentioned in the UK guideline are identical to the interventions or share a similar concept mentioned in other literature. #Intervention contents are non-specified to the Body function or Body structure, or Activity or Participation domain. A, Activity; BF, Body function; BS, Body structure; CF, Contextual factors; EF, Environmental factors; P, Participation.

Table 2.3. Content mapping of the ICF-based literature on the interventions based on their outcome measures in the UK Stroke Guideline (Note: A, activity; BF, body function; BS, body structure; CF, contextual factors; EF, environmental factors; P, participation.) (* The outcome measures of the interventions mentioned in the ICF literature are deemed comparable to the assessments or share similar concepts in the UK Guideline. # The outcome measures are not specific to measurement of Body function or Body structure, or Activity or Participation domain.

Guideline Topics	Guideline Clinical Interventions	ICF Literature Interventions	Brief Outcome Measure Descriptions	BF	BS	A	P	CF	ICF domains	ICF codes
Activities of daily living – Extended activities of daily living (EADL)	• Intervention to increase outdoor mobility*	Interventions for community participation mentioned in Lee et al. (2019)*	• These interventions for community participation target on the ICF-A&P domains such as interpersonal relations and using transportation#			✓#	✓#		✓	
Arm function	• Intensive, repetitive, task-orientated and task-specific training • Constraint-induced movement therapy (CIMT)* • Mental practice with motor imagery • Virtual reality (VR) • Interactive video games* • Robot-mediated treatment* • Mirror therapy*	Trunk restraint training (Pain et al., 2015), including the CIMT (Atler et al., 2015; da Silva et al., 2020; Kwakkel et al., 2015; Pain et al., 2015)*	• The interventions target on the BF (e.g. measured by the Fugl-Meyer Assessment – Upper Extremity [FMA-UE], activity (e.g. measured by the Wolf Motor Function Test, and the Action Research Arm Test) and participation (e.g. measured by the Frenchay Activities Index) domains	✓		✓	✓		✓	
		Upper-limb robotic-assisted therapy (Dehem et al., 2019; Veerbeek et al., 2017; Wu et al., 2020)*	• It targets on ICF-BF domain (e.g. “b730 muscle power functions” measured by the Motor Power Scale), the Activity (e.g. “d512 washing oneself” and “d520 toileting” measured by Barthel Index), and the Participation (e.g. measured by the Stroke-Specific Quality of Life [SSQoL]) domains	✓		✓	✓			✓
		Mirror therapy (da Silva et al., 2020; Jaafar et al., 2021)*	• Mirror therapies target on ICF-BF (measured by the FMA, and sensory function by the Nottingham Sensory Assessment) and Activity (e.g.	✓		✓			✓	

Guideline Topics	Guideline Clinical Interventions	ICF Literature Interventions	Brief Outcome Measure Descriptions	BF	BS	A	P	CF	ICF domains	ICF codes
			measured by the Box and Block Test and Functional Independence Measure) domains							
		Neuroanimation therapy (Krakauer et al., 2021)	• The Neuroanimation Therapy targets on the ICF-BF (measured by the FMA-UE) and Activity (measured by the Action Research Arm Test) domains	✓		✓			✓	
		Upper limb somatosensory interventions mentioned in Yilmazer et al. (2019)	• It targets on the ICF-BF (e.g. measured by the FMA and Finger Position Sense Test), Activity (e.g. measured by the Motor Assessment Scale and Wolf Motor Function Test) and Participation (e.g. measured by the Stroke Impact Scale) domains	✓		✓	✓		✓	
Cognition	• A self-awareness intervention of meal preparation activities	Therapist-lead one-on-one cognitive interventions (Saa et al., 2021)	• The therapist-lead cognitive interventions targets on the ICF-BF cognitive domain, such as attention and calculation	✓					✓	
Mobility – Balance	• Trunk training • Sit to stand and functional walking • Video gaming on balance*	Dance therapies mentioned by Ares-Benitez et al. (2022)	• The dance therapies target on ICF-BF (e.g. gait speed from spatio-temporal parameters of walking) and Activity (e.g. balance measured by Berg Balance Scale) domains	✓		✓			✓	
		Balance training in VR (de Paula Oliveira et al., 2015)*	• It targets on ICF-BF (e.g. measured by the FMA – Lower Extremity), Activity (e.g. dynamic gait by the Balance Evaluation Systems Test), and Participation (e.g. quality of life measured by SSQoL) domains	✓		✓	✓		✓	
		Refer to dance therapies in the “Balance” topic								

Guideline Topics	Guideline Clinical Interventions	ICF Literature Interventions	Brief Outcome Measure Descriptions	BF	BS	A	P	CF	ICF domains	ICF codes
Mobility – Walking	• Task-specific, walking orientated leg exercises	Body weight-supported treadmill training and overground walking training (Combs-Miller et al., 2014)	• The Body weight-supported treadmill training and overground walking training are measured by a validated ICF Measure of Participation and ACTivities tapping on the ICF-AP domains			✓	✓		✓	
		Robot-assisted gait training (Geroin et al., 2013; Meng et al., 2022)	• The robot-assisted gait training targets ICF-A&P domains which measured by the six-minute walk test and the Functional Ambulatory Classification			✓#	✓#		✓	
Sensation	• Mirror therapy	Refer to upper limb somatosensory interventions in the "Arm function" topic								

Note: *Interventions mentioned in the UK guideline are identical to the interventions or share a similar concept mentioned in other literature. #Outcome assessments are non-specified to the Body function or Body structure, or Activity or Participation domain. A, Activity; BF, Body function; BS, Body structure; CF, Contextual factors; EF, Environmental factors; P, Participation.

2.4 Discussion

This review examined the extent of current research into the applicability of ICF-related assessments and interventions for the design and delivery of post-stroke rehabilitation as stipulated in the UK's National Clinical Guideline for Stroke. There were 151 clinical assessments identified under the 36 included ICF-related studies on post-stroke rehabilitation. These assessments were mapped to more than two thirds of the topics in the UK Guideline. Most of the ICF-related assessments were mapped to the arm function- and mobility-related assessment topics contained in the UK Guideline. Moreover, four ICF-related clinical assessments had exact content matches with those classified under the "Cognition," "Mobility – weakness and ataxia," and "Sensation" topics of the UK Guideline. However, the mapping of the ICF-related *interventions* to those contained in the UK Guideline differed in some ways from the mapping of the assessments. Fourteen ICF-related interventions from 25 included studies were mapped to only approximately one third of the UK Guideline's intervention topics. It is noteworthy, however, that nine of the 14 ICF-related interventions showed exact content matches with those contained in the UK Guideline. These matched interventions were grouped under the UK Guideline's topics of "Arm function," "Communication – Aphasia," "Activities of daily living – EADL," and "Mobility – Balance."

The large number of assessments (151) identified in the review suggests that ICF researchers have placed emphasis on developing and validating clinical assessments for use in post-stroke rehabilitation. Two thirds of the 151 assessments were mapped to the UK Guideline, indicating that these assessments can be adopted for daily clinical use. This concurred with a classification by Engkasan et al. (2019), who found that over 70% of clinical assessments mentioned in Cochrane stroke reviews could be classified using the ICF. An important observation is that two thirds of the content-mapped ICF-related assessments were classified by the researchers under the Activities or ICF-A&P domains. An example of an assessment only mapped to the Activities domain is the Modified Barthel Index (Hao et al., 2022). In contrast, the Motor Activity Log assessment (Atler et al., 2015; Hao et al., 2022) was mapped to both ICF-A&P domains. These examples reflect potential difficulties for researchers to differentiate between the Activities and Participation domains. Previous studies have explained the tendency to label content under the ICF-A&P domains as being due to an insufficient understanding of the ICF concepts (Lundälv et al., 2015), resulting in the same "d" code being applied to content related to two different domains (Lexell & Brogårdh, 2015; Lundälv et al., 2015). Future studies are recommended to explore the need to further sharpen the distinction between the contents of the ICF-A&P domains. On the other hand, applying the ICF was found to be challenging by the professionals at the beginning (Biz & Chun, 2019). Therefore, clinical assessments mapped into several ICF categories, which are similar to the ICF Categorical Profile, can provide a comprehensive review to understand patients' conditions as the starting point. These clinical assessments include the Stroke Specific Quality of Life Scale, the Stroke Impact Scale, and the Functional Independence Measure. They cover ten Guideline topics after mapping with ICF. For instance, the Stroke-Specific Quality of Life Scale covered nine guideline topics and mapped with different ICF components. These topics include Independence in daily living, Extended activities in daily living, Communication – Aphasia, and Vision. The findings of this review will enable researchers and clinicians to define the assessment contents and hence improve the validity of the test contents and results.

The two examples cited above indicate that, regardless of whether assessments fall under one or both of the Activities and Participation domains, evaluation of individual-based activities is much more common than evaluation of assessments involving group or community participation. There is a debate about viewing these two domains together or separately. Although the studies included in this review tended to group them together, some researchers have recommended viewing them separately (Barak & Duncan, 2006; Silva et al., 2015). For instance, daily activities (e.g., self-caring, walking, and doing housework) can be classified into the Activities domain, whereas activities in social contexts (e.g., informal social relationships, family relationships, employment, and caring and assisting others) can be classified into the Participation domain. Like the Participation domain, the EF was also found to have been relatively neglected in the literature reviewed. Nonetheless, in the ICF model, these two domains are considered of equal importance to the other domains and factors (Ezekiel et al., 2019). Importantly, previous studies have argued that both the Participation domain and EF can enhance post-stroke patients' independent living and quality of life (Della Vecchia et al., 2023). Post-stroke patients have expressed the need for resuming normal daily living, which includes domestic life, interactions, and relations; social life; and civic life (Leonardi & Fheodoroff, 2021). More studies are called for to develop clinical assessments that cover the contents of the Participation domain and EF. As illustrated by de Rooij et al. (2021) in a study of community walking in post-stroke patients, some EFs were considered as barriers by patients even when they were assessed to be able to walk independently. These barriers included traffic and busy environments, curbs, and stairs. Cawood et al. (2016) reported additional barriers encountered by patients, such as public transportation, attitudes of family and friends, and government policies. Similar comments on environmental barriers in community participation were made by post-stroke patients in Della Vecchia et al. (2023) and Dos Santos et al. (2022).

The review results indicate that compared with assessments, the development of ICF-related interventions is under-emphasized in the literature. ICF-related interventions were content-mapped to three topics of the UK Guideline, namely, "Activities of daily living – EADL," "Arm function," and "Mobility – Balance," and classified under the ICF-BF and the

ICF-A&P domains in the literature. The coverage of these interventions is therefore limited to a narrow scope within the overall ICF concept. Both the number of interventions, i.e., they were mentioned in only 14 of the 25 studies, and the narrow coverage scope suggest much room for researchers to explore, design, and test new post-stroke interventions. The contents of the interventions described in the literature also reflect some shortfalls. Lexell and Brogårdh (2015) proposed that ICF-based neurorehabilitation be considered to comprise baseline assessment, goal-setting, intervention, and outcome definitions and assessment, which should be interconnected. Most of the studies reviewed did contain these elements, but with the exception of goal-setting. Abarghuei et al. (2018) commented that goal-setting was an integral part of personalized intervention for post-stroke patients. In another study, post-stroke patients who were involved in the goal-setting process showed enhanced treatment outcomes (Rice et al., 2017). Some other ICF-related post-stroke rehabilitations also showed comprehensive coverage, such as those in Begum and Haque (2019) and Mehraban et al. (2022). Future studies of ICF-related interventions are recommended to strengthen the coverage of the Participation domain and EF and to incorporate goal-setting as part of a comprehensive intervention regime.

2.5 Limitations

Although our results indicated the limited application of the ICF in current post-stroke rehabilitation processes, using the narrative review approach may demonstrate limitations in the methodology. First, this approach may limit the replicability of the results compared with adopting the systematic review approach, and limit the objectivity of the findings to only in post-stroke rehabilitation. Second, the methodological quality of the included studies varied. Some studies could not be identified due to the nature of the study approaches adopted, such as systematic literature search and case report. It may impact the overall conclusions drawn from this narrative review. Third, the potential for publication bias should be considered. This review focused on published studies, and is possible that studies with negative or non-significant results were underrepresented. Further, concept mapping of ICF concepts with existing clinical assessments and interventions is different from the analysis approaches in the systematic review, which may hinder the use of publication bias analysis. It is recommended that future reviews incorporate a broader range of sources, including unpublished studies, and adopt a guided review reporting method (e.g. the PRISMA) to mitigate this bias.

2.6 Conclusion

Using the UK Guideline as a reference, our findings indicate room for ICF researchers to further develop ICF-based post-stroke rehabilitations, particularly in the areas of participation and EFs. The development and validation of ICF-related assessments for post-stroke patients has received more attention than the development and validation of ICF-related interventions. Given both their large number and wide coverage, ICF-related assessments are already adequate for application in daily clinical use; future studies are recommended to develop new assessments in the Participation domain and EF. In contrast, the development of ICF-related interventions is limited and has a narrow coverage. Clinical interventions require further development to ensure interconnections between assessments and training contents, coverage of the contents of the Participation domain and EF, and inclusion of goal-setting.

Chapter 3

An International Classification of Functioning, Disability, and Health (ICF)-Based Outpatient Rehabilitation Program to Promote Post-Stroke Patients' Community Reintegration

3.1 Introduction

Stroke leads to cognitive impairment and limitations in daily living functioning (Beal, 2010; Broussy et al., 2019). Participation and community reintegration are the key outcomes of post-stroke rehabilitation. A patient-centered approach has been widely adopted in post-stroke rehabilitation to enhance rehabilitation outcomes (O'Keeffe et al., 2016). Personalized treatment programs are characterized by goal-setting and intervention planning (Berntsen et al., 2018), as well as enhanced patient–therapist interactions (Langberg et al., 2019; Mead & Bower, 2000).

The International Classification of Functioning, Disability, and Health (ICF) model conceptualizes an individual's functioning and disability in dynamic interactions (World Health Organization, 2002). In post-stroke patients, Body function (ICF-BF) and Body structure (ICF-BS), Activity, and Participation are interconnected domains that affect an individual's health. These elements are further influenced by two contextual factors: Environmental (EF) and Personal factors. The ICF model has been applied in clinical programs for patients with mental (Chao & Chen, 2019) or neurological disorders (Pfaller et al., 2020). Lexell and Brogårdh (2015) proposed the use of the ICF model to guide patient assessment, goal-setting, training, and outcome measures in neurorehabilitation. One previous study utilized the ICF model to conduct assessments and deliver rehabilitation services to children with cerebral palsy and found that it was able to promote patient-centered care and identify barriers and facilitators for improving the children's functioning (Schiariti et al., 2018). However, limited studies have examined the benefits of an ICF-based service model for post-stroke rehabilitation. Our aim was to understand how the integration of the ICF model into the delivery of a new community undergoing post-stroke rehabilitation would promote community integration. We were interested in exploring its benefits to patients' goal-setting, the patient–therapist interaction, and environmental interaction.

Although the ICF model seems feasible for enhancing community integration, previous studies have revealed issues that may hinder its application, such as therapists being unfamiliar with the terminology used to categorize patients' conditions (Lundälv et al., 2015), no consensus on the definitions of "Activity" and "Participation" (Brogårdh & Lexell, 2015), and no consideration of patients' motivation for prognosis or understanding of the condition (Mitra & Shakespeare, 2019). These issues may impact the effectiveness of the ICF model in post-stroke rehabilitation.

A review of the literature indicated that only a few studies have used the ICF model for post-stroke rehabilitation. A case study of an ICF-based program for a middle-aged post-stroke patient reported improvement in walking abilities and, hence, increased participation in the community (Abarghuei et al., 2018). Some studies explored the feasibility of using the ICF stroke core set to assess post-stroke patient function (Han et al., 2015; Zhang et al., 2018) or to map the contents of the intervention (Evans et al., 2017). The results confirmed that the ICF model was useful for evaluating patients' situations and for representing the training components of the interventions. An earlier study examined the outcomes of a post-stroke intervention based on the ICF model, and changes in ICF-BF further enhanced patients' activity and participation level (Van Puymbroeck et al., 2014). A recent clinical trial reported that the positive effects of the physical and social environment contributed to the treatment outcomes of post-stroke patients (Janssen et al., 2021). The physical environment in that study comprised the environments requiring physical movements, such as personal activities of daily living, while the social environment included activities in which patients interact with others, such as using body gestures to deliver messages. Thus, we are interested in the application of the model in outpatient post-stroke rehabilitation and the factors that facilitate its implementation.

This study had two aims. First, we explored the extent to which the ICF model can be applied to a newly established post-stroke rehabilitation program for promoting community reintegration in patients. Second, we investigated other processes that may enhance the treatment outcomes of ICF model implementation. We hypothesized that the proposed program could broaden the scope of Participation domain and EF for assessment and treatment. A personalized approach and patient–therapist-environment interactions would enhance the community integration outcomes of post-stroke patients.

3.2 Method

3.2.1 Participants

Three groups of participants were included in the study. The first group included patients (*n* = 33) who joined the new rehabilitation program at the Cheng Tak Yim Day Rehabilitation and Care Centre (CTY Centre) under the Hong Kong Society of Rehabilitation (HKSR). The inclusion criteria for the patient group were as follows:1) a diagnosis of stroke with an onset of no more than 24 months, 2) age between 35 and 75 years, 3) medically stable, 4) able to verbally express themselves (i.e., showed no to mild expressive and receptive aphasia, and dysarthria), 5) able to understand the interview questions (i.e., showed no to mild cognitive impairments), and 6) eligible to join the CTY Centre program. The second group comprised the clinical staff (*n* = 3; one physiotherapist, one occupational therapist, and one speech therapist) of the CTY Centre who were involved in delivering the program to the patients. The third group of participants were clinical experts (*n* = 5) who were not involved in the design or delivery of the program, but who were knowledgeable in post-stroke rehabilitation and the ICF model. The clinical expert group consisted of two professors from local universities with expertise in public health, a medical doctor who is a consultant in rehabilitation, an occupational therapist involved in stroke rehabilitation, and an expert who is also a stroke survivor with expertise in rehabilitation service development and policy. All participants voluntarily participated in the study and provided informed consent before attending the interview. This study followed the Declaration of Helsinki and was approved by the Human Subjects Ethics Sub-committee of Hong Kong Polytechnic University (HSEARS 20210407006).

3.2.2 Study design

This study employed a cross-sectional design using data collected in semi-structured interviews. The guiding interview questions were constructed based on the normalization process theory (NPT) of implementation science. NPT explains the processes by which an individual responds and adapts to a new treatment program, such as the four engagement processes: coherence, cognitive participation, collection actions, and reflective monitoring (Delvaux et al., 2020; Murray et al., 2010). The NPT model has been used in previous qualitative studies to identify the strengths and knowledge of program implementation in hand and arm exercise programs for post-stroke patients (Connell et al., 2014).

3.2.3 Setting

The post-stroke rehabilitation program of interest aims to facilitate functional improvement in post-stroke patients, the community, and social reintegration. The intervention program comprises 30 to 48 sessions (1.5 to 2.5 h each) over a period of 1.5 months to six months, depending on the needs and progress of the patients. The Core Set for

Stroke (ICF-CS; Abarghuei et al., 2018; Geyh et al., 2004) provides a framework to guide patients' goal-setting and assessments. The case therapists composed a personalized treatment plan (types, duration, and intensity) with respect to the patients' set goals in the "Service Needs Profile" (Figure 3.1). Treatment outcomes were measured using the same set of ICF-based intake assessments.

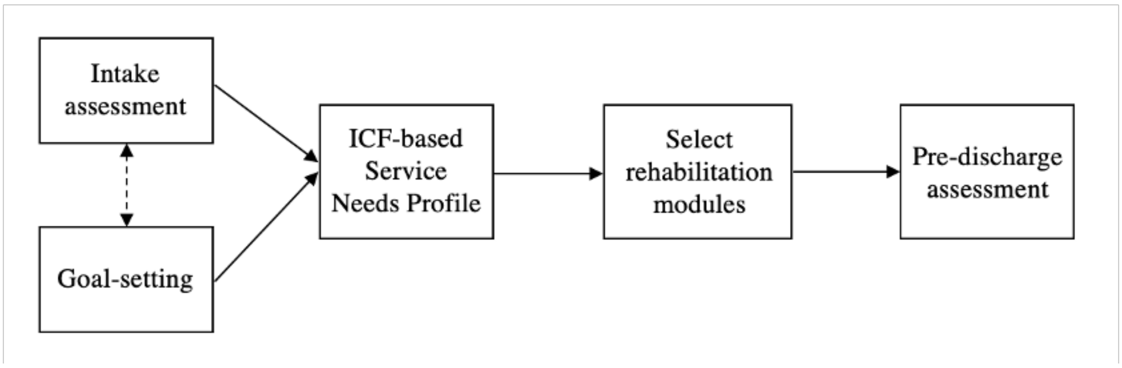


Figure 3.1 Conceptual illustration of the ICF-based post-stroke community reintegration program. Intake assessments were conducted on patients. ICF components that needed to be tackled were identified from the results. These results might or might not reflect patients' needs in goal-setting. The assessment results and patients' goals formed the personalized service needs profile. Therapists selected suitable treatment modules for patients based on the information in the profile. Treatment modules for goals spent a larger proportion of treatment duration than other needs. Case therapists reviewed patients' progress and modified treatment modules during the progress. Pre-discharge assessments, which were identical to intake assessments, were conducted on patients at the end of the program to evaluate treatment outcomes.

3.2.4 Data collection procedures

All interviews were conducted from 22nd April 2021 to 8th December 2021. Patients' ages were first screened by the primary researcher (MW) of this study. Patients' impairments in terms of verbal communication and cognitive abilities were screened by therapists based on the intake assessment results. Face-to-face interviews with eligible patients (and their caregivers) and focus group interviews with the clinical staff were performed in a quiet room at the CTY Centre. Interviews with experts were conducted using Zoom software. The first author (MW) of this study conducted all the interviews and focus groups. The intake and pre-discharge interviews with the patients were completed within the first and last four sessions, respectively. Focus group interviews with therapists and experts were conducted between the patients' interviews.

The leading questions focused on how the design and implementation of the post-stroke program were consistent with the concepts and content stipulated in the ICF model. For post-stroke patients, there were five and nine questions in the intake and pre-discharge interviews, respectively (Appendix A). The flow of the intake interviews was as follows: 1) patients were encouraged to describe their goal(s) and share program-related experience; 2) the interviewer introduced the ICF model to patients in layman terms; and 3) patients were asked to describe their motivation to engage in the program. The flow of the discharge interview was as follows:1) patients were asked to describe the extent to which their goals were achieved and 2) patients were asked to recall the factors that contributed to the program outcomes. Each interview lasted for 20-50 minutes, depending on the conditions and needs of the patients. All interviews were audio-recorded with the consent of the patients and their caregivers if present. Five guiding questions were used for the clinical staff interviews (Appendix A). The flow of the staff interview was as follows:1) staff were asked to compare the ICF-based post-stroke program with other conventional programs and 2) were then asked to suggest continuous improvements in the program. The interviews with clinical experts used the same set of guiding questions. The interviews with both the clinical staff and experts lasted for 60 minutes and were audio-recorded with informed consent.

3.2.5 Data analysis

Interview recordings were analyzed using a qualitative framework analysis, while patient goals mentioned during interviews were mapped with the ICF-CS.

Framework analysis: All Cantonese interview recordings were transcribed verbatim by MW using iFLYREC (iFLYREC, 2022), and the contents were compared with those transcribed by another researcher. Transcribed data were mapped on the theme framework in five steps (Hackett & Strickland, 2018; Kiernan & Hill, 2018): Step 1: data familiarization—MW and another researcher (HT) read the interview transcripts and field notes to develop an overview of themes; Step 2: thematic framework construction—MW and HT independently identified themes and sub-themes based on similarities in concepts and relationships among the concepts, constructed theme and sub-theme definitions and names by consensus, and tested against two transcripts; Step 3: indexing—transcript contents consistent with the theme/sub-theme framework were coded, and new themes and subthemes were created in the course of the analysis (Appendix B); the refinement process was terminated once MW and HT found data saturation; Step 4: charting—**s**ummarized data for each participant were placed in a row and themes were placed in columns (Kiernan & Hill, 2018), in addition, a comment column containing verbatim quotes or codes for each participant was added; and Step 5: mapping and interpretation—conclusions, patterns and structures of the themes and sub-themes were identified and cross-checked against the original data, and the relationships among the themes were abstracted and interpreted.

Mapping with ICF-CS: The rules for mapping the themes and subthemes to the ICF-CS were based on those stipulated by Cieza et al. (2005) and Fayed et al. (2011). Contents with similar concepts were grouped into categories (Bagraith & Strong, 2013), which were then linked to ICF codes at different levels.

3.3 Results

The themes and sub-themes identified based on the participants' responses in the face-to-face interviews were organized according to the intake and pre-discharge occasions. During the interview period, 65 patients joined the program and 54 of them met the inclusion criteria regarding their ages. Forty-four patients were eligible for this study after therapists screened for their verbal communication and cognitive abilities. Thirty-three patients agreed to join the study and were interviewed. Nineteen participants joined both intake and pre-discharge interviews. The remaining participants participated in either the intake (n = 7) or the pre-discharge interview (n = 7). There were four themes: patients' goal-setting, patients' interactions with therapists and the environment, ICF content domains, and ICF-based interventions. Responses obtained from the staff and clinical experts are presented where appropriate.

3.3.1 Theme 1 (Intake): Patients' goal-setting

Sub-theme 1.1: Rehabilitation goals proposed by patients: Ten patients set four goals (38.5%), eight set three goals (30.8%), four set five goals (15.4%), three set two goals (11.5%), and one patient set one goal (3.8%). Among them, "improving walking ability" was the first-ranked goal set by most patients (n = 19). The targets set for this goal included walking with a quadruped stick without assistants, a decrease in the number of assistants, and walking posture and endurance.

> # 27 (from his sister): "*Brother you answered, "I hope I can walk," but the therapist said, 'You now...need two assistants to support you. Hope one assistant can support you after this treatment.'*"

The second-ranked goal was "resuming work" (*n* = 14).

> # 33: "*My goal is to wish for resuming work…I think most stroke patients share the same thought…Hope to resume work as quickly as possible…to earn money as the breadwinner.*"

The third- and fourth-ranked goals were "improving upper limb function" (*n* = 12) and "self-care ability" (*n* = 11), respectively.

Sub-theme 1.2: Rehabilitation goals influenced by covariates. Further analyses for patients' goals with covariates were conducted. These covariates included patients' age, education level, months since stroke and social background. For patients' age, 12 out of 19 young age patients (i.e., 59 years or below; Ng & Chan, 2015) expressed their mindset of resuming work, compared to only two out of seven old patients (i.e., 60 years or above) who showed a similar mindset. However, patients' education level regarding the goal contents was non-comparable since most patients were at the secondary school level (*n* = 17; 65.4%). These patients showed their goals mainly on improving walking ability (*n* = 12) and upper limb function (*n* = 7), self-care ability (*n* = 7) and resuming work (*n* = 7). For patients' months since stroke, only patients at the early subacute (i.e., seven days to three months; *n* = 9; Bernhardt et al., 2017) and chronic (i.e., beyond six months; *n* = 14) stages were comparable since only three patients were at the late subacute stage (i.e., three to six months). Those at the early subacute stage indicated their goals as improving walking ability (*n* = 6) and upper limb function (*n* = 6), while those at the chronic indicated their goals as resuming work (*n* = 11) and improving walking ability (*n* = 9). Regarding patients' social background, more than half of the patients' goals were matched with their social background (*n* = 16; 65.5%).

Sub-theme 1.3: Previous experiences influenced goal-setting: Most of the patients (*n* = 24) had been discharged from public hospitals, while others (*n* = 12) had received outpatient rehabilitation at hospitals or outpatient clinics. According to them, they had not been asked to set goals, and treatment programs focused on functional deficits.

> # 30: *"[The hospitals] seldom talk about goals… When they [therapists] observe you are not able to walk… you need to be trained on walking."*

3.3.2 Theme 2 (Intake): Interaction with therapists and environments

Sub-theme 2.1: Patient–therapist interaction in goal-setting: At intake, as part of the program protocol, case therapists would coach the patients to set treatment goals. As most patients were not familiar with setting goals, case therapists focused on explaining the procedures and the reasons behind the exercise. The patients tended to set few goals (i.e., one to two), and the contents and targets seemed to be bound by the duration of the current program.

> # 31: *"[The therapist] asked what I want to improve…I am not sure … see if I can…with the aid of exercises or other [assistance]…to enhance my abilities."*

From the therapist's perspective, setting goals for treatment planning with patients was a new approach adopted by the rehabilitation center. They found that the process involved more interactions with patients than conventional practices. They reported that patients seemed to benefit from the goal-setting process and had a clearer mindset about their engagement in treatment sessions. From the experts' perspective, the goal-setting stage promoted patients' active participation. The experts further asserted that goal-setting would enable common ground between patients and therapists.

Sub-theme 2.2: Patient-environment interactions: Most goals set by the patients were not environment specific but could be achieved within the rehabilitation center or their own home. Common goals were to regain walking ability (e.g., # 30), upper limb functions (e.g., # 7), and self-maintenance ability at home (e.g., # 17).

> # 30: *"[I wish] I can walk [by myself] … [currently when I walk] from the bedroom to the living room, and walking to the toilet needs to rely on…my wife and domestic helper to hold me."*

Therapists expressed that the goal-setting process would be a good opportunity to encourage patients to consider the roles of the environment in restoring their life and social roles. They shared that they had tried to institute this at their intake.

3.3.3 Theme 3 (Intake): ICF content domains

The participants (*n* = 26) set 94 intake goals. The majority of the goals (94.7%) were classified under the ICF Activities and Participation domains (Table 3.1). The remaining goals (5.3%) were classified according to ICF-BF and ICF-BS categories. Nearly half of these goals (45.4%) were classified under EF, while a smaller proportion of the goals (14.9%) were related to self-care activities. One goal may be to include more than one ICF code.

Table 3.1. Frequency counts and ICF-CS categorization of the goals set (n = 63) by more than 4% of the participants at the intake interview.

Goals in intake interview	Frequency (%)	Activities / Participation / Environmental factors
Improving walking ability	19 (20.2%)	d450 Walking, d460 Moving around in different locations, d465 Moving around using equipment
Resuming work	14 (14.8%)	d845 Acquiring, keeping, and terminating a job, d850 Remunerative employment, d855 Non-remunerative employment e135 Products and technology for employment
Self-care ability	11 (11.7%)	d510 Washing oneself, d530 Toileting, d540 Dressing, d550 Eating e115 Products and technology for personal use in daily living
Improving upper limb function	10 (10.6%)	d430 Lifting and carrying objects, d440 Fine hand use, d445 Hand and arm use
Taking care of family	5 (5.3%)	d570 Looking after one's health, d620 Acquisition of goods and services, d630 Preparing meals, d640 Doing housework
Driving	4 (4.3%)	d475 Driving e540 Transportation services, systems, and policies

Note: Codes begin with "d" equivalent to activity and participant components; codes begin with "e" equivalent to environmental factors; No goals cover body function components in the table.

3.3.4 Theme 4 (Intake): ICF-based interventions

The participants would not have gained enough experience to reflect on the treatment received, as all interviews were conducted within the first four sessions. However, the content formed the basis for meaningful comparisons with those gathered at the pre-discharge occasion. One participant (# 12) shared his experience gained from attending the "community training module” using an escalator. He commented that the approach taken by the therapist (standing next to him) increased his confidence in performing the new task. Other participants commented that the training modules of the program were relevant to their goals and shared that this training was useful for functional regain.

33: *“I told the therapist that…I need to climb the ladder during work…then she [the therapist said] let us try climbing a few steps… the therapist knew my goal.”*

3.3.5 Theme 1 (Pre-discharge): Patients’ goal-setting

Goal-setting was conducted between therapists and patients during the program. Thirty-seven goals were set by 26 patients who participated in the pre-discharge data collection; 11 patients (42.3%) reported that they set two goals, and 15 (57.7%) reported that they set one goal.

Sub-theme 1.1: Rehabilitation goals proposed by patients: Similar to the intake interviews, “improving walking ability” remained the most common goal set by the patients (n = 14). Contrariwise to the intake interview, the contents of this goal became more specific, such as increasing endurance and walking without accessibility.

4: *“Hope…after training…I can…control myself [walking ability] when going out … like grocery shopping, is still a problem now.”*

The specificity of the “improving upper limb function” goal, which ranked second in problem setting, was the use of chopsticks and spoons in eating, writing at work, and carrying items while shopping.

Sub-theme 1.2: Rehabilitation goals influenced by covariates. At pre-discharge, patients' goals were also analyzed with the same set of covariates. Regarding patients' age, the majority of the young (i.e., 59 years or below; eight out of 15 patients) and old age patients (i.e., 60 years or above; six out of 11 patients) indicated walking-related goals, including improving walking ability and taking escalators. For patients' education level, similar to the intake interview, patients' goal contents were non-comparable across other groups since most of them were at the secondary school level (n = 16; 66.7%). These patients showed their goals mainly on improving walking ability (n = 9), followed by improving upper limb function (n = 5). Regarding patients' months since stroke, the comparison occurred between the early subacute (i.e., seven days to three months; n = 11) and chronic stages (i.e., beyond six months; n = 13) as only two patients were at the late subacute stage (i.e., three to six months). Most patients in the early subacute stage expressed their goals as improving upper limb function (n = 5) and walking ability (n = 4), while patients in the chronic stage mostly expressed their goals as improving walking ability (n = 7). Lastly, the goals that half of the patients mentioned in the pre-discharge interview (n = 13) were matched with their social background.

Sub-theme 1.3: Goal accomplishment in the program: Among the 37 goals set by patients, 30 experienced moderate-to-large improvements. Fourteen patients reflected their "walking ability" improved in terms of speed, endurance, and posture. Four patients evaluated improvements in "upper limb function." In particular, one patient added that she could begin performing housework, including cooking, one month into the program. Three patients reported improved dressing and toileting ability. One patient shared his progress toward the "resuming work" goal with improvements in physical functions.

3.3.6 Theme 2 (Pre-discharge): Interaction with therapists and environments

Sub-theme 2.1: Patient–therapist interaction in goal-setting: Patients described their interactions with case therapists, such as setting short- and long-term treatment goals. For instance, one patient (# 1) explained in detail how an occupational therapist worked with her improvement levels and timelines of treatment upgrades. Therapists consistently expressed the importance of embedding activities rather than ICF-BF training in treatment programs. They also shared their skills to help patients attend to their daily living needs and ask them the "why" questions.

> Therapist # 1: *"I provide them with more ways to think…and then drill them to write concrete goals…[the patient] wanted to walk longer and stronger…Why? Any curbs to cross? Any slope to climb?"*

Sub-theme 2.2: Patient–therapist interaction in training contents: Twenty-four patients managed to recall the details of the interactions with the therapists. They included follow-up actions taken on assistive equipment, remediation of walking posture, modifying and upgrading treatment contents, and discussions about pre-discharge plans. Patients expressed that they found the therapists helpful and responsible, while the therapists shared that they actively attended to the patients' feedback and opinions, especially those on the effects of treatment, to address their goals.

Sub-theme 2.3: Patient-environment interactions: Sixteen patients reported their (or caregivers') experiences interacting with different physical environments. Examples of the environment mentioned included window shopping at a supermarket near the home and dining out in a restaurant after taking the Mass Transit Railway (underground train). The remaining 13 patients described their interactions with the social environment within or outside the rehabilitation center. The social environment mentioned involved other patients in the same post-stroke program for exchange of therapy-related information, meeting co-workers at the workplace, and seeing family members and friends in social gatherings outside the home.

3.3.7 Theme 3 (Pre-discharge): ICF content domains

Twenty-eight goals (75.7%) were classified under EF compared with 44 goals (94 goals; 45.4%) classified in the intake interview (see Table 3.2). In addition, the goals set in the pre-discharge interviews were contextualized by Participation domain and EF rather than by Activity domain (Table 3.3). For example, "walking to Chinese restaurant to yum cha" might relate to "e150 Design, construction and building products and technology of buildings for public use" of the restaurant and gathering of "e315 Extended family" or "e320 Friends."

Table 3.2. Frequency counts and ICF-CS for Stroke categorization of the goals set (n = 10) by more than 2% of the participants and some examples at the pre-discharge interview.

Goals in pre-discharge interview	Frequency (%)	Activities / Participation / Environmental factors
Walking and shopping	4 (10.81%)	d450 Walking, d460, Moving around in different locations, d620 Acquisition of goods and services e150 Design, construction, and building products and technology of buildings for public use
Taking Mass Transit Railway	3 (8.11%)	d470 Using transportation e540 Transportation services, systems, and policies
Walking to Chinese restaurant to yum cha	2 (5.41%)	d450 Walking, d460, Moving around in different locations, d910 Community life e150 Design, construction and building products and technology of buildings for public use, e310 Immediate family, e315 Extended family, e320 Friends
Computer typing to assist children's homework	1 (2.70%)	d440 Fine hand use e115 Products and technology for personal use in daily living
Using chopstick	1 (2.70%)	d440 Fine hand use, d550 Eating e110 Products or substances for personal consumption

Note: The goals indicated in the table are specific to patient needs. Patients with more severe sequelae who set goals that were non-specific to any context (i.e., not involving any environmental factors, and there were eight in total) were not indicated here. Codes begin with "d" equivalent to activity and participant components; codes begin with "e" equivalent to environmental factors; No goals cover body function components in the table.

Table 3.3. Comparisons of patients' goals set during the intake versus pre-discharge interviews.

Goals in intake interview	Goals in pre-discharge interview
Improving walking ability	Walking to Chinese restaurant to yum cha Shopping and taking escalator in a shopping mall Stair walking Taking escalator
Taking transportation	Taking Mass Transit Railway Taking bus Taking minibus
Improving upper limb functioning	Writing in workplace Using chopstick Using hand to carry items in shopping

3.3.8 Theme 4 (Pre-discharge): ICF-based interventions

Both patients and experts commented on the new contents of the post-stroke program. They attributed this new content to the adoption of the ICF model to design the program's flow of service. The new goal-setting process seemed to drive a personalized approach to program delivery.

Sub-theme 4.1: Community training: Eight patients reported receiving community-based training. Six of them commented that the new program, delivered in the community, would facilitate their return to their accustomed environment. For example, one patient (# 28) received training with a therapist using an escalator at the Mass Transit Railway station near the CTY Centre. He further explained that he was now able to manage the escalator, which he had previously perceived as too fast to handle.

Sub-theme 4.2: Personalized training contents: Ten patients considered the training modules to be specially designed to meet their set goals and treatment needs. They found that these modules occupied a larger proportion of the program, which differed from the rehabilitation services they received. Examples of these modules were grocery shopping, which involved walking endurance training, and handwriting at work, which involved fine hand function training. The therapist also shared that the patients had a goal-directed design for the intervention program. The content of the modules needed to be specific according to the context and targets of the goals. This approach differs from a conventional program in which the interventions are standardized and general in nature. Therefore, the ICF model was found to be helpful in defining participants' needs for participation and their interactions with the physical and social environment. The experts' views were similar to those of the therapists.

> Expert # 1: *"With the ICF model, we already had a holistic approach. We can see broader…on the patients' needs. From day one [of the rehabilitation], we can…orientate the training toward…his longer-term goals."*

3.4 Discussion

This paper reports qualitative studies examining the implementation of a post-stroke ICF-based program for community reintegration in post-stroke patients. From the patients' and therapists' perspectives, we interpreted that the ICF model enhanced the outcomes of the new program by strengthening patients' participation and emphasizing the impacts of EF.

The goal-setting and patient-therapist interactions embedded in the program design contributed to personalized program delivery for post-stroke patients.

Our results indicate that implementing the goal-setting process facilitated program outcomes. The interactions between the patients and their case therapists throughout the goal-setting process seem to be crucial for developing an effective personalized program for patients. More than half of the goals (61%) set by the patients in the intake interviews were related to ICF-BF and Activity domains. Approximately 30 percent of the goals were related to the ICF-BF and Activity domains. Our findings are consistent with those of a previous study on a post-stroke program in which patients' goals formulated at admission concentrated on ICF-BF and Activity improvements, such as walking ability and upper limb functions (Rice et al., 2017). In this study, the interview scripts indicated that the contents of the patients' goals were largely influenced by the service provision at the acute stage or hospital-based intervention programs. This finding concurred with a study on conventional rehabilitation programs, suggesting that patients' experiences were predetermined by therapists and standardized training content (Crum & Zuckerman, 2017). These goals were inclined to be impaired and less applicable to patients' community reintegration needs. In contrast, the results of the pre-discharge interviews in this study indicated that patients' goals tended to be geared toward their unique life situations, environment, and desires for participation. For instance, patients expressed the need to use an escalator independently instead of merely improving their walking ability. The number of goals classified into the Participation domain increased from 23 percent in the intake to 62 percent in the pre-discharge interviews. The changes in the content of the goals set by the patients between admission and pre-discharge reflected the positive effects of patient–therapist interactions in program delivery, particularly goal-setting. Our results further indicate that the case therapists helped patients explore goals and set targets to achieve them. Agreed goals between patients and therapists were specific in nature and aimed at solving short-term problems faced by patients (Alanko et al., 2019). The built-in content flexibility of treatment plans according to patients' goals contributed tremendously to personalized intervention for this new program. The benefit of patients actively participating in goal-setting is enhanced program outcomes (Rice et al., 2017; Yun & Choi, 2019). More importantly, the goal-setting process and relevance of the training content to the goal can effectively improve patients' treatment engagement and adherence (Hillig et al., 2019). Patients who realized their treatment and training goals showed higher engagement in training intensity than those who only received non-specific training instructions.

The importance of the patient-therapist interaction in the new program was highlighted by having both the patients and therapists participate in this study. Both groups commented that interactions increased as the sessions progressed. Two observations were made. First, at intake, the patients' mindsets appeared to be dominated by their previous experiences in hospital-based rehabilitation programs. The majority of the patients interviewed displayed reserved goal-setting and hesitated to play an active role in interacting with the case therapists. This result is consistent with existing literature stating that patient behaviors may result from perceived professional dominance in rehabilitation (Leach et al., 2010; Rosewilliam et al., 2015). Second, we observed the benefits of personalized treatment offered by the program and one-on-one support from case therapists. The patient-therapist interaction was the key to bringing about personalized training content designed according to the patients' goals. Patients expressed their concerns about their needs and progress to their case therapists—an opportunity denied in conventional settings. These interactions contributed to the positive experiences of care and satisfaction reported by our patients. Patients perceive the amount and quality of patient–therapist interactions as more important than the amount and content of treatment (Peiris et al., 2012). A sufficient number of interactions was considered by patients as valuable content in rehabilitation, which enhanced treatment outcomes (O'Keeffe et al., 2016).

The assessment and treatment of the post-stroke program were based on the ICF model. One aim of the program was to expose patients to the EF of the ICF, such as how technology and policies facilitate or hinder community integration. During the intake interviews, patients tended to perceive their ICF-BF and Activity-based deficits as obstacles to dependent living. They further explained that the EF had been less of a concern as their environment had centered around the home and rehabilitation center. They did not perceive the need to go elsewhere, and their caregivers could help whenever necessary. In the pre-discharge interviews, there was a drastic increase in the proportion of patients who expressed concerns about their limitations from an environmental context. A significant reason, as expressed by both the patients and therapists, was the living environment exposure during training. Participants often window-shopped in supermarkets and took escalators in the Mass Transit Railway during training. Our findings are consistent with those of a previous study that emphasized the EF embedded in post-stroke rehabilitation (Kim et al., 2014). The results indicated the effect of conducting training in environments similar to real-life situations on mobility in the community. Other studies have reported the application of EF in treatment programs (Debrouwere et al., 2016; Pike et al., 2021). For example, Debrouwere et al. (2016) used ICF-based patient profiles to delineate patient health conditions based on ICF components. The model demonstrated sensitivity in identifying patients' situations and factors that contribute to treatment, including personalized EF.

3.5 Limitations

One limitation of this qualitative study is the lack of a control group. All post-stroke patients who chose the rehabilitation services in the CTY centre first received this ICF-based program. A wait-list control group approach in this study, however, was not feasible due to the clinical ethical consideration as delayed intervention would have jeopardized the recovery potential of post-stroke patients (Sima et al., 2021), particularly in the first year after stroke onset. Second, the interpretation of the results obtained in this study would need to be cautious because of the potential maturation and placebo effects would have existed among the patients. Third, potential response bias might have occurred as both patients' intake and pre-discharge interviews were conducted by the same researcher, MW. Although both interview sections had their own set of guided questions, the contents which the researcher received in the intake interview might have contaminated the patients' responses in the pre-discharge interview and vice versa (Bergen & Labonté, 2019). Future studies can cooperate with organizations which deliver other forms of post-stroke rehabilitation, such as conventional post-stroke programs and robot-assisted motor training. Interviewing post-stroke patients who received training other than the ICF-based program would promote the comparison and generalizability of the results. Further, allocating different interviewers to different interview sections can help lower the response bias in patients. Under the setting of this study, one interviewer is required to conduct the intake interview with patients, while another interviewer is for the pre-discharge interview.

3.6 Clinical implications

The findings of this study demonstrate the importance of patient–therapist relationships in enhancing treatment outcomes. ICF-based programs focus on nurturing positive patient-therapist relationships at the start of the program during the goal-setting process. Goal-setting guided by the ICF-based content, particularly the Participation domain and EF, would help patients and therapists target independent living. These goals should form the basis for delivering personalized treatment programs for patients. Service providers, however, should be aware of possible increases in human and nonhuman resources. The anticipated increase in resources would be prominent for settings that lack experience implementing the patient-centered approach in service delivery. Clinicians are likely to invest time during the intake interview to familiarize patients discharged from acute settings with the goal-setting process and ICF content domains.

3.7 Conclusion

The current study examined the extent to which the ICF model can be applied to a new post-stroke rehabilitation program and the significant factors that would enhance the program's outcomes. Using a qualitative study design, the results indicate that patient / case therapist consensus goal-setting, strong patient–therapist relationships, and personalized intervention are significant factors contributing to program outcomes. The ICF model is vital in offering a wider scope of concerns for patients and therapists when formulating a treatment plan. The patient–therapist and environment interactions embedded in personalized interventions have been found to shift patients' concerns from ICF-BF and Activity to Participation and EF. Further studies are needed to reveal the effectiveness and cost-benefit of an ICF-based rehabilitation program for post-stroke patients.

Chapter 4

Effects of an ICF-based rehabilitation program to promote activity and participation-based outcomes in post-stroke patients

4.1 Introduction

Stroke is a neurological disease and one of the leading causes of death and disability globally (Feigin et al., 2022). Post-stroke patients often encounter disabilities, such as limitations in their activities of daily living (ADL) and cognitive impairment (Yao et al., 2021). Studies have described multidisciplinary post-stroke rehabilitation programs (Vluggen et al., 2021) and their positive effects on post-stroke patients' community integration and quality of life (Chinchai et al., 2020). Other post-stroke rehabilitation programs have targeted the promotion of patients' independence in ADL (Choi & Kang, 2015) and instrumental activities of daily living (IADL; Alsubiheen et al., 2022). These studies have emphasized an eclectic approach to maximizing the regaining of function and independence after stroke. Adopting a comprehensive framework, such as the International Classification of Functioning, Disability, and Health (ICF), may offer a systematic approach to the provision of post-stroke rehabilitation. This framework addresses post-stroke patients' concerns and synchronizes the expertise of multidisciplinary team members to achieve desirable patient-centered clinical outcomes. The ICF model (World Health Organization, 2002) emphasizes activity and participation (ICF-A&P) as the core concepts of rehabilitation. Activity refers to functioning at the individual level (e.g., ADL), while participation refers to functioning in all areas of life (e.g., IADL; Campos et al., 2019). The conventional body function (physiological; ICF-BF) and body structure (human anatomical parts) components are the building blocks that support the ICF-A&P. These three components are affected by two contextual factors: personal and environmental factors. The ICF model has been widely applied in the design of assessments, patient profiles, and treatment approaches in different rehabilitation disciplines (Liu, 2017; Schiariti et al., 2018).

Applications of the ICF model to design rehabilitation programs for post-stroke patients are scarce. A review of the existing literature only identified three ICF-based studies. A case study by Abarghuei et al. (2018) reported the effect of a 1-month occupational therapy program for a middle-aged man with chronic stroke. The ICF Core Set (ICF-CS) for Stroke was deployed in the assessments, personalized goals were set, and the treatment contents were administered to enhance independent community living. The patient’s outcomes were improvements in muscle power and muscle tone, the ability to walk up and down stairs, and outdoor mobility without assistance. A second case study by Begum and Haque (2019) involved an ICF-based physiotherapy program for a female post-stroke patient. The ICF-CS was used to identify the patient’s problems and set goals. The results showed improvements in the balance and shoulder mobilization components of the ICF-BF and the walking ability component of the ICF-A&P after the 3-month treatment program. For the third study, Mehraban et al. (2022) designed an ICF-based 2-month occupational therapy program with an approach comparable to that of Abarghuei et al. (2018). When compared with the patients in the usual practice control group, patients in the ICF-based program showed improvements in motor function and satisfaction with their level of productivity in paid/unpaid work and household management and their leisure activities. All three studies described above were operationalized by a single rehabilitation discipline, which is likely to limit the scope covered by the ICF-A&P in the delivery of the rehabilitation program. More importantly, the limited number of studies indicates the need to further investigate the clinical applications of the ICF model in post-stroke rehabilitation.

The aim of the current study was to design and test the effects of the first ICF- and community-based multidisciplinary rehabilitation program for post-stroke patients in Hong

Kong. We used a pre- and post-treatment design to evaluate the effectiveness of the new program. We focused on the relationships between the ICF-A&P and ICF-BF embedded in the treatment contents, and the patients' subjective satisfaction with the treatment outcomes. We hypothesized that post-stroke patients would show improvements in both ICF-A&P and ICF-BF measures at the end of the program. Moreover, we hypothesized significant relationships between the ICF-A&P and ICF-BF components, which would contribute to the patients' subjective satisfaction with the treatment outcomes.

4.2 Methods

4.2.1 Participants

Before the actual recruitment of post-stroke patients for this study, the power analysis indicated a minimum sample was 20 in order to detect a medium effect size in patients' changes ($f = 0.25$; Kang, 2021). The actual recruitment consisted of 52 post-stroke patients from a community-based rehabilitation program operated by a non-governmental organization in Hong Kong. Patients were included if they 1) had a diagnosis of stroke with an onset in the previous 3 to 24 months, 2) were medically stable, 3) were able to transfer or walk with no more than one item of assistance, and 4) were able to tolerate at least 2 hours of active rehabilitation treatment. Thirty-three (63.5%) of the participants were male, and the ages of the participants ranged from 34 to 78 years (mean = 56.1 years, standard deviation [SD] = 10.6). The mean duration since the stroke was 7.8 months (SD = 5.7). All participants voluntarily participated in the study and provided informed consent. This study was approved by the Human Subjects Ethics Sub-committee of The Hong Kong Polytechnic University (HSEARS 20210407006) and was conducted in accordance with the Declaration of Helsinki.

4.2.2 Setting

The ICF-based post-stroke rehabilitation program (ICF-PSRP) used in this study targeted the facilitation of patients' functional improvement and community and social reintegration. The duration of the ICF-PSRP was 8 or 12 weeks, comprising 30 or 48 2-hour sessions depending on the patients' needs and progress. The goal-setting, intervention contents, pathways and flow, and assessments were based on the ICF-CS for Stroke as the framework.

After admission, the patients completed an intake interview with a case therapist for an initial assessment and goal-setting (Figure 4.1). The patients (and their caregivers, if any) discussed their treatment goal(s) with the case therapist. The therapist assisted the patient with setting goals that were related to the ICF-A&P rather than the ICF-BF, and to their life roles and functional gaps. At the case conference, the multidisciplinary program team composed a personalized treatment plan for the patient based on the results of the intake interview. The treatment plan included prescriptions of specific intervention modules with set intensities and durations for each of the prescribed modules. The progress made by each patient in terms of assessment results (see below) and updates to the treatment plans or discharge plans were discussed in monthly case conferences.

The treatment program was designed by a multidisciplinary team with expertise in physiotherapy, occupational therapy, and speech therapy. The contents were organized in terms of intervention modules. The aim of the physiotherapy component was to enhance patients' lower extremity (LE) function. The intervention modules covered ICF-BF content, such as stretching to reduce muscle tone and virtual-reality balance training, and ICF-A&P content, such as body-weight-supported training and transfer exercises. The aim of the occupational therapy component was to enhance patients' upper extremity (UE) function. The modules covered ICF-BF content, such as strengthening and cognitive exercises, and

ICF-A&P content, such as simulated bathing, escalator training, and fine-motor hand function training. The aim of the speech therapy component was to address patients' swallowing and communication deficits. The modules covered ICF-BF content, such as articulation exercises and oral motor training, and ICF-A&P content, such as expressive language training for high-frequency words and receptive language training based on the comprehension of short passages. As an overall practice strategy, community training was offered to patients who were competent in fulfilling the demands of on-site training (e.g., taking public transportation and shopping at the supermarket).

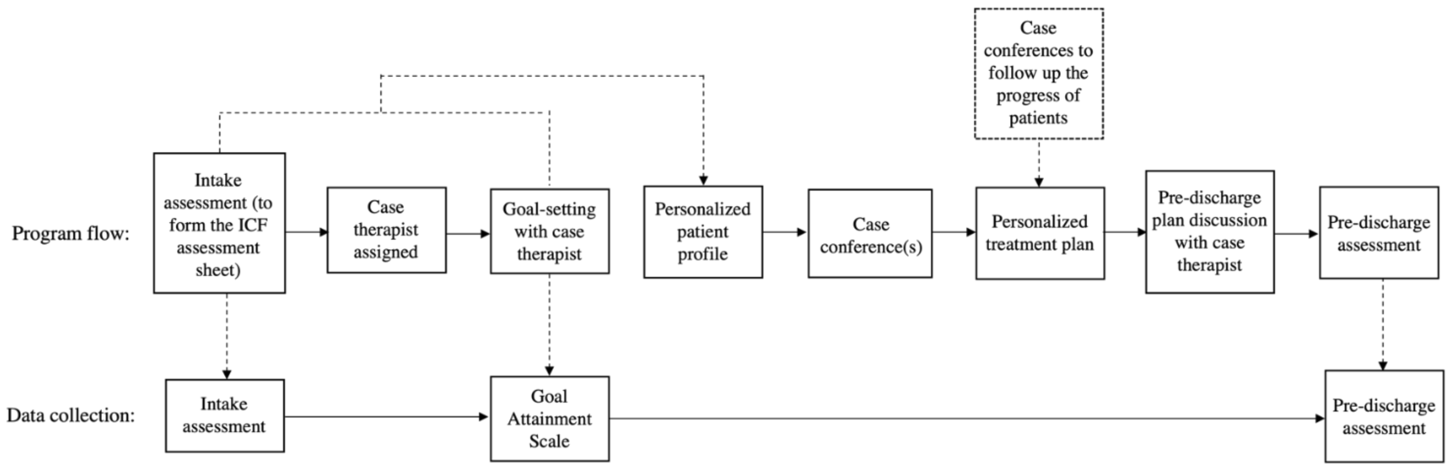


Figure 4.1. The flow diagram of the ICF-based Post-Stroke Rehabilitation Program.

4.2.3 Materials

The ICF-CS for Stroke was adopted as the framework to design the intake and pre-discharge assessments. The ICF-PSRP team did not use the ICF Categorical Profile as the clinical measure due to inexperience with rating the items in the Profile. A previous study reported less than satisfactory inter-rater reliability among novel raters (Chen et al., 2016). Instead, the ICF-PSRP team decided to deploy standardized discipline-based clinical measures and map the measures' contents to the ICF-CS for Stroke (Table 4.1). The Chinese version of the Modified Barthel Index (mBI-C), Chinese version of the Lawton Instrumental Activities of Daily Living (iADL-CV), Elderly Mobility Scale (EMS), Therapy Outcome

Measure (TOM), Manual Muscle Testing – Lower Extremity (MMT-LE), Hong Kong version of the Functional Test for the Hemiplegic Upper Extremity (FTHUE-HK), Hong Kong version of the Oxford Cognitive Screen (HK-OCS) were the primary outcomes of the ICF-PSRP, and scores for the Goal Attainment Scale (GAS) and subscales of the Stroke Specific Quality of Life Scale (SSQoL-C) were the secondary outcomes.

ICF-A&P (ADL) (Schepers et al., 2007). The Chinese version of the Modified Barthel Index (mBI-C) measures the level of self-care management activities (Leung et al., 2007; Shah et al., 1989). It has shown moderate to strong test-retest reliability in post-stroke patients (Kappa value > 0.60; Leung et al., 2007).

ICF-A&P (IADL) (Campos et al., 2019). The Chinese version of the Lawton Instrumental Activities of Daily Living (iADL-CV) Scale measures the level of independent living (Graf, 2008; Tong & Man, 2002). Its inter-rater and test-retest reliability have demonstrated intra-class correlation coefficient (ICC) values greater than 0.90 (Tong & Man, 2002).

ICF-A&P (mobility) (de Morton & Nolan, 2011). The EMS measures the mobility level (Maso et al., 2019; Yu et al., 2007) with satisfactory test-retest reliability (ICC > 0.87; Kuys & Brauer, 2006).

ICF-A&P/ICF-BF (expressive and receptive languages [ERL]). The Therapy Outcome Measure (TOM) assesses patients' abilities and difficulties in terms of their impairment, activity, participation, and well-being in ERL abilities (Enderby & John, 2015). The Impairment scale refers to the ICF-BF, while the Activity, Participation, and Well-Being scales refer to the ICF-A&P (Enderby & John, 2015). The instrument has shown high ICCs (> 0.70; Enderby & John, 2015; Moyse et al., 2020).

ICF-BF (LE) (Yen et al., 2017). The Manual Muscle Testing – Lower Extremity (MMT-LE) scale measures muscle strength impairments (Bohannon, 2005). The MMT-LE has shown good reliability and validity (Cuthbert & Goodheart, 2007).

ICF-BF (UE) (Kegelmeyer et al., 2014). The Hong Kong version of the Functional Test for the Hemiplegic Upper Extremity (FTHUE-HK) measures recovery of the hemiplegic UE (Fong et al., 2004; Wilson et al., 1984). The test has shown high sensitivity and specificity, item-level correlation ($r > 0.71$), and internal consistency ($\alpha > 0.840$) in post-stroke patients (Fong et al., 2004).

ICF-BF (cognition) (Kegelmeyer et al., 2014)**.** The Hong Kong version of the Oxford Cognitive Screen (HK-OCS) measures stroke-induced cognitive disabilities (Demeyere et al., 2015; Kong et al., 2016). The test has been validated in post-stroke patients in Hong Kong, with strong concurrent validity ($r > 0.50$), fair test-retest reliability ($\alpha < 0.80$) for most subtests, and acceptable internal consistency ($\alpha = 0.725$).

Goal attainment. The GAS was used to enable patients to set achievable goals at the beginning of the program (Jung et al., 2020). The goals were set according to the patients' functional gaps and life roles prior to stroke onset via interactions with therapists. The scale has been found to reflect changes in the extent of achieving set goals among post-stroke patients (Debreceni-Nagy et al., 2019). The GAS score was a secondary outcome in this study.

Quality of life. The Chinese version of the Stroke Specific Quality of Life Scale (SSQoL-C) measures post-stroke patients' health-related quality of life (Lo et al., 2017; Williams et al., 1999) with good internal consistency ($\alpha > 0.63$) and acceptable convergent validity (Spearman's rho > 0.40; Lo et al., 2017). The SSQoL-C score was a secondary outcome in this study. For subscales of the SSQoL-C, our program focused on A&P-based outcomes; thus, only those identified in that category were assessed.

Table 4.1. The mapping of standardized clinical instruments on the ICF Body Function (ICF-BF) and Activity and Participation (ICF-A&P) components administered by the occupational therapists (OT), physiotherapists (PT) and speech therapists (ST) in the ICF-PSRP.

ICF Categories	Clinical instruments
Primary Outcome Measures – ICF Body Function	Hong Kong version of the Functional Test for the Hemiplegic Upper Extremity (FTHUE-HK; OT) Hong Kong version of the Oxford Cognitive Screen (HK-OCS; OT) Manual Muscle Testing – Lower Extremity (MMT-LE; PT) Therapy Outcome Measures (TOM) – Impairment scale (ST)
Primary Outcome Measures – ICF Activity and Participation	Chinese Version of the Lawton Instrumental Activities of Daily Living Scale (iADL-CV; OT) Chinese version of Modified Barthel Index (mBI-C; OT) Elderly Mobility Scale (EMS; PT) Therapy Outcome Measures (TOM) – Disability, Handicap, Well-being scales (ST)
Secondary outcome measures	Chinese version of the Stroke Specific Quality of Life Scale (SSQoL-C) – Family role, Language, Mobility, Self-care, Social role, Upper extremity function, Work and productivity subscales (CASE) Goal Attainment Scale (GAS; CASE-intake)

Note: CASE refers to case therapists administering the instrument to the patients. CASE-intake refers to case therapists administering the instrument to the patients during the intake interview.

4.2.4 Study design and data collection procedures

This study employed a quasi-experimental, within-subject design. There were two waves of data collection: at intake and prior to discharge. The patients completed intake assessments 1 to 3 weeks before the start of the program, depending on their availability. The therapists who administered the intake assessments were either occupational therapists, physiotherapists, or speech therapists in the ICF-PSRP team. Clinical instruments were administered by relevant professionals (Table 4.1). The intake interview covered demographic information and medical histories, including previous rehabilitation programs received. To set patient-specific goals for the program, the patients (and their caregivers, if any) underwent individual intake interviews with their case therapist within the first to fourth sessions of the program. The case therapist for a patient was any one of the therapists in the ICF-PSRP team and was familiar with the objectives and flow of the program. All of the assessment results and patients' goals were recorded in the patients' case files for review by the therapists to formulate the treatment program plan during the case conference. In the final four sessions of the program (i.e., the 27th to 30th or 45th to 48th sessions), the patients (and their caregivers, if any) were followed up by their case therapist to assess their goal attainment level. Pre-discharge assessments were administered in these four sessions using the same set of instruments used in the intake assessments.

4.2.5 Data analysis

The patients' demographic variables and medical histories are summarized using descriptive statistics. The scoring of the clinical instruments followed the method stipulated in the test manuals. The sums or means of the scores were computed for all instruments except the MMT-LE. Transformation of the MMT-LE score was performed using the method described by Bohannon (2005) before computing the mean score. Missing data from the original data set were imputed using the expectation–maximization method. All statistical analyses were conducted using SPSS Statistics (version 26; IBM, Armonk, NY, USA).

One-way repeated-measures analysis of variance was used to test the significance of the differences between the intake and pre-discharge assessment scores of the instruments for the primary and secondary outcomes. To test if covariates (e.g., age, gender, education level, and stroke duration) controlled treatment results, one-way repeated-measure analysis of covariance was further used to test the assessment score changes. Bonferroni adjustments of the 0.05 significance level were applied to control for potential type I errors in these two types of analyses (Perneger, 1998).

Mediation analyses were conducted using the PROCESS tool (version 4.1; Hayes, 2022). Two models were tested. The first model adopted ICF-A&P (mediator) and ICF-BF (independent variable; IV) scores, while the second model adopted ICF-BF (mediator) and ICF-A&P (IV) scores. Both models included secondary outcomes as the dependent variable (DV; i.e., GAS and SSQoL-C subscale scores). Figure 4.2 presents the speculated relationships between the variables. Further, to explore the effect of covariates affecting the two aforementioned models. A moderating variable was included in each original mediation model as the covariate. Possible covariates which affected the model covered patients' age, gender, education level, and stroke duration. Figure 4.3 presents the relationship of the effect from the covariate on original mediation model. All measures for the ICF-A&P and ICF-BF were changes in the scores between the intake and pre-discharge assessments (Fu & Holmer, 2015). The covariates were the age and sex of the patients. Significant models identified in the mediation analyses were combined and tested using structural equation modelling (SEM) using IBM SPSS Amos (version 28). The data-to-model fits were assessed based on the results of chi-square tests, and root mean square error approximations, the comparative fit, and the goodness-of-fit index were indicators used to assess the fit of the model. A second-level analysis was conducted to relate the ICF-A&P and ICF-BF treatment models with the results of the significant SEM outcome models. Qualitative content analyses of the scheduling of the ICF-A&P and ICF-BF treatment modules were conducted. The results determined how the timing and sequential relationships between these two types of modules contributed to the secondary treatment outcomes. The ICF-PSRP for each patient was divided into three phases: beginning (i.e., the 1st to 10th sessions of a 30-session program or the 1st to

16th sessions of a 48-session program), middle (i.e., the 11th to 20th or 17th to 32nd sessions), and late (i.e., the 21st to 30th or 33rd to 48th sessions). The type (ICF-A&P or ICF-BF) and timing/sequence of the intervention modules delivered to each patient for the entire period of each phase were coded and collated. For instance, the mBI-C and IADL-CV were categorized as ICF-A&P, while the MMT-LE and FTHUE-HK were categorized as ICF-BF. There were five different scenarios used for the delivery of the intervention modules of the ICF-PSRP. They were: 1) delivering the ICF-BF modules before the ICF-A&P modules (i.e., BF→A&P), 2) delivering the ICF-A&P modules before the ICF-BF modules (i.e., A&P→BF), and 3) delivering both the ICF-BF and ICF-A&P modules concurrently (i.e., BF|A&P). The module sequence of BF→A&P, A&P→BF or A&P|BF and the number of patients in each sequence were collated and compared and related to the results of the SEM models.

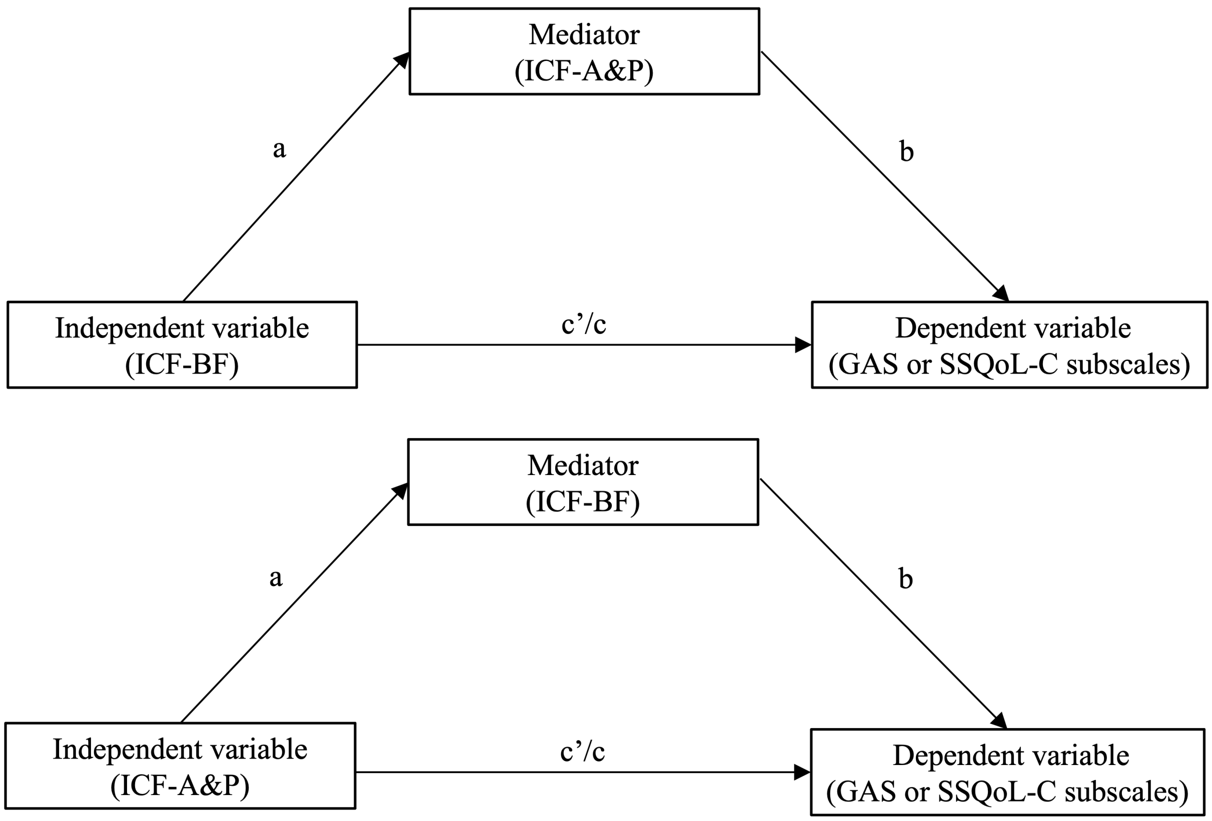


Figure 4.2. The conceptual model describing the relationships among the BF, A&P and secondary outcomes (i.e. Goal Attainment Scale [GAS] or subscales in the Chinese version of

the Stroke Specific Quality of Life Scale [SSQoL-C]) of the ICF-based post-stroke rehabilitation program. The change in the independent variable contributes to the secondary outcomes as the dependent variable, which is controlled by the mediator. a) ICF-BF as the independent variable and ICF-A&P as the mediator contributing to secondary outcomes. b) ICF-A&P as the independent variable and ICF-BF as the mediator contributing to secondary outcomes. In both models, the a, b and c paths are indirect effects, and the c' path is a direct effect.

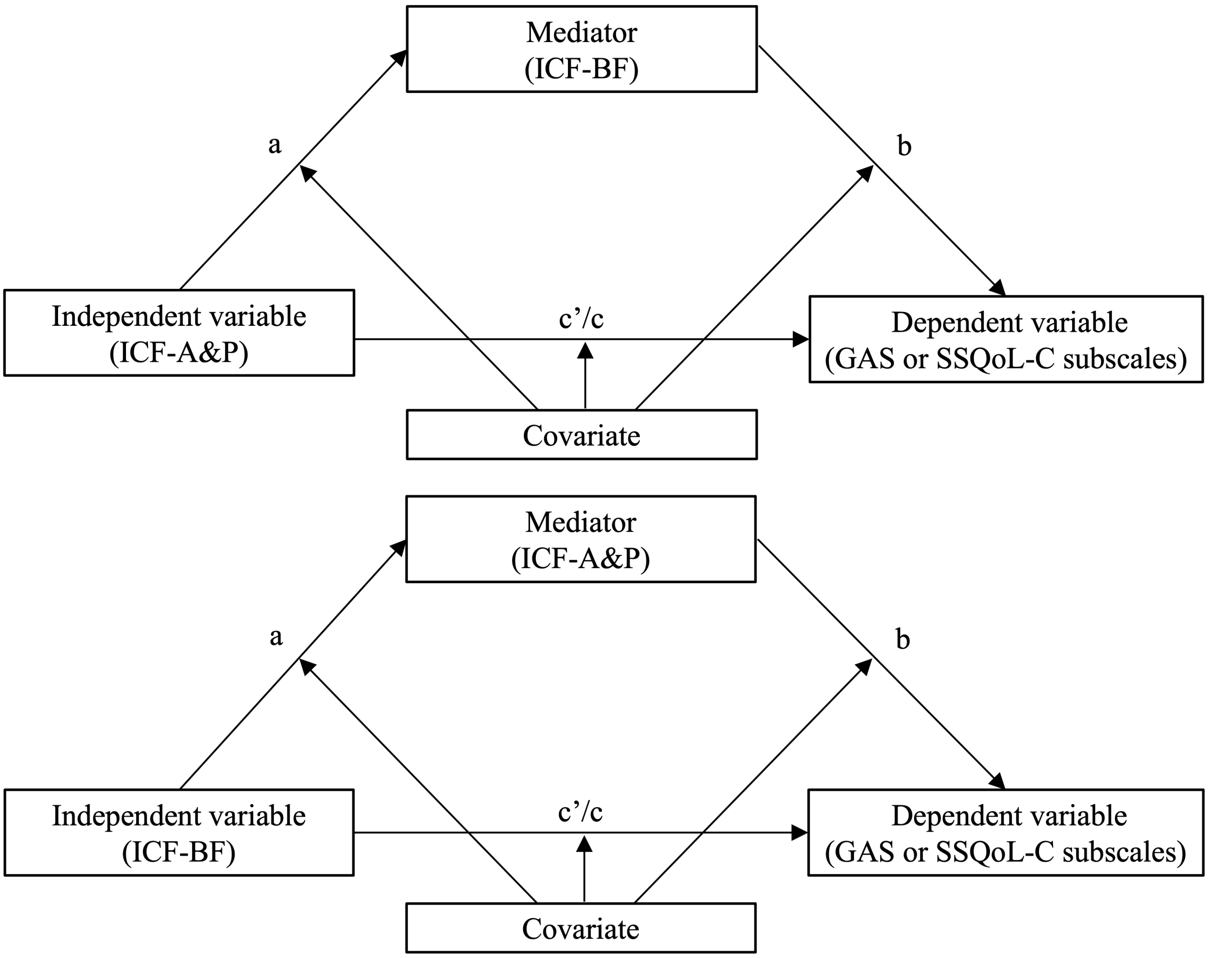


Figure 4.3. A moderating variable was included in the original mediation models mentioned in Figure 4.2 as the covariate. The covariate included in the analysis could be patients' age, gender, education level, or duration of stroke onset.

4.3 Results

4.3.1 Demographics

Of the 52 patients included in the study, 22 reported having an ischemic stroke, and 24 reported having a hemorrhagic stroke. One patient reported having an ischemic stroke followed by a hemorrhagic complication, and five patients did not indicate their type of stroke. Twenty-six patients (50%) had left hemiplegia, 24 patients (46.2%) had right hemiplegia, and two patients had diplegia (Table 4.2).

Table 4.2. Demographic characteristics of the post-stroke patient participants.

Variables	*N* (%)
Age range (in years)	34 to 78
Mean age (in years; *SD*)	56.1 (10.6)
Gender (*SD*)	
Male	33 (63.5)
Female	19 (36.5)
Months since stroke* (*SD*)	7.8 (5.7)
Types of stroke	
Ischemic stroke	22 (42.3)
Hemorrhagic stroke	24 (46.2)
Ischemic stroke with hemorrhagic complication	1 (1.9)
Not indicated	5 (9.6)
Side of hemiparesis	
Left	26 (50.0)
Right	24 (46.2)
Bilateral	2 (3.8)

Note: *SD*, standard deviation.

*Calculated between the date of the stroke to the date of completing the intake assessment.

4.3.2 Effects of the treatment on body function (ICF-BF)

Patients completing the ICF-PSRP showed significant improvements in scores for the FTHUE-HK ($p < .001$); HK-OCS Attention subtest ($p = .017$); MMT-LE ($p < .001$); and TOM impairment scales for receptive aphasia ($p = .017$), expressive aphasia ($p < .001$), and dysarthria ($p < .001$; Appendix C). No significant changes were observed in the other HK-OCS subtests ($p > .05$). After Bonferroni adjustments ($p = .0125$), significant changes were found in the scores for the FTHUE-HK, MMT-LE, and TOM impairment scales for expressive aphasia and dysarthria.

4.3.3 Effects of the treatment on activity and participation (ICF-A&P)

After completing the ICF-PSRP, the patients showed significant improvements in scores for the EMS ($p < .001$); iADL-CV ($p < .001$); mBI-C ($p < .001$); TOM disability scales for receptive aphasia ($p < .001$), expressive aphasia ($p < .001$), and dysarthria ($p < .001$); TOM handicap scales for receptive aphasia ($p < .001$), expressive aphasia ($p < .001$), and dysarthria ($p < .001$); and TOM well-being scales for receptive aphasia ($p = .005$), expressive aphasia ($p < .001$), and dysarthria ($p < .001$; Appendix C). Similarly, after Bonferroni adjustments ($p < .0125$), statistically significant improvements persisted for all of the abovementioned A&P-based clinical instruments showing pre- and post-treatment changes.

4.3.4 Effects of the treatment on secondary outcomes

Significant improvements were also observed for secondary outcomes in patients completing the ICF-PSRP. Scores for the GAS ($p < .001$) and the SSQoL-C subscales of Family Role ($p = .047$), Language ($p < .001$), Mobility ($p = .004$), Social Role ($p = .001$), and

Work and Productivity (p = .037) were significantly improved after completing the ICF-PSRP (Appendix C). Changes in the scores for the SSQoL-C subscale of the Upper Extremity scale were marginally statistically significant (p = .055).

4.3.6 Treatment effects with covariates

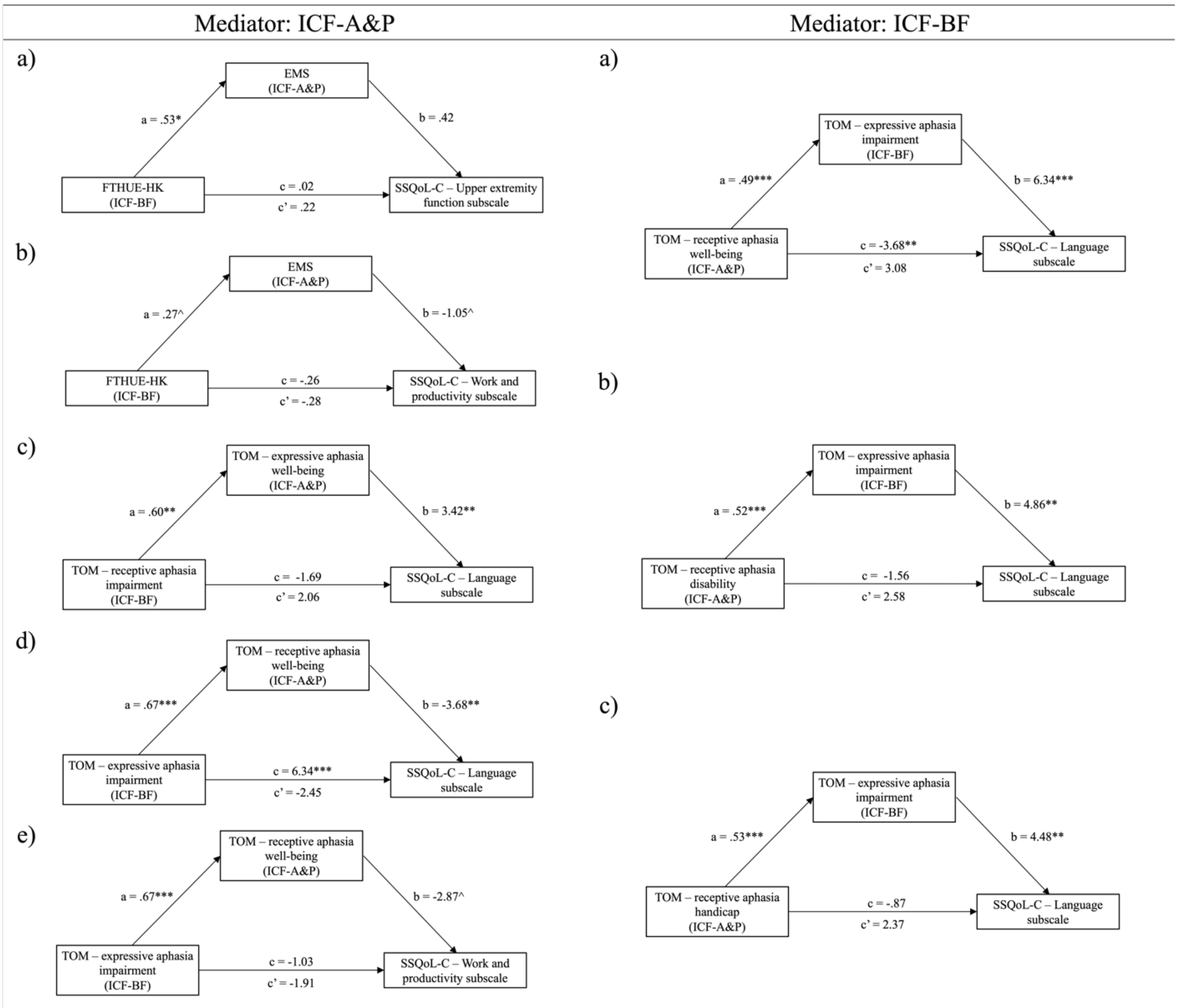
After including covariates to measure patients' changes between two assessments, limited significant results were computed. One significant result was controlled by age. Score for the HK-OCS Numerical calculation subtest indicated a significant result ($F(1, 49) = 6.86$, $p = .012$, $\eta^2_p = 0.12$). Another significant result was controlled by stroke duration on the SSQOL-C Work and Productivity subscale ($F(1, 49) = 5.00$, $p = .030$, $\eta^2_p = 0.09$). The last significant result was controlled by education level on the SSQOL-C Language subscale. No further significant results could be observed after assessment scores were controlled these variables.

4.3.7 Mediation and SEM analyses

All measures showing significant changes were extracted and entered into mediation analyses. Changes in the scores for the ICF-BF- and ICF-A&P-based measures and the secondary outcomes were grouped according to the model stipulated in Figure 4.2. Eight mediation models with ICF-BF as the IV and ICF-A&P as the mediator were constructed to predict the secondary outcomes (Table 4.3; Appendix D). Secondary outcomes were satisfaction with quality of life (SSQoL) and goal attainment (GAS). The model with ICF-BF (i.e., TOM impairment scale for expressive aphasia score) as the IV, ICF-A&P (i.e., TOM well-being scale for receptive aphasia score) as the mediator, and SSQoL-C Language subscale as the DVs yielded the best prediction (β = -2.45, 95% confidence interval [CI]

[-.498, -.305]). Another model with ICF-BF (i.e., FTHUE-HK score) as the IV, ICF-A&P (i.e., EMS score) as the mediator, and the SSQoL-C Work and Productivity subscale score as the DV revealed significant results (β = -.28, 95% CI [-.758, -.023]). Three models with the ICF-A&P score as the IV and the ICF-BF score as the mediator were constructed to predict the secondary outcomes (Table 4.3; Appendix E). The model with ICF-A&P (i.e., TOM well-being scale for receptive aphasia score) as the IV, ICF-BF (i.e., TOM impairment scale for expressive aphasia score) as the mediator, and the SSQoL-C Language subscale score as the DV yielded the best prediction (β = 3.08, 95% CI [0.637, 5.017]). In contrast, no significant models were found to be statistically significant when the patients' goal attainment was used as the DV. Regardless of the DV, covariates such as age and sex were not significant factors in any of the significant models. Regarding the mediation models controlled by covariate, no significant results were obtained from the analysis.

Table 4.3. Significant models from mediation analyses.



Note: The Left column indicates models with A&P as the mediator and BF as the independent variable (IV); the right column indicates models with BF as the mediator and A&P as IV. Dependent variables are subscales from the SSQoL-C. Path a, b and c’ are indirect effects, while Path c is the direct effect. ^*p* = 0.07; **p* < .05; ***p* < .01; *** *p* < .001. CI, confidence interval.

4.3.6 Qualitative analysis of treatment sequence and the number of patients in the BF→A&P, A&P→BF, and A&P|BF modules

Content analyses were conducted on the sequence and number of intervention modules received by the patients (Table 4.4). In all three treatment phases, LE (beginning phase: 69.8%, middle phase: 76.9%, late phase: 82.2%) and speech (beginning phase: 42.3%, middle phase: 54.5%, late phase: 52.9%) intervention modules showed predominantly concurrent delivery of the ICF-BF and ICF-A&P components, i.e., BF|A&P. Different sequence patterns were identified for the UE intervention modules. There were increases in the delivery of ICF-BF modules from the beginning to the late phases (beginning phase: 40%, middle phase: 47.9%, late phase: 68.4%). UE treatments tended to focus on the concurrent delivery of intervention modules in the beginning phase, but their proportion decreased with time (beginning phase: 54%, middle phase: 43.8%, late phase: 26.3%) and with the increase in the proportion of patients undergoing ICF-BF treatments (beginning phase: 40%, middle phase: 47.9%, late phase: 68.4%).

Table 4.4. Content analyses on the types (BF or A&P) and sequences (BF→A&P, A&P→BF, and A&P|BF) of the intervention modules involving upper extremity, lower extremity and speech received by the patients in the ICF-PARP in the beginning, middle and late phases of the program.

Treatment contents in case note	Beginning phase, patterns included*:					Middle phase, patterns included*:					Late phase, patterns included*:				
	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Upper extremity	54%	4%	0%	40%	2%	43.8%	6.3%	0%	47.9%	2.1%	26.3%	2.6%	2.6%	68.4%	0%
Lower extremity	69.8%	17%	3.8%	5.7%	3.8%	76.9%	3.8%	5.7%	3.8%	9.6%	82.2%	6.7%	2.2%	6.7%	2.2%
Speech	42.3%	7.7%	7.7%	19.2%	23.1%	54.5%	0%	0%	13.6%	31.8%	52.9%	5.9%	0%	11.8%	29.4%

Note: The beginning phase is equivalent to 1st to 10th for a 30-session program or 1st to 16th for a 48-session program; the middle phase is equivalent to 11th to 20th or 17th to 32nd sessions; the late phase is equivalent to i.e. 21st to 30th or 33rd to 48th sessions. BF = Body Function; A&P = Activity and Participation. Content and sequence patterns: A) A&P|BF (integrative contents): BF and A&P contents, no A&P versus BF sequence is observed. B) BF→A&P (body function then activity and participation contents), BF contents occupy the prior 50 % of the phase, A&P contents are added at the late 50% of the phase. C) A&P→BF (activity and participation then body function contents), A&P contents occupy the prior 50 % of the phase, BF contents are added at the late 50% of the phase. D) BF only. E) A&P only.

4.4 Discussions

The current study aimed to investigate the effectiveness of an ICF-PSRP in enhancing patients' ability to reintegrate into the community. Our results indicated improvements in almost all aspects of body functions (i.e., ICF-BF) and activity and participation (i.e., ICF-A&P), such as mobility and IADL, after implementation of the ICF-PSRP. The only exception was cognition, which did not show significant improvements. These improvements were comparable to those previously reported for various conventional post-stroke programs (Kamo et al., 2019; Rice et al., 2016) and ICF-based rehabilitation programs (Abarghuei et al., 2018; Mehraban et al., 2022). New findings from this study are that improvements in the ICF-BF and ICF-A&P scores, and their relationships, predicted patients' satisfaction in different ways. The strongest prediction was found for interventions provided by speech therapists who targeted expressive and receptive aphasia. Patients' satisfaction with their quality of life related to language (SSQoL-C Language subscale) was predicted by improvements in the ERL function (ICF-BF, TOM Impairment Scale) and mediated by patients' ERL improvements in daily life (ICF-A&P, TOM Well-Being Scale). The reciprocal relationships between ERL components, i.e., the ICF-A&P score as the predictor and the ICF-BF score as the mediator, also showed comparable predictability of patients' satisfaction. The closed-looped predictor–mediator–outcome relationships in ERL may have been confounded by the overlapping measurement constructs among the instrument's subscales. However, the patients' satisfaction with their work-related quality of life gave a clear demonstration of the contributions of BF-A&P to the ICF model. UE function improvement (ICF-BF, FTHUE-HK), mediated by LE mobility improvement (ICF-A&P, EMS), was a significant predictor of the patients' satisfaction with their work (SSQoL-C Work and Productivity subscale). Content analyses further supported a combined BF–A&P treatment approach throughout the program, and particularly during treatments targeting LE and speech, to support personalized treatments to achieve the patients' goals that were set at the beginning of the program.

Patients showed significant improvements in various aspects after the ICF-based program. The results were consistent with those of previous post-stroke rehabilitation studies based on a one-group pre- and post-intervention design. Our results suggested that the goal-setting process and customized treatment content may have largely contributed to the positive outcomes. Emphases were placed on resuming life roles and community reintegration during the patients' goal-setting process. The variety of treatment contents and modules in the post-stroke program was purposefully expanded to cater to the potentially diverse goals set by the patients. For instance, outdoor walking training was offered to patients who wished to walk better in their community, and simulated escalator training was offered to those who wished to resume community living. Effective goal-setting and personalized treatment contents in post-stroke rehabilitation have been reported to result in enhanced motivation for behavioral changes, improved functional abilities, and the resumption of meaningful activities of daily life (Barnden et al., 2022). The goals set by the patients determined the type, intensity, and duration of the interventions assigned by the case therapist. For instance, Patient A expressed a desire to return to his teaching role. Therefore, improving writing skills was identified as a core component to be addressed in this patient's personalized treatment program. Patient A was assigned fine motor skill training, including ICF-BF- (e.g., hand grip and pinch grip strengthening) and ICF-A&P-related activities (e.g., fine motor exercises and writing tasks). The goals set and the subsequent personalized treatment arrangements were comparable to those described by Abarghuei et al. (2018). The goal set by the patient in the case study reported by Abarghuei et al. (2018) related to independent living in the community. Therefore, ICF-BF- (e.g., splint and orthosis position) and ICF-A&P-related training (e.g., gait training) were assigned to meet his needs. In contrast to other studies, the ICF-based program we designed used a multidisciplinary approach, including physiotherapy, occupational therapy, and speech therapy, to offer multidimensional treatments to patients. Other studies have used single-discipline ICF-based post-stroke programs with only physiotherapy or occupational therapy (Begum & Haque, 2019; Mehraban et al., 2022).

Our findings that the ICF-BF or ICF-A&P scores played mediating roles in determining the intervention outcomes are noteworthy. The ICF model does not stipulate the specific relationship between or sequence of these two components. In this study, there appeared to be a tendency for the ICF-A&P score to play a mediating role. The ICF-A&P score became a significant mediator of the ICF-BF score when predicting patients' satisfaction with their expressive and receptive language, work, and productivity. These results are intuitive and consistent with those reported in non-ICF studies of post-stroke patients. First, in our ICF model, the improvement in UE function (ICF-BF) mediated by the improvement in LE function (ICF-A&P) predicted patients' satisfaction with their work and productivity. UE and LE functions are moderately correlated with the dynamic postural balance of post-stroke patients (Rafsten et al., 2019; Yamamoto et al., 2020). UE and LE dysfunction has also been found to significantly hinder patients' ability to return to work (Balasooriya-Smeekens et al., 2016). In many job types, such as desktop service and computing, the ability to maneuver equipment with the UEs would be more challenging to regain than using a wheelchair to replace LE mobility. Second, in another ICF model, ERL improvements (ICF-BF) mediated by language improvements in daily life (ICF-A&P) predicted patients' satisfaction with their language. Our results are consistent with those of previous studies, suggesting that the combination of ICF-BF and ICF-A&P in speech therapy allows patients to pursue social interactions and employment (Dalemans et al., 2010; Souchon et al., 2020). Simulated life-related situations during therapy have been incorporated in the syntax and naming of training programs to enable post-stroke patients to resume their life roles (Fridriksson & Hillis, 2021).

However, the predictor and mediator roles of ICF-BF and ICF-A&P in satisfaction with ERL were reversed. The analyses of the treatment program contents substantiated that the predictor–mediator roles would largely be influenced by the patients' treatment goals set at the beginning of the program and, hence, the sequence of the treatment modules. Content analyses showed that most of the LE- and language-related treatment contents were a combination of the ICF-BF and ICF-A&P modules throughout the post-stroke program. The combined BF–A&P approach revealed in this study has its merit. On one hand, ICF-BF-related training is an essential treatment approach for enhancing the regaining of functions lost after a stroke (Arene & Hidler, 2009). On the other hand, focusing on ICF-A&P has been found to promote the resumption of life roles after a stroke (Fridriksson & Hillis, 2021). More importantly, the combination of different types of intervention and breaking down the treatment goals can enhance patients' motivation and their adherence to the treatment regime (Wang et al., 2014). Another study found that the breaking down of treatment goals and patients' achievements and the provision of intermittent rewards empowered patients to experience their successes and internalize their treatment goals (Lau et al., 2022). We found that the UE interventions tended to organize in patterns that began with a combined approach but ended with ICF-BF-related training. The main constraint observed for the program was that the low level of UE function in patients impacted their engagement in ICF-A&P-related training. Another reason for the UE interventions to show this trend was the relatively short length of the post-stroke program in this study, which did not cater to the extended recovery period required to regain UE function (Lee et al., 2015; Paci et al., 2016).

4.5 Limitations

There were several limitations of our study. First, the use of a non-randomized clinical trial and no blinding in post-stroke patients might have biased the results pertaining to treatment effectiveness. Second, the absence of a control group and randomization may limit the observations of patients' improvements from the ICF concepts. However, a wait-list control group was not feasible in this study because of clinical ethical considerations. Delayed intervention in post-stroke patients would affect their recovery potential (Sima et al., 2021). Considering post-stroke patients who joined other rehabilitation programs (e.g., conventional programs and constraint-induced therapies) as the control groups would facilitate the comparison of the results. Third, the small sample size ($N = 52$) might have weakened the power of the analyses and hence the significance of the results, particularly the path analyses. Although positive results from the repeated-measures ANOVA demonstrated patients' improvements in ICF-BF and ICF-A&P, a larger sample size would be required to obtain significant results in path analyses and more complicated analyses such as SEM (Wolf, 2013). Further, the non-significant results obtained for predicting goal attainment as a secondary treatment outcome were unexpected. Despite qualitative analyses indicating general increases in the pre-discharge rating on the GAS, the instrument uses a 7-point Likert scale, which may have lowered its sensitivity to reflect the patients' gains from the post-stroke program (Finstad, 2010). A previous study concluded that changes in patients' goal attainment levels could not be entirely captured using conventional clinical assessments (Krasny-Pacini et al., 2013). Alternative measures suggested to assess changes in goal attainment include the Canadian Occupational Performance Measure (Vyslysel et al., 2021) and ICF-based goal statements with the ICF classification system codes (Leonardi & Fheodoroff, 2021). Moreover, the clinical instruments used to assess body function, activity, participation, and satisfaction with the ERL-related quality of life were non-ICF assessments.

Some of these concepts used in clinical assessments, particularly those that were overgeneralized, may not have been described by the ICF model. For example, concepts such as “personal life” in the SSQoL could not be described using the ICF (Fréz et al., 2013). These test items may have confounded the results and, hence, the interchanging predictor–mediator roles in the two ICF-models. Future studies using a randomized clinical trial format and the ICF Categorical Profile are recommended to further explore the effectiveness of the ICF-PSRP.

4.6 Conclusion

The current study explored the effect of a new ICF-PSRP in terms of enhancing patients’ community reintegration. The program was delivered by a multidisciplinary professional team. The results indicated that the goal-setting process and the combined treatment regime improved patients’ body function, activity, participation, and satisfaction with their quality of life. The treatment contents focused on UE, LE, and language functions. Significant ICF models showed that, in general, the patients’ improvements in their body functions, mediated by improvements in the activity of participation, predicted their levels of satisfaction with their quality of life in the community. The treatment goals set by the patients formed the basis for the professional team to select and organize the contents and flow of the intervention modules. The combination of training contents related to body function and activity and participation may be a common feature of future ICF-PSRPs.

Chapter 5

General Conclusion

In applying the ICF model in post-stroke rehabilitation, this thesis explored the role of the model from its application in previous post-stroke ICF-related studies to investigate its effectiveness of a newly developed ICF-based post-stroke rehabilitation program (ICF-PSRP) in Hong Kong.

5.1 Summary of significant findings

Using the UK Stroke Guideline as a reference, the narrative review indicated the unreadiness of applying the ICF model in post-stroke rehabilitation. In terms of the results from the classification of assessments, the coverage of over two-thirds of the Guideline topics indicated the focus on developing and validating post-stroke clinical assessments. Yet, only four clinical assessments showed the exact classification with the Guideline, which covered the “Cognition”, “Mobility – Weakness and ataxia”, and “Sensation” topics. When classifying these assessments with ICF domains, over two-thirds of the ICF-related assessments were classified into the Activity domain alone or Activity and Participation (ICF-A&P) domains with no clear distinction. The Environmental factors (EF) were also not emphasized in these assessments. Further, fourteen ICF-related post-stroke interventions were found in 25 literature, and about one-third of the Guideline’s topics were mapped. Nine out of the 14 ICF-related interventions indicated exact content matches with those contained in the Guideline, including the topics of “Arm function”, “Communication – Aphasia”, “Activities of daily living – extended activity of daily living”, and “Mobility – Balance”. The dominance of the Activity domain in ICF-related assessments and the narrow scope in ICF-related interventions suggested limited research in ICF post-stroke rehabilitation for the

Participation domain and EF (Engkasan et al., 2019). Moreover, the non-compliance of the rehabilitation processes suggested by Lexell and Brogårdh (2015) revealed the goal-setting process was not included in these ICF-related interventions, which hindered the personalized intervention contents for post-stroke patients.

The qualitative study revealed implementing the ICF-PSRP could facilitate community reintegration in post-stroke patients. First, patients' concepts in goal-setting were modified in the program which facilitated program outcomes. Patients' previous rehabilitation experiences in public hospitals and outpatient clinics revealed limited chances of goal-setting and the focus on functioning deficits. Yet, patients in the current program could set and achieve self-relevant rehabilitation goals, covering areas tapping into the ICF-A&P domains and EF such as writing at work and walking without accessibility. Second, the ICF-PSRP initiated patient–therapist interactions starting from the goal-setting process and maintain the interactions throughout the program, which facilitated the treatment personalization for patients. When treatment proceeded, patients received follow-ups from therapists regarding training contents to ensure program flow was concurrent with their goals. Lastly, applying the ICF increased environmental interactions in patients. Analysis of goals contents in terms of ICF domains showed a percentage increase in the environmental factors from 45.4% to 75.7%. Patients also reported increased interaction with physical and social environments, and the on-site community training facilitated their return to the accustomed environment.

The quantitative study indicated the effectiveness of an ICF-PSRP in enhancing patients' ability for community reintegration. Analyses from intake and pre-discharge assessments confirmed patients' improvements across the ICF-BF and ICF-A&P aspects, including mobility and instrumental activities of daily living, but not for cognition in the ICF-BF domain. These results were consistent with other post-stroke ICF-based rehabilitation programs conducted by Abarghuei et al. (2018) and Mehraban et al. (2022). Further, path analyses indicated the relationships between the improvements in the ICF-BF and ICF-A&P to predict patients' satisfaction in their abilities (e.g., quality of life). One significant model was the ICP-BF (i.e., improvements in expressive and receptive functions) mediated by the ICF-A&P (i.e., improvements in daily life language) to predict secondary outcome of satisfaction with the quality of life related to language. Another significant model was also the ICF-BF (i.e., improvements in the upper extremity functions) mediated by the ICF-A&P (i.e., improvements in the lower extremity mobility) to predict secondary outcome of satisfaction with the quality of life related to work and productivity. Other less significant models were a mix of ICF-BF mediated by ICF-A&P or reciprocal relationships of ICF-A&P mediated by the ICF-BF. Content analyses showed a combined ICF-BF and ICF-A&P relationships in most of the treatment program contents. The combined approach referred to the patients engaged in both types of training either within or across treatment sessions. These integrated arrangements were found to be common in the lower extremity and language-related training. Such arrangements reflected the personalized treatment contents based on patients' goals set at the beginning of the program. However, the upper extremity training tended to show a trend of integrated approach shifted to the ICF-BF-dominated in the latter part of the program. This may be due to the relatively longer recovery period required for the upper extremity and the duration of the ICF-PSRP was limited to eight to twelve weeks.

5.2 Limitations

There are several limitations in current studies. First, no control groups were included in both qualitative and quantitative studies. A single-group design was adopted for intake and pre-discharge interviews and clinical assessment comparisons. A randomized controlled trial with blinding in patients is suggested for future studies to explore treatment effects from the ICF model with other post-stroke rehabilitation, such as conventional programs and robot-assisted motor training. Second, the small sample size in both studies may limit the validity and generalizability of the results. An increase in sample size is suggested to obtain robust and meaningful results on the flow of ICF components to treatment outcomes, particularly the path analyses and SEM-related analyses. Third, clinical assessments which mapped with ICF domains were used instead of the ICF Categorical Profile to measure patients' changes in body function, activity and participation, and satisfaction with quality of life. Although previous studies successfully classified a number of clinical assessments with ICF domains, some of these concepts in clinical assessments might not be described by the ICF model (Fréz et al., 2013). Further, the non-significant results in the quantitative study obtained for predicting goal attainment were out of our expectation. Despite qualitative analyses indicated general increases in the pre-discharge rating on the Goal Attainment Scale and patients' satisfaction on their goal achievement, the Likert scale of the instrument with seven-point or below may have lowered its sensitivity to reflect the patients' gains and for quantitative analysis (Finstad, 2010). Lastly, this study did not explore the relationship between all ICF domains. For example, the Environmental factors (EF) were only explored in the qualitative study but not in the quantitative study; the personal factors (PF) were seldom mentioned by patients during interviews and were not supported by the clinical assessments in the quantitative study. The EF and PF form the contextual factors that are considered as facilitators and barriers to affect the level of community reintegration (Abarghuei et al., 2018; Perin et al., 2020).

5.3 Suggestions for future studies

To improve the validity of the results, future studies may consider adopting a randomized clinical trial, such as comparing the impacts of a conventional post-stroke program with the current ICF-based program. This can help tackle the results that might have possibly been driven by patients' natural recovery after stroke and the placebo effects. Furthermore, increasing the sample size of post-stroke patients can help compute more concrete results, particularly in building more significant and meaningful models to explain the flow of ICF concepts towards treatment outcomes. Future ICF-based studies should further emphasize the role of EF and PF in how they react with ICF-BF and ICF-A&P to facilitate community reintegration in post-stroke rehabilitation. Lastly, applying objective measures on top of the subjective ones helps validate the treatment outcome results, and enhances the understanding of ICF in building statistical models.

5.4 Implications

The ICF-PSRP was found to be effective for post-stroke patients to improve their body function, activity and participation abilities for community reintegration and resuming life roles. The goal-setting process that appears early in the program is curial to deliver the ICF concepts, particularly the Participation domain, to post-stroke patients from therapists. Patients' participation in the goal-setting process allows them to set self-relevant goals other than general goals related to mobility and self-caring. The contents of goals influence the professional team to select and organized personalized intervention modules for each patient. Our findings further support utilizing a combined approach of ICF-BF and ICF-A&P to benefit patients with enhanced intervention outcomes and their satisfaction with the quality of life. Improvements in ICF-BF are mediated by the improvements in ICF-A&P and hence patients' self-perceived quality of life. The interplay of ICF-BF and ICF-A&P informs the importance of including these domains in the future development of ICF-based post-stroke rehabilitation programs.

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Appendices

Appendix A Guiding Questions in Patient Interviews and Focus Groups

Table A1. Guiding questions in intake and discharge patient interviews.

Guiding questions
1) What are your goals to achieve in this treatment program?
2) Could you provide details of previous treatment program(s) that you joined?
3) When compared with the program you joined before, how different in terms of the aims do you think about this treatment program and the one you joined?
4) When compared with the program you joined before, how different in terms of the contents do you think about this treatment program and the one you joined?
5) You know that this treatment program is different from your previous treatment program, do you believe that joining this program can help you achieve your goals and return to the community as much as possible?

Table A2. Guiding questions in discharge patient interview.

Guiding questions
6) Did you observe improvements in general on yourself throughout the treatment program? What improvements on yourself did you observe?
7) Given your improvements from the treatment program, did you think these improvements can also fulfil the goals you set at the beginning?
8) In what aspects do you think this treatment program is good for other individuals who have similar problems with you?
9) In what aspects do you think the treatment program need to change to achieve your goals?

Table A3. Guiding questions in focus groups.

Guiding questions
1) [Open-ended question] When compared with a conventional program, how different in terms of the treatment aim do you think this ICF program is? Specify those differences.
2) [Open-ended question] When compared with a conventional program, how different in terms of the treatment contents do you think this ICF program is? Specify those differences.
3) [Open-ended question] What other features in this ICF program do you think are important in addition to the unique assessment and treatment contents?
4) [Open-ended question] Are there any other specific issues or concerns you think in implementing the ICF model against post-stroke rehabilitation?
5) [Open-ended question] Are there any actions that CTY therapists can do to enhance the service outcomes with the ICF model?

Appendix B Final Thematic Framework for Indexing and Charting

Themes	Definitions	Sub-themes	Definitions
Rehabilitation goal(s)	Step(s) to tailor rehabilitation to meet patients' needs, which is a behavior change technique to enhance clinical outcome(s) from intervention(s) (Dekker et al., 2020)	Shorter-term goal(s)	The intended consequence of actions defined by rehabilitation team and patient (Wade, 2009)
		Longer-term goal(s)	Patients' indented future state, include their hopes and aspirations (Dekker et al., 2020; Wade, 2009)
Perceived content	Set of previous interventions designed to optimize functioning and reduce disability in post-stroke patients to interaction with their environment (World Health Organisation, 2021, November 10)	Other experiences	Rehabilitation experiences received other than HKSR (e.g., from public services or private sectors)
Perceived goal	Rehabilitation goal(s) set in different services to optimize functioning and reduce disability in post-stroke patients to interaction with their environment (World Health Organisation, 2021, November 10)	Current experiences	Rehabilitation experiences expected or received in HKSR
Perceived personnel	Staff, including therapists in different disciplines and rehabilitation assistants, involved in the rehabilitation process (Christakou & Lavallee, 2009)	Comparison	Comparison of [theme] between other programs and the HKSR
Evaluation of self in rehabilitation program	Patients' contribution and rehabilitation outcome perception	Goal-based outcome comparison	Individualized outcome achievement from the program (Turner-Stokes, 2009)
Evaluation of rehabilitation program	Factors and patients' opinions that may affect rehabilitation outcome(s)	/	/

Themes	Definitions	Sub-themes	Definitions
Therapeutic relationship	Collaboration between patients and therapists to identify and achieve program-specific and long-term rehabilitation goals. Therapist caring toward patients promotes desired outcomes (Cummins et al., 2021)	Other experiences	Rehabilitation experiences received before HKSR (e.g., from public services or private sectors)
		Current experiences	Rehabilitation experiences expected or received in HKSR
Patient-environment interaction	Patients interact with environments inside and outside of HKSR, including surrounding objects and people, to restore or return to a state of optimal functioning (Bonnechère & Van Sint Jan, 2019)	Physical environment	Environments can be barriers or facilitators to patients. Changes in the physical environment influence patients' activity and social interactions (Anåker et al., 2020)
		Social environment	Interactions or activities to support patients' social contact and communication skills with friends, family, and others (Kylén et al., 2021)
Lack of stroke rehabilitation knowledge	Patients may show insufficient knowledge on continuing stroke rehabilitation and aspects related to it (Kamalakannan et al., 2016)	/	/
Build up confidence from therapists	Positive reinforcement and encouragement received from therapists that helped to build belief in patients (Horne et al., 2014)	/	/
Practice against goal	Patients practiced on their outside the rehabilitation center	/	/
Community reintegration	Environments that patients have been apart from their home and rehabilitation	/	/

Themes	Definitions	Sub-themes	Definitions
	centres (Brookfield & Mead, 2016)		

Appendix C Results of repeated measures ANOVAs on the scores of the Body Function (ICF-BF), Activity and Participation (ICF-A&P), and secondary outcome measures between the intake and the pre-discharge assessment occasions.

Measures	intake Scores (Mean, SD)	Pre-discharge Scores (Mean, SD)	Repeated Measures ANOVAs
		Body Function (ICF-BF)	
FTHUE-HK	3.51 (2.30)	3.98 (2.23)	$F(1,51) = 18.15, p < .001^{***}, \eta^2_p = 0.26$
HK-OCS			
Picture naming	3.23 (1.52)	3.21 (1.48)	$F(1,51) = 0.06, p = .811, \eta^2_p = 0$
Semantics	2.65 (0.88)	2.69 (0.88)	$F(1,51) = 0.31, p = .580, \eta^2_p = 0.01$
Orientation	3.67 (0.96)	3.73 (1.17)	$F(1,51) = 0.21, p = .652, \eta^2_p = 0$
Visual field-left	1.58 (0.80)	1.54 (0.83)	$F(1,51) = 0.28, p = .598, \eta^2_p = 0.01$
Visual field-right	1.69 (0.70)	1.69 (0.73)	$F(1,51) = 0.01, p = .940, \eta^2_p = 0$
Sentence reading	17.35 (7.78)	17.85 (7.45)	$F(1,51) = 0.60, p = .443, \eta^2_p = 0.01$
Number writing	2.30 (1.13)	2.33 (1.18)	$F(1,51) = 0.08, p = .773, \eta^2_p = 0$
Calculation	3.36 (0.99)	3.31 (0.99)	$F(1,51) = 0.06, p = .801, \eta^2_p = 0$
Attention	36.33 (18.56)	39.13 (16.33)	$F(1,51) = 6.14, p = .017^{*}, \eta^2_p = 0.11$
Praxis	9.67 (3.77)	9.94 (3.78)	$F(1,51) = 0.74, p = .394, \eta^2_p = 0.01$
Verbal memory	3.13 (1.34)	3.40 (1.36)	$F(1,51) = 2.23, p = .142, \eta^2_p = 0.04$
Episodic memory	3.41 (1.17)	3.45 (1.22)	$F(1,50) = 0.28, p = .598, \eta^2_p = 0.01$
Executive test	1.86 (4.30)	1.84 (4.65)	$F(1,50) = 0, p = .978, \eta^2_p = 0$
MMT-LE	6.43 (3.38)	6.98 (3.27)	$F(1,51) = 11.45, p = .001^{**}, \eta^2_p = 0.18$
TOM			
Receptive aphasia – impairment	3.90 (1.69)	4.09 (1.49)	$F(1,34) = 4.61, p = .017^{*}, \eta^2_p = 0.16$
Expressive aphasia – impairment	3.59 (1.74)	3.94 (1.44)	$F(1,34) = 19.50, p < .001^{***}, \eta^2_p = 0.36$
Dysarthria – impairment	4.23 (0.76)	4.60 (0.58)	$F(1,29) = 15.67, p < .001^{***}, \eta^2_p = 0.35$

Measures	intake Scores (Mean, SD)	Pre-discharge Scores (Mean, SD)	Repeated Measures ANOVAs
Activity and Participation (ICF-A&P)			
EMS	12.50 (3.88)	14.87 (3.33)	$F(1,51) = 89.61$, $p < .001$***, $\eta^2_p = 0.64$
iADL-CV	8.33 (6.53)	11.40 (7.25)	$F(1,51) = 41.87$, $p < .001$***, $\eta^2_p = 0.45$
mBI-C	74.21 (20.06)	83.85 (16.98)	$F(1,51) = 81.72$, $p < .001$***, $\eta^2_p = 0.62$
TOM			
Receptive aphasia – disability	3.96 (1.60)	4.33 (1.19)	$F(1,34) = 17.90$, $p < .001$***, $\eta^2_p = 0.35$
Receptive aphasia – handicap	3.97 (1.57)	4.37 (1.11)	$F(1,34) = 19.23$, $p < .001$***, $\eta^2_p = 0.36$
Receptive aphasia – well-being	3.91 (1.69)	4.20 (1.37)	$F(1,34) = 9.13$, $p = .005$**, $\eta^2_p = 0.16$
Expressive aphasia – disability	3.66 (1.66)	4.20 (1.23)	$F(1,34) = 26.60$, $p < .001$***, $\eta^2_p = 0.44$
Expressive aphasia – handicap	3.69 (1.61)	4.23 (1.16)	$F(1,34) = 28.78$, $p < .001$***, $\eta^2_p = 0.46$
Expressive aphasia – well-being	3.63 (1.73)	4.10 (1.34)	$F(1,34) = 21.21$, $p < .001$***, $\eta^2_p = 0.38$
Dysarthria – disability	4.33 (0.65)	4.87 (0.32)	$F(1,29) = 27.60$, $p < .001$***, $\eta^2_p = 0.49$
Dysarthria – handicap	4.35 (0.63)	4.85 (0.33)	$F(1,29) = 27.19$, $p < .001$***, $\eta^2_p = 0.48$
Dysarthria – well-being	4.23 (0.77)	4.68 (0.53)	$F(1,29) = 15.77$, $p < .001$***, $\eta^2_p = 0.35$
Secondary Outcome Measures			
GAS	-2 (same for all patients)	0.50 (1.30)	$F(1,44) = 167.23$, $p < .001$***, $\eta^2_p = 0.79$
SSQoL-C			
Family role	7.42 (1.99)	8.16 (2.28)	$F(1,51) = 4.15$, $p = .047$*, $\eta^2_p = 0.08$
Language	19.88 (5.33)	21.42 (4.75)	$F(1,51) = 12.34$, $p = .001$**, $\eta^2_p = 0.20$
Mobility	21.73 (5.48)	23.72 (4.50)	$F(1,51) = 9.26$, $p = .004$**, $\eta^2_p = 0.15$
Self-care	18.37 (4.95)	19.42 (4.06)	$F(1,51) = 2.30$, $p = .135$, $\eta^2_p = 0.04$

Measures	intake Scores (Mean, SD)	Pre-discharge Scores (Mean, SD)	Repeated Measures ANOVAs
Social role	12.98 (3.50)	14.69 (3.86)	$F(1,51) = 11.42$, $p = .001$**, $\eta^2_p = 0.18$
Upper Extremity function	18.48 (4.20)	19.63 (3.85)	$F(1,51) = 3.85$, $p = .055$^, $\eta^2_p = 0.07$
Work and productivity	8.47 (2.94)	9.78 (2.12)	$F(1,51) = 4.61$, $p = .037$*, $\eta^2_p = 0.08$

Note: ^$p = 0.07$; *$p < .05$; **$p < .01$; ***$p < .001$. Effect sizes using partial eta squared (η^2_p) were reported for the ANOVA results. Small, medium and large effect sizes of the results were represented by 0.01, 0.06, and 0.14 respectively. EMS, Elderly Mobility Scale; FTHUE-HK, Hong Kong version of the Functional Test for the Hemiplegic Upper Extremity; GAS, Goal Attainment Scale; HK-OCS, The Hong Kong version of the Oxford Cognitive Screen; iADL-CV, Chinese Version of the Lawton Instrumental Activities of Daily Living ; mBI-C, Chinese version of Modified Barthel Index; MMT-LE, Manual Muscle Testing – Lower Extremity; SSQoL-C, Chinese version of the Stroke Specific Quality of Life Scale; TOM; Therapy Outcome Measures.

Appendix D Results of mediation analyses with ICF-BF factors as independent variables, secondary outcomes as dependent variables, and ICF-A&P factors as mediators.

Independent variable (X)	Dependent variable (Y)	Mediator (M)	Indirect effects										Direct effect			
			Path a (X to M)				Path b (M to Y)				Path c' (X to Y)		Path c			
			β	SE	*t*	*p*	β	SE	*t*	*p*	β	95% CI [lower, upper]	β	SE	*t*	*p*
FTHUE-HK	SSQoL-C – Upper extremity function	EMS	.53	.20	2.66	.010	.42	.35	1.20	.237	.22	[.004, .627]	.02	.52	.033	.974
TOM – receptive aphasia impairment	SSQoL-C – Language	TOM – expressive aphasia well-being	.60	.22	2.78	.009	3.42	1.04	3.30	.002	2.06	[.179, 4.466]	-1.69	1.43	-1.18	.247
TOM – expressive aphasia impairment		TOM – receptive aphasia well-being	.67	.17	3.97	.000	-3.68	1.05	-3.52	.001	-2.45	[-4.498, -.305]	6.34	1.22	5.18	.000
FTHUE-HK	SSQoL-C – Work and productivity	EMS	.27	.14	1.93	.060	-1.05	.53	-1.99	.053	-.28	[-.758, -.023]	-.26	.53	-.50	.619
TOM – expressive aphasia impairment		TOM – receptive aphasia well-being	.67	.17	3.97	.000	-2.87	1.42	-2.02	.052	-1.91	[-3.674, -.134]	-1.03	1.67	-.62	.539

Note: Path a (i.e. from BF factors to A&P factors), b (i.e. from A&P factors to secondary outcomes) and c (i.e. from BF factors to secondary outcomes with the presence of mediator) were indirect effects, while Path c' (i.e. from BF factors to secondary outcomes without the presence of mediator) was the direct effect. CI, confidence interval; EMS, Elderly Mobility Scale; FTHUE-HK, Hong Kong version of the Functional Test for the Hemiplegic Upper Extremity; SSQoL-C, Chinese version of the Stroke Specific Quality of Life Scale; TOM; Therapy Outcome Measures.

Appendix E Results of mediation analyses with ICF-A&P factors as independent variables, secondary outcomes as dependent variables, and ICF-BF factors as mediators.

			Indirect effects										Direct effect			
			Path a (X to M)				Path b (M to Y)				Path c’ (X to Y)		Path c			
Independent variable (X)	Dependent variable (Y)	Mediator (M)	β	SE	*t*	*p*	β	SE	*t*	*p*	β	95% CI [lower, upper]	β	SE	*t*	*p*
TOM – receptive aphasia well-being	SSQoL-C – Language	TOM – expressive aphasia impairment	.49	.12	3.97	.000	6.34	1.22	5.18	.000	3.08	[.637, 5.017]	-3.68	1.05	-3.52	.001
TOM – receptive aphasia disability			.52	.13	4.04	.000	4.86	1.42	3.43	.002	2.58	[1.101, 5.442]	-1.56	1.31	-1.19	.241
TOM – receptive aphasia handicap			.53	.12	4.29	.000	4.48	1.47	3.05	.005	2.37	[.964, 5.177]	-.87	1.30	-.67	.508

Note: Path a (i.e. from ICF-A&P factors to ICF-BF factors), b (i.e. from ICF-BF factors to secondary outcomes) and c (i.e. from A ICF-&P factors to secondary outcomes with the presence of mediator) were indirect effects, while Path c’ (i.e. from ICF-A&P factors to secondary outcomes without the presence of mediator) was the direct effect. CI, confidence interval; EMS, Elderly Mobility Scale; FTHUE-HK, Hong Kong version of the Functional Test for the Hemiplegic Upper Extremity; SSQoL-C, Chinese version of the Stroke Specific Quality of Life Scale; TOM; Therapy Outcome Measures.