DEVELOPMENT AND FEASIBILITY EVALUATION OF AN mHEALTH INTERVENTION FOR MANUAL WHEELCHAIR SKILLS TRAINING WITH OLDER ADULTS

by

Edward Mark Giesbrecht

B.S.W., University of Manitoba, 1987

B.M.R.(OT), University of Manitoba, 1994

M.Sc.(Rehab), University of Manitoba, 2006

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF

THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

in

THE FACULTY OF GRADUATE AND POSTDOCTORAL STUDIES

(Rehabilitation Sciences)

THE UNIVERSITY OF BRITISH COLUMBIA

(Vancouver)

May 2016

Abstract

Many older adults rely on a manual wheelchair (MWC) for mobility but are not provided with skills for independent and effective use. Access to wheelchair skills training is constrained by the logistics, expense and limited availability of rehabilitation services. A supervised, home-based program specifically designed for older adults and delivered via a mobile computer tablet (mHealth) could potentially be a useful and efficient strategy to provide skills training.

Purpose
To explore the experience and needs of older adults transitioning to MWC use (Chapter 2); collaboratively develop, refine and pilot test an mHealth training program (Chapter 3); evaluate the program's feasibility (Chapter 4); estimate impact on skill capacity and clinical outcomes (Chapter 5); and explore user-perceived benefits (Chapter 6).

Methods
Qualitative methods were used to understand the MWC transition experience. A mixed-methods Participatory Action Design and pre-post pilot trial were used for program development. A feasibility randomized controlled trial (RCT) assessed feasibility and clinical indicators, and follow-up interviews explored participants' experiences.

Results
Older adult MWC users identified a lack of supports during transition to MWC use, particularly with skills training, often resulting in compromised community participation and increased care provider burden. The Participatory Action Design approach proved useful in constructing a viable prototype tablet-based home-training program that incorporated self-efficacy strategies and promoted principles of adult learning. In the feasibility RCT, the program was delivered safely and consistently, achieving most of the feasibility indicators; recruitment proved challenging but participants demonstrated good adherence with only one health-related dropout. There was a statistically significant difference and large effect size for measures of self-efficacy ($p = 0.06$; $\eta_p^2 = 0.28$) and performance of outdoor wheelchair activities ($p = 0.02$; $\eta_p^2 = 0.40$), but not for the primary outcome of skill capacity. Participants and care providers identified substantial clinical benefits in terms of confidence with wheelchair use, engagement in activities of life, and reduced care provider demands.

Conclusions: The mHealth program shows promise as a potentially effective and appealing wheelchair skills training program for older adult MWC users. Future evaluation should enhance recruitment strategies, facilitating a larger RCT for more robust evaluation of clinical benefits.

Preface

The research conducted for this dissertation was coordinated through the GF Strong Rehabilitation Research Lab in Vancouver, British Columbia with additional data collection at the University of Manitoba. I was responsible for developing all of the projects and methods included, in consultation with Dr. William C. Miller (supervisor) and Drs. Janice J. Eng and Roberta L. Woodgate (advisory committee). Ethical approval for the EPIC Wheels study was obtained from the University of British Columbia Ethics Committee (Phase 1 & 2 #H11-02558; Phase 3 H12-02043); the University of Manitoba Health Research Ethics Board (Phase 1 & 2 #H2011:357/H2012:069; Phase 3 H2012:330); Vancouver Coastal Health Research Institute (certificate #V12-02043); and the Winnipeg Regional Health Authority (certificate #2012-038). The EPIC Wheels RCT study was registered with ClinicalTrials.gov (Identifier NCT01740635).

A version of chapter 2 has been published with the following citation: Giesbrecht, E.M., Miller, W.C. & Woodgate, R.L. (2014). Navigating uncharted territory: a qualitative study of the experience of transitioning to wheelchair use among older adults and their care providers. BMC Geriatrics, 15, 91. Two publications have resulted from the work contained in chapter 3 with the following citations: Giesbrecht, E.M., Miller, W.C., Mitchell, I.M. & Woodgate, R.L. Development of a wheelchair skills home program for older adults using a Participatory Action Design approach. *BioMed Research International*. 2014:172434, 1-13. doi: 10.1155/2014/172434 and Giesbrecht, E.M., Miller, W.C., Jin, B.T., Mitchell, I.M. & Eng, J.J. Rehab on wheels: A pilot study of tablet-based wheelchair training for older adults. *JMIR Rehabilitation and Assistive Technologies*, 2(1), e3. doi:10.2196/rehab.4274. A version of chapter 4 has been published with the following citation: Giesbrecht, E., Miller, W.C., Eng, J.J., Mitchell I.M., Woodgate, R.L., and Goldsmith, G.H. (2013). Feasibility of the Enhancing Participation In the Community by improving Wheelchair Skills (EPIC Wheels) program: study protocol for a randomized controlled trial. *Trials, 14*, 350. doi:10.1186/1745-6215-14-350. For each of these publications the study design and conceptualized was the work of EMG and WCM. EMG was responsible for supervising data collection at the Winnipeg site, data analyses, and drafting each chapter and manuscript. WCM supervised the projects and data collection at the Vancouver site, analyzed data and provided guidance and editing on the published manuscripts. JJE contributed to the study designs and provided feedback and editing on the pilot study and RCT protocol papers. RLW participated in the qualitative data analyses, contributed to study design, and provided feedback and editing on the program development and RCT protocol papers.

Table of Contents

List of Tables

List of Figures

Glossary

Assistive technology: “technology designed to be utilized in an assistive technology device or assistive technology service.” (Assistive Technology Act, 2004, p. Sec. 3(3))

Assistive technology device: “any item, piece of equipment or product system whether acquired commercially off the shelf, modified, or customized that is used to increase, maintain or improve functional capabilities of individuals with disabilities.” (Assistive Technology Act, 2004, p. Sec. 3(4))

Confidence: “a feeling or belief that you can do something well or succeed at something” (Merriam-Webster.com, 2015). For the purposes of this thesis, the terms confidence and self-efficacy are used synonymously.

Electronic Health (eHealth): the use of Information and Communication Technology (ICT) for health-related purposes, such as electronic health records; health education for providers or patients; consultation between providers or between provider and patient; assessment, goal-setting; education and/or treatment; and patient monitoring (WHO, 2011).

Feasibility RCT: a study intended to emulate the delivery of a subsequent large-scale efficacy RCT, but the focus is primarily on evaluation of feasibility indicators (i.e., confirming factors essential to conducting a large scale study) rather than comprehensive analysis of the treatment effect.

Information and Communication Technology (ICT): broad term widely used to describe both communication devices and applications.

Manual Wheelchair: “a wheelchair that the user propels with his or her own muscle power.” (Cook & Miller-Polgar, 2008, p. 550)

mHealth: medical and public health practice supported by mobile devices (WHO, 2011).

Mobile Device: a mobile computing device such as a cell phone, smart phone, tablet, personal digital assistant (PDA), or other wireless device.

Pilot study: a small-scale study evaluating issues of treatment intervention delivery and procedural administration.

Self-efficacy: the belief individual have in their ability to perform specific behaviours to achieve desired outcomes (Bandura, 1997).

Telehealth: the use of ICT to deliver health services and transmit health information over both long and short distances (International Standards Organization, 2014).

Telemedicine: delivery of health-related clinical service using ICT (Cason, 2015).

Telerehabilitation: delivery of health-related rehabilitation services using ICT, typically for monitoring and assessment/consultation purposes (Agostini et al., 2015).

Wheelchair: "a manually-operated or power-driven device designed primarily for use by an individual with a mobility disability for the main purpose of indoor or of both indoor and outdoor locomotion." (Americans With Disabilities Act, 1990, p. 33)

Wheelchair acquisition: for the purposes of this dissertation, it is the act of acquiring or obtaining a wheelchair for use, by purchase or otherwise, and regardless of the process by which the wheelchair was selected, obtained or configured.

Wheelchair procurement: “… the process through which individuals obtain … their wheelchair” (Mortenson & Miller, 2008, p. 167). For the purpose of this thesis, procurement refers to the process of ordering, purchasing and delivering a wheelchair to a consumer, which may include obtaining funding.

Wheelchair service provision: “The wheelchair service provision process is not simply assessment followed by prescription; rather, providing a client with an appropriate wheelchair requires a full spectrum of services. The wheelchair service delivery model … includes the following components: referral, assessment, equipment recommendation and selection, funding and procurement, product preparation, fitting, training and delivery, follow-up maintenance and repair, and outcome measurement.” (Arledge, et al., 2011, p. 3)

Acknowledgements

So many people made significant contributions to this endeavour that I cannot possibly include them all; I will humbly acknowledge the following and respectfully beg pardon those I have missed.

The EPIC Wheels data collection was faithfully conducted by Linh Huynh, Deepak Joshi, Natalie Manuel, Sarah McCuaig, Jennifer Querques, Chelsey Shura, Cynthia Swarnalatha, and Jennifer Zelmer. Naomi Bartz-McCormick, Courtney Denman, Madeline Hannan-Leith, Diane Jansen, Angie Maidment, Sandra Ott, and Emma Smith served as supremely competent trainers for our study participants. The Winnipeg site study coordinators included Erica Ramos, Srikesavan Sabapathy, and Kara Staples. Kate Keetch was the Vancouver site coordinator, but her role extended well beyond that – she was a spring of boundless encouragement and practical support throughout my PhD program, with unparalleled competence and humour. Dr. Ian Mitchell and graduate students Andy Kim and Tom Jin, from the UBC department of computer science, were integral to development of the EPIC Wheels program and the success of this project; their contribution cannot be overstated. Art Quanbury, Mick Williams, and Joy Willis all made practical contributions to making the EPIC Wheels training program usable and safe. Dr. Charles Goldsmith was a valuable contributor to the study design and data analysis.

I would like to acknowledge the generous financial support provided by the University of British Columbia, Canadian Occupational Therapy Foundation, Manitoba Society of Occupational Therapists and the Canadian Institutes of Health Research to support my education and fund my research studies.

My educational experience at UBC was both exceptional and enjoyable, in large part because of the support, encouragement, challenge and insight provided by my colleagues in the GF Strong lab. While my presence was sporadic and often virtual, working primarily from Winnipeg, I always felt connected and among friends. In particular, my cohort of Dr. Krista Best, Debbie Field, Bita Imam, Dr. Paula Rushton, Dr. Brodie Sakakibara, Lisa Simpson, Emma Smith and Dr. Dominik Zbogar have been my Vancouver family and I am forever grateful.

I was incredibly fortunate to have the support of a supervisory committee composed of such wisdom, experience and expertise. Dr. Roberta Woodgate nurtured my growth in qualitative methods and fueled my enthusiasm. Dr. Janice Eng provided exceptional guidance in methodology and encouraged excellence in my work. And finally, Dr. Bill Miller was a mentor to me in ways uncountable. His expertise in content, aptitude for teaching, facilitation of networking, and ability to connect on a personal level were immeasurably impactful on my development and I am sincerely grateful.

Dedication

My doctoral journey had many convolutions; when things were darkest and when things were brightest, I could always turn to my family and know how fortunate I was to share a larger journey with them. Lynda has been my cornerstone and Virginia, Paige and Holly my touchstones; this work is humbly dedicated to them.

1. Introduction

1.1 Statement of the problem

Many older adults rely on a manual wheelchair (MWC) for community mobility but are not provided with skills for independent and effective use. As a result, many lack confidence in their ability to use the wheelchair effectively to perform occupations of importance in daily life. Disuse or suboptimal use of the wheelchair results in substantial social costs such as reduced engagement in meaningful activity, social isolation, and higher care provider burden. This represents a poor use of financial resources, including the cost of wheelchair acquisition and demands for attendant care. Access to wheelchair skills training is constrained by the expense and limited availability of therapists; demands of consumer and/or clinician travel; limitations in clinician expertise related to wheelchair mobility skills; and training accommodations required to meet the needs of older adults. A supervised, home-based program specifically designed for older adults and delivered via a computer tablet could potentially be an effective and efficient strategy for addressing skill training and may also have application for other target groups, particularly those with limited access to rehabilitation services.

1.2 Aging and mobility impairment

As with many other industrialized countries, Canada has a rapidly aging population (Turcotte & Schellenberg, 2007). It is estimated that over the next 50 years, the proportion of seniors in Canada will double to more than 1 in 4 (Cranswick & Dosman, 2008). With age, the risk of a disabling health condition increases, with personal mobility being the second most prevalent area of impairment (following pain) among older adults in Canada at over 20% (Statistics Canada, 2013). Mobility is a prerequisite to engagement in life activities; consequently, such impairment can compromise community participation and quality of life.

There is considerable variability in the literature regarding the definition of “older adult” (Moon, Guo, & McSorley, 2015). For the purposes of this dissertation, older adult refers to individuals 55 years of age and older. Various Canadian governmental agencies have made the distinction between “seniors”, referring to those 65 years of age and older, and the broader category of older adult, referencing those 55 and older (Brennan, 2012; Statistics Canada, 2013; Canada Mortgage and Housing Corporation, 2012). While the target population of this dissertation work incorporates this age range, the definition has been expanded in places to include those 50 years of age and older where recruitment was particularly challenging.

1.3 Using a wheelchair to address mobility impairment

To address mobility impairment and the associated environmental barriers that compromise mobility and function, an assistive technology (AT) device such as a MWC, is often prescribed. Concomitant with an aging population, the number of wheelchairs provided to older adults is also rising. Between 2001 and 2011, the estimated number of community-dwelling Canadians aged 65 and older requiring a wheelchair for mobility increased from 81,000 (Shields, 2004) to over 108,000 (Smith & Miller, 2014), reflecting a prevalence of wheelchair use four times the national average (Clarke & Colantonio, 2005). A study among multiple AT device users reported the MWC was considered third most important, behind only eyeglasses and canes, and one-third of MWC users reported it was their *most important* assistive device (Mann, Lllanes, Justiss, & Tomita, 2004).

The introduction of AT devices, like wheelchairs, is thought to increase function as well as reduce the need for personal assistance for older adults and diminish care provider burden (Madara Marasinghe, 2015; Mortenson, Demers, Fuhrer, Jutai, Lenker, & DeRuyter, 2013). However, merely acquiring a wheelchair does not guarantee independence in mobility or satisfactory performance of functional activities. In both Canada and the United States, over 90% of older adult MWC users still experience performance restrictions in at least one major life activity (Statistics Canada, 2008) compared with only 15% for those who don't use a mobility device (Kaye, Kang, & LaPlante, 2000). To accomplish these activities, assistance must be engaged from a family member or other care provider (Hoenig, Tayor, & Sloan, 2003; Giesbrecht, Miller, & Smith, 2014). In Canada, nearly 6 in 10 older adult wheelchair users require assistance from a care provider for basic mobility (Shields, 2004). A study of stroke survivors adjusting to wheelchair use identified substantial restriction in care providers' occupational roles and an increased burden of care (Laliberte-Rudman, Hebert, & Reid, 2006). In particular, environmental issues such as carpet, inclines, curbs, gravel and poor sidewalk conditions presented barriers to mobility and self-propulsion was identified as a primary challenge.

The provision of a MWC for improved mobility also has implications for the healthcare system. A MWC can range in cost from several hundred to thousands of dollars (Smith, Giesbrecht, Mortenson, & Miller, 2016), not including the expense of clinician time incurred during the prescription process, and represents a substantial expense for consumers and the health care system. When a MWC is used sub-optimally, infrequently, or abandoned altogether, it represents a waste of resources expended on wheelchair acquisition (Riemer-Reiss & Wacker, 2000), a decrease in functional mobility and independence for the user, and an increase in the cost and provision of support and personal care (Hoenig, Tayor, & Sloan, 2003; Giesbrecht, Miller, & Smith, 2014).

1.4 Transition to wheelchair use

Despite the potential positive impact of the wheelchair, the transition from ambulatory to wheeled mobility is often not a smooth or easy one. The research literature provides only a very limited insight into the process and challenges associated with the transition to wheelchair use, particularly among older adults. Irrespective of age, the wheelchair continues to carry a social stigma of disability and consenting to its use can have a strong emotional impact (Kittel, DiMarco, & Stewart, 2002). Miles-Tapping (1996; Miles-Tapping & MacDonald, 1994) describes the psychological barriers to accepting a wheelchair for mobility purposes, which may be perceived as acquiescing to impairment and adopting the label of disability. Some individuals struggle with redefining their self-identify following the transition to wheelchair use (Levins, Redenbach, & Dyck, 2004) or lower personal expectations of others and the environment to minimize disappointment (McClain, Medrano, Marum, & Schukar, 2000). Chaves et al (2004) found that poor self-concept and the perception of negative social attitudes was a factor that prevented individuals with spinal cord injury venturing into the community with their wheelchair.

Adapting to the new reality of MWC use involves both “pragmatic and emotional phases” (Laliberte-Rudman, Hebert, & Reid, 2006). Users must change the way occupations are performed using a wheelchair and adapt their sense of self and identity as a MWC user, the latter often taking longer to achieve. The process of wheelchair acquisition and acceptance is a developmental one, in which the user's capacity and performance evolve with increased experience and exposure to varied environments. This career-path approach (Gitlin, 1998) differentiates the novice and experienced user, and the need to consider both the introductory and extended use stages (Fuhrer, Jutai, Scherer, & DeRuyter, 2003). Kraskowsky and Finlayson (2001) in a review of the literature, identified addressing user needs, providing sufficient training, and evaluation in the context of use as the key elements in promoting acceptance and continued use of AT such as a MWC among older adults. A qualitative study exploring the willingness of older adults to use an assistive mobility device reported that the opportunity to learn how to use the device, particularly during the early stages of acquisition, was a precondition to acceptance (Hedberg-Kristensson, Ivanoff, & Iwarsson, 2007). The World Health Organization (2008) also advocates for such an approach, identifying training as a core component in the wheelchair acquisition process.

AT use increases when demonstration-based follow-up occurs in the home setting (Gitlin & Levine, 1992) and older adults are better able to consolidate skills of AT use when they are provided in the home context (Chiu & Mann, 2004; Walker, Morgan, Morris, DeGroot, Hollingsworth, & Gray, 2010). Walker et al (2010) found that mobility device users were apprehensive about attempting skills in the community when training occurred in a clinical context, and suggest that community-based training may actually *decrease safety risks* and increase generalization of AT use in more environments. Chiu and Mann (2004) were able to increase independence with AT use among older adults from 56.5% to 96.7%, as well as improve user satisfaction with their AT device, through provision of brief home-based training.

Much less is known about the personal experience of older adults during this transition to wheelchair use or how they go about learning to use the wheelchair effectively. Adoption of a MWC may be an entirely different experience for the older adult than in early or mid-life. Furthermore, the process of aging *with* a MWC has received only limited attention. In particular, decreasing confidence in one's ability to adapt to and use a wheelchair in later life may be of critical importance. The extent of skills training and the methods by which it is delivered to older adults has not been investigated, nor impacts of such training for care providers. This represents a substantial gap in the research literature and merits further investigation.

1.5 Self-efficacy and wheelchair use

Self-efficacy is an individual's evaluation of their capacity to perform the actions necessary for attainments or the performance of an activity (e.g., going shopping with a wheelchair) (Bandura, 1997). Self-efficacy refers to both the task itself (i.e., belief in one's capacity and potential to go shopping) and self-regulation (i.e., belief one can acquire the skills necessary). According to Social Cognitive theory (SCT), *outcome expectation* is the belief that developing proficiency with skills (e.g., MWC mobility) will result in successful performance of the desired activity (Bandura, 1986). Self-efficacy is promoted through four influences. First, *mastery experience* is acquired through successful performance following persistent practice, and provides the strongest contribution to belief in future success. Second, *vicarious experience* is the observation of comparable peers achieving success, which in turn facilitates belief in one's own capacity for success. Third, *verbal persuasion* comes from the encouragement and confidence of others, particularly those socially valued, for successful performance. Finally, the *reinterpretation of* *physiological and affective state* can impact self-efficacy, with increased anxiety and discomfort having a negative influence (Bandura, 1997).

Recent research has drawn attention to the relevance and importance of self-efficacy with respect to wheelchair use. Roelands and colleagues (2002) explored the contribution of SCT constructs to use and nonuse of AT devices among older adults, including a wheelchair. They found that *attitudes to use*, *subjective norms* (i.e., the impact of significant others), and *self-efficacy* influenced intention to use assistive technologies ($R^2 = .31$), which in turn was a predictor of actual use ($R^2 = .16$). Chen and Chan (2011) conducted a review of the literature on acceptance of technology among older adults using the Unified Theory of Acceptance and Use of Technology (UTAUT) model (Venkatesh, Morris, Davis, & Davis, 2003), which incorporates self-efficacy, and identified two additional constructs influencing intention and use behaviours: *performance expectancy* (perceived usefulness) and *effort expectancy* (perceived ease of use). For older adults, the belief that a particular technology would improve life and address their needs (i.e., usefulness) was paramount, along with increasing independence, making activities easier to engage in, improving safety, and enhancing convenience. Perceived ease of use was also identified as an important indicator, although less influential. Reluctance among older adults to adopt technology is often related to concern over their capacity for skilled operation; older adults are reported to have lower self-efficacy and higher anxiety around technology (Laguna & Babcock, 2000). Conversely, acceptance of a mobility device can generate feelings of independence, security and confidence, which in turn may facilitate greater engagement in and performance of everyday activities (Hedberg-Kristensson, Ivanoff, & Iwarsson, 2007).

1.6 The role of occupational therapy in wheelchair acquisition

Occupational therapy is focused centrally on optimizing function in activities of daily life (Whiteneck & Dijkers, 2009; Fuhrer, Jutai, Scherer, & DeRuyter, 2003). A fundamental tenet of practice is facilitation of client engagement in meaningful occupation and fulfillment of important social roles (Hinojosa, Kramer, Brasic Royeen, & Luebben, 2003). Participation, defined as "involvement in a life situation" (World Health Organization, 2001, p. 10), is a core health outcome according to the International Classification of Functioning and Disability (ICF) and the construct most closely aligned with "occupation" (Polatajko, et al., 2007). Despite using a transactional person-environment-occupation conceptual model, occupational therapists have traditionally focused on modifying environmental factors such as accessibility (e.g. installing a ramp) and equipment (e.g. obtaining and configuring a wheelchair) to address mobility limitations. However, a ramp may be a facilitator or a barrier depending upon whether or not one is able to ascend the ramp, and the *wheelchair itself* has been reported to be a barrier to participation because it is difficult to use in some environments (Chaves, Boninger, Cooper, Fitzgerald, Gray, & Cooper, 2004; Meyers, Anderson, Miller, Shipp, & Hoenig, 2002). In short, optimal occupational engagement [participation] results from *effective use* of the wheelchair rather than use of the wheelchair device per se (Fuhrer, Jutai, Scherer, & DeRuyter, 2003). Provision of wheelchair skills training, a component identified as critical to uptake of AT, seeks to modify personal factors (i.e., individual ability), which can have a powerful mediating effect on environmental barriers to facilitate participation (Alon, Sunnerhagen, Geurts, & Ohry, 2003; Bonaparte, Kirby, & Macleod, 2004). Existing research indicates that skill training has the potential to increase independent wheelchair mobility (Kilkens, Post, Dallmeijer, Seelen, & van der Woude, 2003; Desai, Jayavant, & Varshneya, 2013) and quality of life (Hosseini, Oyster, Kirby, Harrington, & Boninger, 2012), and both consumers and clinicians identify practical benefits.

1.7 Mobility skill training and wheelchair acquisition

1.7.1 Benefits of a structured training program

The Wheelchair Skills Training Program (WSTP) (Dalhousie University, 2012) is the only *structured* training program reported in the literature. An experienced trainer guides the wheelchair user through skills considered to be relevant for participation in activities of daily living. Training and practice are typically conducted in a clinical setting as 1:1 sessions up to one hour in length. The number of sessions will vary depending upon initial proficiency, skill progression, and participant/trainer assessment of further potential, but typically ranges between 4 and 6 (Best, Kirby, Smith, & MacLeod, 2005; MacPhee, Kirby, Coolen, Smith, MacLeod, & Dupuis, 2004; Ozturk & Ucsular, 2011). Several studies have demonstrated the WSTP to be safe and practical (Coolen, et al., 2004; Kirby, et al., 2004), and randomized controlled trials have reported a statistically significant improvement in wheelchair mobility skill performance among groups of adult MWC users during inpatient rehabilitation (MacPhee, Kirby, Coolen, Smith, MacLeod, & Dupuis, 2004) and in the community (Best, Kirby, Smith, & MacLeod, 2005). A community-based study in Turkey demonstrated comparable improvement in performance as well as safety, although the results are challenged by a high attrition rate (Ozturk & Ucsular, 2011). These 3 studies report roughly 25-30% improvement in skills; however, this must be considered in light of several factors. Intention to treat was not employed in the analyses, creating a potential bias towards overestimating benefit. The primary outcome, the WST, integrates with the training program and there is potential bias of “training to the test”. Finally, the improvement rate reported represents a *relative change from baseline*, creating bias in favour of lower baseline scores and regression to the mean; adjusting to a raw score suggests a mean change closer to 15-20%, with control groups also improving by 3-8%.

Few studies have looked at wheelchair skills training specifically for older adults. Hoenig and colleagues (2005) investigated the impact of a comprehensive wheelchair intervention with older adults (age M = 65.0; SD = 13.7) that included skill training; however, the extent and nature of this training was not fully described and the entire intervention was only 30 minutes more than usual care. Participants in the treatment group reported statistically significant greater wheelchair use, both immediately and at 6-month follow-up. No difference was noted in wheelchair confidence, although this outcome was evaluated using a single question without evaluation of measurement properties.

1.7.2 Extent of training in clinical practice

Despite the preliminary evidence that formal wheelchair skills training can improve mobility performance, there has not been widespread adoption within the clinical community. Even among younger populations in active rehabilitation, only 17-18% of wheelchair users receive any formal training (Karmarkar, Collins, Kelleher, Ding, Oyster, & Cooper, 2010; Smith & Kirby, 2011). Among those who do receive training during rehabilitation, the focus is often on skills not directly related to mobility *with* the wheelchair, such as transferring from the wheelchair to other locations such as a bed, toilet or tub. Furthermore, older adults typically receive little or no training in the skills necessary for MWC use in daily activities (Karmarkar, et al., 2009). A survey of older veterans (age M = 65; SD = 9.25) who were prescribed a wheelchair post-stroke found 53% had received no instruction on wheelchair use (Garber, Bunzel, & Monga, 2002). In another study that followed veterans who had been prescribed a MWC, more than 50% of participants reported difficulty with basic wheelchair propulsion, despite having access to a trained clinician and a custom-fitted wheelchair (Ganesh, Hayter, Kim, Sanford, Sprigle, & Hoenig, 2007).

1.7.3 Factors contributing to limited training

Several factors may contribute to the problem of inadequate training. First, not all clinicians have sufficient knowledge of skills for operating a wheelchair or the performance capacity to demonstrate skills during training. In a study evaluating the effectiveness of a structured training program among occupational therapy students, students receiving the standard occupational therapy curriculum demonstrated skill performance that was comparable to baseline scores of MWC users in clinical studies (i.e., ~65% on the WST) and substantially lower than post-intervention MWC user scores (i.e., ~ 80%). Furthermore, students who received extra training scored higher on knowledge of skills compared with skill capacity, indicating they could explain how to perform more demanding skills, but were not necessarily able to demonstrate or perform these skills (Coolen, et al., 2004). A recent study found only eight of 21 Canadian university occupational and physical therapy programs incorporated a structured wheelchair skills training program in their curriculum and less than half incorporated actual demonstration of skills (Best, Miller, & Routhier, 2015).

Second, during rehabilitation other competing demands may be prioritized over wheelchair training. A study surveying MWC training practice at 87 Canadian rehabilitation centres found in only two-thirds was teaching basic skills common practice, and teaching advanced skills was standard in less than 12% (Best, Routhier, & Miller, 2015). For some individuals, wheelchair training is not perceived as relevant during their hospital stay, but becomes important later when accessibility challenges are encountered in the community. It may be that post-discharge is a more optimal time for training with some clients. Third, the acquisition process often suffers in continuity of care and comprehensiveness. The initial wheelchair assessment and prescription typically occurs during a hospital stay, but older adults may be discharged with a temporary wheelchair and ultimate delivery and 'fitting' occurring in the community with minimal or no therapist involvement. Finally, funding for home care and community-based services in Canada and the United States has been in relative decline and is often insufficient to support clinician-intensive training either before or after discharge (Tousignant, Dubuc, Hebert, & Coulombe, 2007; Gill, Baker, Gottschalk, Peduzzi, Allore, & Byers, 2002). Often, the time and travel demands for both consumers and clinicians make wheelchair skills training impractical and cost-prohibitive (Sanford, Griffiths, Richardson, Hargraves, Butterfield, & Hoenig, 2006). Long wait lists and the inaccessibility of rehabilitation services, particularly in rural areas, further confound the problem (Sanford, Griffiths, Richardson, Hargraves, Butterfield, & Hoenig, 2006; Tousignant, Boissy, Corriveau, & Moffet, 2006).

1.8 Motor skill training with older adults

Enhancing use of the wheelchair involves learning new motor skills. For older adults, learning these skills must be considered in light of developmental changes, which can greatly influence the acquisition process.

1.8.1 Physiological changes and motor skill training

With aging, there is a decline in strength (Narici, Maffulli, & Maganaris, 2008) and coordination (Fradet, Lee, & Dounskaia, 2008). Fine motor function is impacted more than gross motor performance, making small adjustments and refining skilled performance more challenging particularly as task complexity increases. In addition, reaction time and motor response is slowed with increasing age (Voelcker-Rehage, 2008). With wheelchair skill performance, achieving synchronous and asynchronous movement for propulsion (e.g., turning the wheelchair by moving the wheels in opposite directions) and reacting to dynamic changes in centre of gravity (e.g., propelling across a slope) requires considerable coordination, dexterity and balance responses. Studies examining the impact of aging on motor skill learning identify that older adults are capable of new skill acquisition comparable to younger counterparts, but require more time and do not achieve the same level of proficiency with more complex, precise and effortful tasks (van Hedel & Dietz, 2004; Tunney, et al., 2003). This may be due to losses in agility, speed and strength as well as cognitive changes and lower confidence (Voelcker-Rehage, 2008). While these developmental declines mean older adults typically operate at a lower baseline performance level than younger individuals, they are able to achieve a comparable learning benefit (Voelcker-Rehage, 2008). For example, Routhier et al (2008) reported lower baseline and follow-up scores for older adults but a comparable relative improvement to younger adults using the WSTP in a mixed-age study. Bonaparte et al. (2004) found that learning to perform a wheelchair “wheelie” (i.e., a highly complex and demanding skill) was achievable across age groups, but increasing age was correlated with longer training time (R = 0.70) and greater postural sway (R = 0.52). Older participants in the study reported that coordination of movement was the most difficult aspect, rather than force on the pushrim (i.e., strength).

1.8.2 Cognitive changes and motor skill training

Intelligence is differentiated into two types: *fluid*, which refers to reasoning and new learning, and *crystallized*, which incorporates previous experience, relationships and social context (Horn & Cattell, 1967). With age, fluid intelligence wanes while crystallized intelligence increases (Fenter, 2002; Horn & Cattell, 1967). Learning that accesses previous experience and contextual relevance is more likely to promote skill acquisition among older adults (Zurakowski, Taylor, & Bradway, 2006). Aging adults struggle more to filter out competing stimulation and have greater difficulty with contextual interference, where different skills are practiced intermittently rather than in a singular and repeated (blocked) fashion (Fenter, 2002; Porter & Magill, 2010). As a result, training motor skills (e.g. those required to operate a wheelchair) should incorporate adaptations to address the needs of older adult learners, such as using a more structured learning environment, incorporating smaller learning components, highlighting relevance and critical information, and providing specific feedback on performance (Wolfson, Cavanagh, & Kraiger, 2014).

1.9 Theoretical approach to learning with older adults

In addition to the developmental changes that influence skill training for older adults, one must also consider the style of learning that will optimize engagement and promote acceptance of both the wheelchair technology and the training process. Knowles (1980) advocated that learning also follows a developmental sequence and older adults approach the learning process differently than young people, using a conceptual framework he called Andragogy (Merriam, Caffarella, & Baumgartner, 2007). Knowles integrated the *law of readiness*, proposed earlier by Thorndike (1932), which identifies that individuals learn more effectively when they are prepared to act or learn. Older adults will be motivated to engage and invest in learning when they recognize the outcome as relevant and beneficial to them - comparable to the concept of perceived usefulness previously identified in the literature on acceptance and use of assistive technology (Zurakowski, Taylor, & Bradway, 2006). Knowles identifies six core principles of Andragogy that promote uptake of learning among older adults. Adult learners are internally motivated and prefer to direct their own learning; they bring life experience and knowledge to the learning process; they are goal-oriented; they desire learning that is relevant to their existing social roles; they prefer practical learning strategies; and they like to be respected during the learning process. The emphasis on integrating life experience into learning reinforces the strength of crystallized intelligence among older adults (Fenter, 2002). The principles of collaborative goal setting and relevance to occupation and social role are also consistent with literature that identifies user involvement and user perception of need as critical to assistive technology uptake. Both Knowles (1980) and Delahaye and Ehrich (2008) identify a preference for self-directed learning and practice among older adults, rather than more didactic approaches. Delahaye and Ehrich reported older adults preferred a more directed approach when first learning a new skill, followed by a more self-directed, self-paced approach to practice and refinement.

1.10 Home programs as a training intervention

As identified earlier, providing AT interventions in a home or community context contributes to better uptake and continued use. Delivering rehabilitation training as a monitored or self-managed home program among older adults has been effective for strengthening (Layne, et al., 2008), physical activity (Fanning, et al., 2015), mobility (Chang, Lin, Chen, Jane, Yeh, & Wang, 2015; Ashari, Hamid, Hussain, & Hill, 2015), cardiac rehabilitation (Taylor, et al., 2015) and exercise (Gill, Baker, Gottschalk, Peduzzi, Allore, & Byers, 2002; Hoenig, Sandford, Butterfield, Griffiths, Richardson, & Hargraves, 2006) outcomes. Beswick et al (2004) report that difficulties getting to outpatient appointments and reticence to engage in group-based programs are substantive barriers in cardiac rehabilitation. Home programs are advantageous because they allow privacy for the user, occur in a familiar and real-life context, can be conveniently integrated into the users schedule and do not require the time, effort and expense of travel to another location. (Jette, et al., 1998). In a recent systematic review of cardiac rehabilitation (primarily composed of exercise training) found comparable health-related outcomes between home- and centre-based programs, with home programs demonstrating slightly lower drop-out rates (RR 1.04, 95% CI 1.01 to 1.07) and better program adherence (Taylor, et al., 2015).

Several factors have been identified as important to the success of home-based programs. Since adherence is critical to effectiveness, components that promote sustained engagement and program adherence are of great interest (Shaughnessy & Resnick, 2009). A recent Cochrane review of exercise adherence interventions identified programs that incorporate SCT (i.e., self-efficacy and outcome expectations), are monitored, and grade the activity are more effective in improving adherence, frequency and duration of exercise (Jordan, Holden, Mason, & Foster, 2010). Age and sex were not related to adherence, while higher level of education and positive attitude were (Jette, et al., 1998). Programs are better received when individualized and focused on user-relevant outcomes (Shaughnessy & Resnick, 2009; Winnett & Davy, 2009). Increasing demands and complexity through activity grading improves adherence and appears to reduce boredom or lack of interest that threatens continuity of involvement and integrates the approach of the "just right challenge" in occupational therapy (Townsend & Polatajko, 2007). Interactions with peers and social support have also been identified as enhancing program adherence (Layne, et al., 2008) and provide opportunity for vicarious experiences (Bandura, 1997).

1.11 Use of mHealth and telerehabilitation interventions with older adults

Information and Communication Technologies (ICT) is a broad term widely used to describe both communication devices and applications. The variety of products that fall within this categorization grows on a daily basis, but would include landline and mobile telephones; radio, television and satellite communication; and computers and internet-connected devices. Various terms have been used to describe the delivery of health-related services using ICT, and the regular introduction of new terms can make it difficult to categorize these services in a consistent manner. *Electronic health* (eHealth) is perhaps the most global term and refers to “the use of ICT for health”, versus other purposes such as business or education (World Health Organization, 2011, p. 6). Such health-related services include, but are not limited to, electronic health records; health education for providers or patients; consultation between providers or between provider and patient; assessment, goal-setting, education and/or treatment; and patient monitoring. The specific delivery of clinical service using ICT is often differentiated by the term *telemedicine* (Cason, 2015), while *telehealth* refers to using “ICTs to deliver health services and transmit health information over both long and short distances” (International Standards Organization, 2014). These terms are admittedly difficult to separate with precision due to a lack of a unifying concept (International Standards Organization, 2014). Delivering rehabilitation therapy services via ICT is commonly called *telerehabilitation*, although traditionally this has focused on monitoring and consultation/assessment (Agostini, et al., 2015).

A more recent development is delivery of eHealth using a mobile device (i.e., mobile phone, patient monitoring device, tablet and other wireless devices), and is referred to as *mHealth* (World Health Organization, 2011). The near-ubiquitous presence of mobile devices, even in less-developed countries, means that healthcare consumers have ready access to such services at almost any time. Mobile devices provide several advantages over traditional computer-based applications. First, if they have cellular capability they can operate with or without a WiFi connection. Second, *native* applications (i.e., designed for a mobile device operating system) reside exclusively on the device, providing access to and collection of user data, which can be transmitted at a later point with intermittent connectivity to the Internet (Fanning, Mullen, & McAuley, 2012). While the term *mRehabilitation* (or *mRehab*) has not yet been introduced, this would seem a logical progression given the evolution of eHealth nomenclature to date.

Telerehabilitation interventions have been used to some extent in occupational therapy practice and its use is increasing, although clinicians have typically been reluctant to adopt the technology in the belief that the quality of service is inferior to traditional face-to-face rehabilitation (Reimer, 2006) and that components of therapy must be conducted "hands on" (Russell, 2009). The most common application of telerehabilitation identified in the literature is teleconferencing, where clinician and client communicate via a video link and the therapist provides consultation, assessment and potentially treatment services. Kairy et al (2009) conducted a systematic review of 28 telerehabilitation studies specifically related to intervention or treatment. Studies that incorporated activity-based interventions (e.g. physiotherapy; exercise; mobility/transfer training) employed either a personal computer (PC) or televideo (i.e., using a dedicated camera to convey image and sound over a telephone line), which required specialized equipment to be set-up and configured in the participant's home as well as Internet connectivity. Four studies, all addressing cardiac home exercise programs, incorporated data monitoring (i.e., ECG, heart rate) conveyed to the supervising clinician via telephone or email. The authors found statistically significant improvements in clinical outcomes for physical, functional and psychological outcomes, and high attendance and adherence rates (including studies with a control group). While satisfaction rates were generally high among both participants and clinicians, concerns were raised about the quality of video transmission and scheduling of sessions. The authors also identified a lack of understanding as to why satisfaction was high (i.e., which active ingredients related to the technology, content and service delivery impacted their experience positively).

Agostini et al (2015) conducted a systematic review and meta-analysis comparing effectiveness of telerehabilitation with conventional programs targeting motor function. No statistically significant differences were realized (SMD = -0.08; $CI_{95\%}$ -0.43, 0.27), except for treatment following total knee replacement, where statistically significant improvements in speed on the Timed Up and Go test were observed. Similarly, Laver et al (2013) conducted a systematic review of telerehabilitation in stroke recovery and found no statistically significant differences from usual care in outcomes related to function, cognition, communication or cost-effectiveness. Several studies included specialized computer training applications, but the outcomes were also inconclusive and this technology is not readily accessible to clinicians. The authors also note that studies did not report on user confidence or the technical support and infrastructure required to implement these telerehabilitation solutions, and that future studies should incorporate a mixed methods approach to explore usability and satisfaction among participants (Laver, Schoene, Crotty, George, Lannin, & Sherrington, 2013). Several studies have examined telerehabilitation services related to wheelchair users (Sanford, Hoenig, Griffiths, Butterfield, Richardson, & Hargraves, 2007; Barlow, Liu, & Sekulic, 2009; Schein, Schmeler, Holm, Saptono, & Brienza, 2010). Sanford et al used a telephone-based video connection to assess home accessibility and transfer skills, while the other two studies involved teleconferencing for the purposes of assessment and prescription of the wheelchair or seating system; none of these studies addressed training in the use of a wheelchair. A common element among all of these studies is that none utilized an mHealth/mRehabilitation approach (i.e., use of mobile phone or tablet device).

1.11.1 Use of computer and gaming technology

As an extension to telerehabilitation, a variety of computer and gaming technologies have been explored for delivery of home-based rehabilitation programs. With advances in affordability, size, portability, accessibility and user-interface simplicity, computer-related devices are becoming increasingly useful for rehabilitation purposes. For example, the use of virtual reality and popular gaming console systems (e.g., Nintendo Wii™, Microsoft Kinect™) have been used in rehabilitation to cast therapy in an occupation-focused and engaging context, with encouraging results (Clark & Kraemer, 2009; Flynn, Palma, & Bender, 2007; Nichols, 2009; Rand, Kizony, & Weiss, 2008; Bainbridge, Bevans, Keeley, & Oriel, 2011). More specifically, their use in rehabilitation among older adults has also been explored. Aarhus et al. (2011) introduced a commercial gaming system in a Danish nursing home as a physical training activity. Participant involvement was above 90% throughout the study. Social interaction was identified as an important contributor. While some participants embraced the competitive nature of the activity, many focused on competing with themselves to improve their score. The authors identified improvements in physical function and increased motivation and tolerance for activity, particularly due to the gaming aspect that distracted participants from their physical exertion. Trends towards improvement in fitness outcomes were also noted. Creating an interesting interface, such as the use of games, is positively associated with older adults' intention to use (Aarhus, Gronvall, Larsen, & Wollsen, 2011).

Recently, the use of gaming specifically for wheelchair users has been explored. The focus of such research has been primarily on enabling wheelchair users access to facilitate physical activity and the associated health benefits (Mandryk, Gerling, & Stanley, 2014), encourage cognitive and physical stimulation (Gao & Mandryk, 2011), and impact emotional well-being (Jung, Li, Janissa, Gladys, & Lee, 2009). However, such games require either the manipulation of an external device (such as the Nintendo Wii™ controller) or recognition of discrete body movements (such as the Microsoft Kinect™), which are not feasible while seated in a wheelchair and can be compromised by the reflective surface of the wheelchair (Anderson, Woodbury, Phillips, & Gauthier, 2015). Gerling et al (2015) have recently developed several gaming applications specifically for the Kinect™ system that incorporate a select combination of wheelchair movements and upper extremity gestures. In addition, they created a developers toolkit to facilitate the integration of these movements/gestures into other commercial and custom applications with the Kinect™ system. The authors identify the benefits of having MWC-based gaming input for older adults to promote physical activity and improve familiarity with their wheelchair. Furthermore, they suggest a potential application for wheelchair skills training among older adults, particularly given the motivational benefits of gaming and the opportunity to induce repetition of movement in a less mundane context (Gerling, Mandryk, Miller, Kalyn, Birk, & Smeddinck, 2015). However, the existing applications lack specificity of movement and scope of maneuvers. For example, the tracking system only recognizes that the MWC is moving forward, backward or turning; speed, distance and angle of rotation/turn are not well differentiated. Without feedback on these variables, it is difficult to address the acquisition and refinement of MWC mobility skills.

1.11.2 Acceptance and use of ICT by older adults

Delivery of a rehabilitation program using a computer tablet also presents challenges, most notably that the delivery interface becomes an additional form of AT which older adults must also adopt. Older adults are less likely than younger people to use technologies such as computers and cell phones. As with other types of AT, the effect of age is strongly mediated by computer-related anxiety, self-efficacy and cognitive ability (Chen & Chan, 2011). Computer use is continuing to grow among the elderly; a recent study in the United States found 84% of those over 60 had experience with computers (Czaja, et al., 2005). Among those over 65, 40% are regular computer and Internet users, although the prevalence drops to 25% for those 75-84 and only 5% for those over 85 (Charness, Fox, & Mitchum, 2010). Studies have found that older adults, albeit those without disability, generally have positive attitudes towards technology, particularly devices that support independence at home and assist performance with health-related tasks (Mitzner, et al., 2010).

Navigating a computer or mobile device involves new learning, and the declines in memory, processing speed, and fluid intelligence that accompany aging may play a role in restricting uptake (Czaja, et al., 2005). It has been suggested that these issues can be addressed through self-paced training that is structured for success experiences to build confidence (Czaja, et al., 2005;

Callahan, Kiker, & Cross, 2003) and adapting the interface design for familiarity and ease of use with minimal memory requirements (Risk, Rogers, Charness, Czaja, & Sharit, 2004). Developmental declines in vision, hearing, tactile sensation and dexterity may also influence the ease of interface between computers and older adults (e.g., seeing and touching small icons) (Chen & Chan, 2011). With declines in both selective and dynamic attention, older adults have greater difficulty inhibiting external stimuli and are more vulnerable to extraneous distraction. Procedural memory, such as recalling a series of steps in a new activity, also declines with age while familiar activity sequences are better retained. Consequently, adapting technology to address these limitations by using an interface that is simple and easily understood is key to improving self-efficacy for use, ease of use, and adoption among older adults.

1.11.3 A theoretical framework for acceptance and use of ICT

The impact of an mHealth intervention is dependent upon the target individual accepting and then persisting in use of the application. The Unified Theory of Acceptance and Use of Technology (UTAUT) is a theoretical model developed to explain the acceptance and use of information and communication technology (Venkatesh, Thong, & Xu, 2012). The UTAUT integrates constructs and evidence from eight models and theories related to technology uptake or use behaviour. It was originally applied in an organization context, such as employees' adoption of workplace technologies (Venkatesh, Morris, Davis, & Davis, 2003). The UTAUT authors subsequently expanded the model to also apply to a consumer audience, where the adoption of technology is voluntary and the cost of acquisition more relevant. In this updated version, three additional constructs were incorporated, increasing the ability to explain variance in intention to use (from 56% to 74%) and use behaviour (from 40% to 52%) (Venkatesh, Thong, & Xu, 2012).

The UTAUT model identifies seven determinants that influence the behavioural intention to use technology, which in turn impacts actual use behaviour, with some determinants also impacting use directly. Four of these constructs appear in the original UTAUT model. *Performance expectancy* is the extent to which the user believes the technology will benefit performance in some activity and demonstrates the strongest correlation with intention to use. This determinant is closely tied to the construct of self-efficacy; some judgment is made about the expected benefit based on a belief in one's ability to perform the required actions to successfully engage the technology. The relative ease in using the specific technology is termed *effort expectancy* and influences intention to use at the initial stage of adoption rather than persistent use. Once the technology benefit is realized and use initiated, effort expectancy becomes less important. *Social influence* relates to how important the user perceives adoption of the technology is in the view of close and important individuals. This construct also draws a parallel with self-efficacy theory and the influence of verbal persuasion. The last of the original UTAUT determinants relates to the perception of adequate external resources and support in using the technology effectively, termed *facilitating conditions*. This construct is postulated to influence use behaviour directly, rather than simply behavioural intention.

Originally, because the model focused on organizational contexts where technology was implemented in a directive manner, *voluntariness* was an additional determinant of intention to use but in the broader application to a consumer focus, it was subsequently dropped.

Furthermore, three additional constructs were added. *Intrinsic* or *hedonic motivation* reflects the perceived enjoyment or pleasure aroused through engagement with the technology. This "fun factor" has been reported to influence both intention to use and use behaviour (van der Heijden, 2004; Thong, Hong, & K, 2006) and the UTAUT authors recently found hedonic motivation more influential than even performance expectancy (Venkatesh, Thong, & Xu, 2012). *Price value* reflects the benefit of technology use relative to its cost to the consumer and is influential of behavioural intention. Finally, the authors draw in the determinant of *habit* as a direct precipitant for technology use, although they are admittedly equivocal in conceptualizing the term. A habit of use is typically constructed over time through learning and reflects the automatic behavior of technology use, typically within a specific environmental context (e.g. checking email on your mobile device when you wake up). There is some debate in the literature as to whether this is a conscious behavioural intention (i.e., this practice has been valuable and the cue of waking in bed is a trigger to repeat the intention to act) or an automatized response (i.e., waking in bed cues an impulse to perform a reflexive action). In either case, *experience* is an associated concept that refers to the passage of time through which one has opportunity to engage with the technology. Experience can facilitate habit, but is not a prerequisite, and the degree of habituation over a given time varies among individuals.

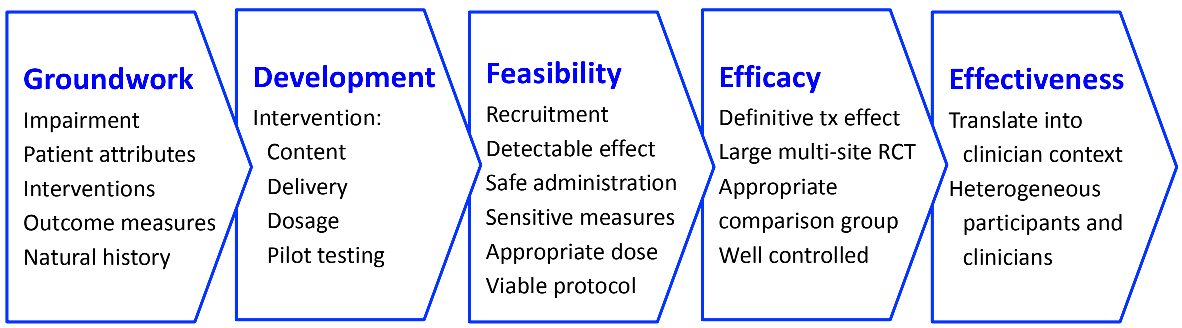
Three personal variables are postulated to moderate determinants in the UTAUT model: *sex, experience* and *age*. Hedonic motivation is higher among men than women. Men are reported to be more willing to expend effort in the face of obstacles while women weigh the balance between effort and outcome; consequently, facilitating conditions are more influential to the behavioural intentions of women. Conversely, increased experience with technology breeds greater familiarity and lessens the requirement for facilitating conditions. Finally, the challenges of new learning with increasing age create additional demands for facilitating conditions while the influence of hedonic motivation wanes. In summary, providing facilitative supports is critical for older adult technology users, particularly women and those with limited technology experience generally. While a fun and engaging interface contributes to uptake, it becomes less important than the perceived benefit of the technology for older users.

1.12 Study methodologies

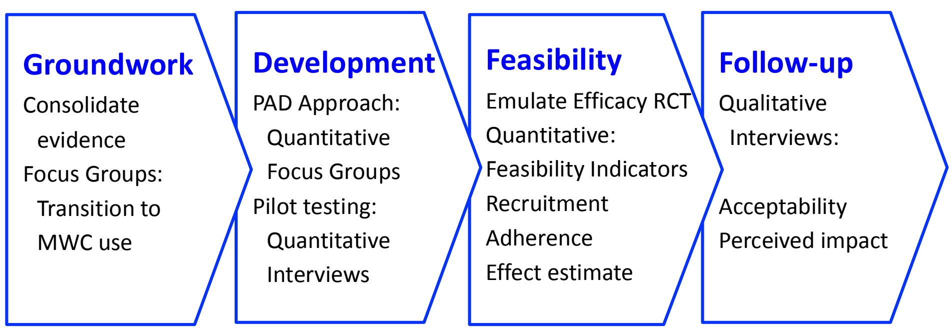
Effective knowledge translation of a clinical intervention into practice requires a systematic and structured approach, building on previous findings (Figure 1.1) (Whyte & Barrett, 2012). Consequently, the stage of intervention development dictates which research methodology might be best suited to address the relevant questions at hand. The groundwork of identifying needs, appropriate outcomes, and the natural history of a particular client group is paramount before beginning to develop a relevant intervention (Whyte, Gordon, & Rothi, 2009). Once developed, feasibility of the proposed intervention should be ascertained before undertaking a large and expensive clinical trial to determine its effect.

During the developmental phase, particularly with a novel intervention, there is often limited evidence to fully inform the treatment composition. There is considerable evidence to suggest that consumers should be involved during treatment development to ensure that it best suits their needs, preferences and priorities, and is more likely to be acceptable (Protheroe, Blakeman, Bower, Chew-Graham, & Kennedy, 2010). A participatory research approach is relevant at this juncture, actively involving intended users and stakeholders. A specific approach that is well-suited to assistive technology intervention development is Participatory Action Design (PAD) (Ding, Cooper, & Pearlman, 2007), and was chosen for this dissertation work. The PAD process typically addresses the groundwork and development phases, prior to undertaking a clinical trial but may involve some preliminary prototype testing (Ding, Cooper, & Pearlman, 2007).

Figure 1.1 A phased approach to intervention translational research



Adapted from Whyte, Gordon & Rothi (2009)



While offering some flexibility in implementation, this methodology incorporates a number of common fundamental principles. Stakeholders, particularly end users, are actively involved in assessment and decision-making throughout the development and evaluation process and are important, valued members of the research team (Ding, Cooper, & Pearlman, 2007; Protheroe, Blakeman, Bower, Chew-Graham, & Kennedy, 2010; Demiris, Oliver, Dickey, Skubic, & Rantz, 2008; Waller, Franklin, Pagliari, & Greene, 2006). Their participation is hands-on and experiential, rather than simply being provided with information (Waller, Franklin, Pagliari, &

Greene, 2006; Seale, McCreadie, Turner-Smith, & Tinker, 2002; Ding, Cooper, & Pearlman, 2007). Participants should be drawn from a broad range of conditions and impairments (Ding, Cooper, & Pearlman, 2007) representing a variety of individuals who might be affected, and include diverse stakeholders such as relatives who might also be impacted (Eriksson, A, & Johansson, 2000). The development process is cyclical and iterative, with multiple points of entry for stakeholders (Demiris, Oliver, Dickey, Skubic, & Rantz, 2008; Eriksson, A, & Johansson, 2000; Seale, McCreadie, Turner-Smith, & Tinker, 2002) and evaluation should ideally occur in natural and real-world settings (Ding, Cooper, & Pearlman, 2007; Demiris, Oliver, Dickey, Skubic, & Rantz, 2008; Waller, Franklin, Pagliari, & Greene, 2006). The process should incorporate qualitative methods to appreciate the complex life context within which the intervention might be implemented (Ding, Cooper, & Pearlman, 2007), such as focus groups during the early development stages (Protheroe, Blakeman, Bower, Chew-Graham, & Kennedy, 2010) (Protheroe, Blakeman, Bower, Chew-Graham, & Kennedy, 2010) and interviews during evaluation and pilot testing (Seale, McCreadie, Turner-Smith, & Tinker, 2002).

Once an intervention has reached the point where the prototype is viable, the focus turns to evaluation through clinical trial (Whyte, Gordon, & Rothi, 2009). A randomized controlled trial (RCT) offers the strongest level of evidence to support changing clinical practice, but is particularly challenging and expensive to conduct in the field of rehabilitation (Hart & Bagiella, 2012). Consequently, some preliminary evaluation of feasibility is strongly recommended before moving forwards with a large scale RCT (Thabane, Ma, & Chu, 2010). Such trials are referred to as *feasibility* and *pilot* studies in the literature, without a clear distinction between these terms (Lancaster, 2015). For the purposes of this dissertation, a *pilot* is a small-scale study evaluating issues of treatment intervention delivery and procedural administration. While considerable debate exists within the scientific literature around a precise definition, it is generally agreed that a *feasibility* RCT is intended to emulate the delivery of a subsequent efficacy RCT, but the focus is primarily on evaluation of feasibility indicators (i.e., confirming factors essential to conducting a large scale study) rather than comprehensive analysis of the treatment effect (Arain, Campbell, Cooper, & Lancaster, 2010). Among the primary objectives of a feasibility RCT are establishing the potential recruitment and retention rates and estimation of an effect size to inform future sample size calculations. However, a comprehensive feasibility study should address a broad spectrum of factors that could potentially impact study implementation, including issues related to process (i.e., steps necessary to enroll participants), resources (i.e., time and budget considerations such as data collection procedures), management (i.e., human and data optimization) and treatment (e.g. safe administration, dose-level response, treatment effect estimation) (Thabane, Ma, & Chu, 2010; Arain, Campbell, Cooper, & Lancaster, 2010; Van Teijlingen & Hundley, 2002). Furthermore, specific criteria should be established for these indicators as well as some method of evaluating whether they are sufficiently robust or require some degree of modification before proceeding to a full scale study (Thabane, Ma, & Chu, 2010). A feasibility RCT does not necessarily require a sample size sufficient for confirmatory hypothesis testing, but should be sufficient to evaluate the feasibility indicators (Tickle-Degnen, 2013). The integration of qualitative methods is also recommended to ascertain participant assessment of acceptability and utility, and inform any necessary changes before moving forwards (Bowen, et al., 2009; Van Teijlingen & Hundley, 2002; Tickle-Degnen, 2013).

1.13 Summary

Despite the growing number of older adults who acquire a MWC to address mobility limitations, we have a limited understanding of the experience transitioning to wheelchair use among older adults and how this might be best enabled. Despite emerging evidence that training is critical to adoption and effective use of a MWC, very little time is currently spent teaching older adults effective wheelchair mobility skills. Structured training has proven to be an effective intervention; however, older adults require accommodation for developmental changes in physical and learning capacity to acquire new motor skills and the best strategies for providing this training requires further elaboration. Limited availability of clinicians to provide training and the challenges associated with acquiring and accessing out-patient rehabilitation therapy mean that alternative and innovative approaches to training need to be developed. Home-based programs, particularly those that incorporate principles of self-efficacy and adult learning, have proven to be an effective strategy for older adults. The use of mobile computing devices as a delivery method for rehabilitation (mHealth) with older adults shows great promise, but their potential uptake and persistent use of such technology is unknown. The purpose of my dissertation is to investigate and elucidate a clearer understanding of the information gaps identified, including: 1) the experience of and issues involved in the transition to MWC use among older adults; 2) the content and method of delivering wheelchair skills training via mHealth most appropriate for older adults; 3) the feasibility of delivering such training in an mHealth format to older adults; 4) the potential benefits of such a training program on skill, self-efficacy and mobility for older adults; and 5) the acceptance of and experience with using an mHealth training program.

The findings of this investigation are presented in Chapters 2 through 6. Chapter 2 presents an in-depth description of older adults' experience with the transition to wheelchair use and aging with a wheelchair. Chapter 3 reports on a participatory research approach with multiple stakeholder groups to develop and pilot test a tablet-based mHealth training intervention, including the program content and learner interface. Assessment of the key feasibility indicators for implementing the mHealth training program, via a factorial design RCT feasibility study, is reported in Chapter 4. Initial findings related to the program's impact on wheelchair skill capacity and related clinical outcomes are summarized in Chapter 5. Finally, Chapter 6 explores wheelchair users' and their care providers' experiences, including evaluation of the EPIC Wheels intervention and its impact.

2. Navigating uncharted territory: Older adults' experience transitioning to wheelchair use [a]

[a] A version of this chapter has been published. Giesbrecht, E.M., Miller, W.C. & Woodgate, R.L. (2014). Navigating uncharted territory: a qualitative study of the experience of transitioning to wheelchair use among older adults and their care providers. BMC Geriatrics, 15, 91.

2.1 Introduction

The wheelchair is becoming an increasingly common assistive device for older adults. With age, the risk of a disabling health condition increases and mobility is the second most prevalent area of impairment among older adults in Canada (Statistics Canada, 2013). A 2004 study reported that among multiple assistive device users, the manual wheelchair (MWC) was considered third most important, following eyeglasses and canes (Mann, Lllanes, Justiss, & Tomita, 2004). In fact, the wheelchair icon has become synonymous with accessibility (and disability). The number of wheelchairs provided to address mobility issues among older adults is rising. In 2012, an estimated 108,000 community-dwelling Canadians 65 years and older required a wheelchair for mobility (Smith & Miller, 2014). The introduction of an assistive device is intended to improve mobility, function and quality of life as well as reduce the need for personal assistance and diminish burden for care providers (Chen, Mann, Tomita, & Nochajski, 2000). However, the *acquisition* of a wheelchair does not necessarily mean the user will become independently mobile or improve performance of functional activities. In both Canada and the United States, over 90% of older adult MWC users experience performance restrictions in at least one major life activity (Statistics Canada, 2008) compared with only 15% for those who don't use a mobility device (Kaye, Kang, & LaPlante, 2000). To accomplish these activities, assistance must often be engaged from a family member or other care provider (Hoenig, Tayor, & Sloan, 2003). In Canada, nearly 6 in 10 older adult wheelchair users require assistance from a care provider for basic mobility (Shields, 2004). Compromised participation and social connectedness have been implicated with restrictions in mobility (Finlayson & van Denend, 2003), often manifesting in experiences of isolation, stress and low self-esteem that diminishes quality of life (Turner Goins, et al., 2014). These challenges to independent mobility affect not only wheelchair users, but their families as well. A 2006 study of stroke survivors adjusting to wheelchair use identified substantial restriction in care providers' social roles and an increased burden of care (Laliberte-Rudman, Hebert, & Reid, 2006). One quarter of all care providers for the elderly in Canada are themselves over 65 (Cranswick & Dosman, 2008) and at increased risk for injury and burnout because they provide assistance to these wheelchair users.

Wheelchair service provision, or provision of any assistive device for that matter, requires a complex and multi-step process, including comprehensive assessment, prescription, procurement, configuration, proper fitting, adequate training and follow-up (World Health Organization, 2008). Mortenson and Miller (2008) have explored user and prescriber experiences during the wheelchair procurement process, and identified how physical, environmental and resource constraints often compromise the ability to secure optimal equipment and achieve desired goals. Beyond procurement, learning to effectively operate and maneuver the wheelchair in a variety of contexts is a critical factor. In fact, older adults' acceptance of assistive devices, such as a wheelchair, depends greatly on the adequacy of training provided, particularly following initial acquisition (Kraskowsky & Finalyson, 2001). While evidence indicates that structured training improves wheelchair mobility and operational skill, older adults typically receive little or no skills training. A recent survey of 68 Canadian rehabilitation centres reported only two-thirds offered basic skills training (e.g. operation of wheel locks and foot rests, basic propulsion), typically for 1-4 hours, and advanced skills training (e.g. propelling on inclines; managing curb-cuts) was provided in less than 12% of facilities (Best, Routhier, & Miller, 2015). This lack of training not only diminishes user independence and capacity to participate in meaningful activities, but also place them at greater risk for injury. The estimated annual incidence of tips and falls among Canadian wheelchair users is 5.2%, with roughly 80% causing injury and half resulting in an Emergency department visit (Kirby, Ackroyd-Stolarz, Brown, Kirkland, & MacLeod, 1994). Recent studies in the United States estimate the cost to treat such an injury is $25,000 – 75,000 and there is, on average, one fatality per week due to wheelchair-related accidents (Gain-Dreschnack, et al., 2005).

Despite the documented rise in wheelchair use, little is known about the user experience of transitioning from ambulatory to wheelchair mobility, particularly among older adults; supporting this mobility transition has been an identified need in the literature (Turner Goins, et al., 2014). To inform the development of a novel wheelchair skills training program specifically for older adults (Giesbrecht E. , Miller, Eng, Mitchell, Woodgate, & Goldsmith, 2013), we pursued a clearer, nuanced understanding of the process and impact of adjusting to wheelchair use. The challenges and facilitators encountered by participants were of particular concern.

2.2 Methods

As part of this larger training program development study (Giesbrecht, Miller, Mitchell, & Woodgate, 2014) employing a Participatory Action Design approach (Whyte, Greenwood, & Lazes, 1989), a series of focus groups were conducted in Winnipeg and Vancouver. Exploration of the transitional experience to wheelchair use was explored in the first focus group conducted at each site. We used a qualitative research strategy because the experience of transitioning to wheelchair use is a relatively unexplored phenomenon and difficult to ascertain through quantitative means (Creswell, 2003). A focus group format provided an organic means to elicit participants' experiences and uncover underlying contributing factors, rather than seeking confirmation for *a priori* assumptions. Furthermore, focus groups were intentionally used to promote exchange and dialogue, drawing out less vocal participants, and fostering both common and diverse experiences. Participants were recruited through public advertisement and direct invitation via consumer advocacy agencies, rehabilitation hospitals, and research lab databases. A total of four focus groups were undertaken with older experienced MWC users, consisting of two sessions conducted three months apart in each city. We had targeted 3-6 participants for each group to ensure a balance between breadth of experience and opportunity for participant engagement, and to be able to pragmatically gather on multiple occasions (McLafferty, 2004).

2.2.1 Data Collection

Having previous facilitation experience and expertise in the content area (Giesbrecht, Ripat, & Quanbury, 2011), I facilitated both focus groups together with a Research Assistant (RA). Each focus group was approximately two hours in length and included an introduction identifying the purpose of the study, agenda for the session process, and procedures for analyzing and sharing data. Discussion was initiated using a semi-structured guide with broad questions informed by our review of the literature; prepared follow-up questions and probes to elicit additional information; and spontaneous questions responsive to content raised by participants. In particular, questions related to the experience of transitioning to wheelchair use (e.g. "Tell me about your experience using a wheelchair?"); developing proficiency with use and the impact on function (e.g. “Tell me about how you learned to use your wheelchair/what skills have been most useful”), and barriers to use (e.g. “Tell me about situations or activities that have been most challenging”). I kept field notes related to session content and personal interpretations while the RA kept field notes on session process and participant interaction. All sessions were audio- and video-recorded to capture non-verbal communication for later review. The co-facilitating RA transcribed audio-recordings verbatim and a second RA verified transcription accuracy against the audio recordings before removing personal identifiers.

2.2.2 Data Analysis

Our intention was to explore the phenomenon of participants’ lived experience. Given the absence of any predisposing theory due to limited research in this field, we analyzed the transcripts using a Conventional Content Analysis approach (Nsieh & Shannon, 2005), allowing insights to emerge inductively from the text. I reviewed each transcript multiple times to become immersed in the data. Content from the first transcript was parsed into elements capturing discrete thoughts or concepts, with codes formulated for each. This process was repeated with each subsequent transcript, integrating existing and emergent codes using a constant comparative approach (Lincoln & Guba, 1985). After completing this initial open coding, the data were reconstructed and reduced into complementary axial codes reflecting broader conceptual issues; documented inclusion parameters were created to delineate concepts. Using an iterative and reflexive process, data were then consolidated into overarching themes that explicated congruity and conveyed underlying commonalities between multiple participant experiences. These themes were reflective of participants’ experience accepting changes in their mobility and how they adapted accordingly.

To address trustworthiness of the data, I communicated regularly with Drs. Miller and Woodgate to review coding; any discrepancies were discussed until consensus was reached. An audit trail of research and analysis processes, including all coding procedures, was documented. To enhance credibility of the data, I had extended engagement and communication with participants throughout the broader program development study and engaged them in member checking following the focus group analyses.

2.2.3 Ethics Approval

Informed consent was obtained from all participants prior to conducting the focus groups and study approval was obtained from the Research Ethics Boards at the University of Manitoba (#H2011:357) and the University of British Columbia (#H11-02558). To ensure anonymity, participants' names were replaced with pseudonyms in the transcriptions used for analysis.

2.2.4 Participants

Ten individuals agreed to participate; six in Vancouver and four in Winnipeg (Table 2.1). Participants were required to be 55 years of age or older, live independently in the community, use a MWC as their primary means of mobility for at least one year and have sufficient cognition and English language skills to engage in a focus group. Our desire was to recruit wheelchair users who had acquired their MWC *as an older adult*. Accessing and successfully recruiting individuals from this specific population is challenging and, in order to secure a sufficient number of participants, we enrolled all who met the inclusion criteria as stated. Consequently, some participants had made the transition to wheelchair use later in life while others were more experienced, having acquired their wheelchair in early- to mid-life, and all were dealing with the effects of aging on wheelchair use.

Table 2.1 Description of Wheelchair User focus group participants

Pseudonym	Age	Health Condition	MWC Experience	Formal Skills Training	Location
Tim	69	Spinal Cord Injury	50 years	Yes	Vancouver
Mike	83	Orthopedic injury	4 years	No	Vancouver
Louise	61	Spina Bifida	48 years	No	Vancouver
Vern	61	Spinal Cord Injury	39 years	Yes	Vancouver
Ted	55	Multiple Sclerosis	11 years	Yes	Vancouver
Richard	57	Spinal Cord Injury	23 years	No	Vancouver
Michelle	63	Polio	60 years	No	Winnipeg
Frank	73	Spinal Cord Injury	25 years	No	Winnipeg
Brent	75	Spinal Cord Injury	37 years	No	Winnipeg
Allen	77	Polio	15 years	No	Winnipeg

2.3 Results

Participants at the two sites identified a variety of issues impacting their transition to wheelchair use, which are summarized in three overarching themes.

2.3.1 Theme 1: On My Own

Most participants indicated they received little preparation for the demands of navigating their wheelchair in an "ambulatory world". A few shared similar experiences receiving some degree of wheelchair mobility skills training (having all attended the same rehabilitation centre), such as Tim who said: *"I came through [Rehabilitation Facility] and learned quite a bit from the staff but found that getting out at home and the park and other places, encountered things that I didn't experience [in Rehab]."* However, most participants reported little or no specific skills training to prepare them for navigating barriers in the community. Michelle said she learned *"by trial and error, I don`t remember any formal or informal contact with any professional."* Frank reflected on how *"I realized I have to do this now because … it's with blood and tears all the time, you know, we own this … a lot of getting used to different things."* Mike highlighted the frustration of not having access to potential resources: *"I know there is a lot of training and knowledge out there but it seems it isn't handed out, there's no system of giving [training]."*

Learning to use a wheelchair was perceived as an experiential undertaking – in order to learn how to navigate the world you must explore your environment, as Frank puts it: *"Hey, I have to do it now because look, somebody's … not going to be there all the time, so we need to know [how to do it]."* Participants spoke often about the need for exposure to new situations so they could master wheelchair maneuvers and generalize the skills they had acquired to novel and increasingly challenging environments:

> *"[the most effective way to learn skills is] going out and doing them … the first time I do something I usually try to take somebody who … can help me get through it if I really have difficulty … and then once I know that I can cope, then I can do it on my own forever after."* [Louise]

More experienced wheelchair users, particularly contemporaries, were a source of some benefit. Participants identified that learning sometimes transpired through intentional means. For example, Vern identified "*peers and mentors that would show you tricks that they learned over the years having used a wheelchair.*" However, this wasn't always engendered through a direct relationship and in some cases mentoring was more subtle and detached:

"If you see some active people doing things and start to think about what it is they're doing differently … because they're not going to explain it to you, it's something that you learn by … seeing them doing it." [Tim]

An interesting conundrum emerged during participants' exchange; support from significant others was identified as both a help and hindrance to wheelchair mastery. Michelle stated she never really learned wheelchair independence until she moved out after university:

"[At home] if I needed to go up a ramp, somebody was there to push me … it wasn't probably until I was in my twenties and had my own apartment and then had a car that I then started doing things on my own."

Another example of this dichotomy, for those who acquired a wheelchair later in life, revolved around having a partner. Frank related his experience as a single man learning to adapt to mobility with a wheelchair, where practicing was particularly difficult and fraught with risk: *"I was quite prone to accidents because I did some things just where I had to learn, and I learned the hard way because when I got out of the hospital, my wife took off so I was on my own."*

2.3.2 Theme 2: More than meets the eye

Participants identified that effective wheelchair use resulted from a multifactorial interplay between the individual, the activities they pursue, and environmental variables. Environmental factors related to accessibility, such as ramps and curb cuts, were essential to have the *opportunity* to practice mobility skills, as well as the wheelchair device itself. The type of wheelchair obtained, such as a lightweight rigid-frame chair that required less effort to push and allowed for greater customization, impacted participants' capacity for active mobility:

> *"Choosing the right chair for the right person is very, very important. I hate those old clunkers that they give to people and they can't do anything with them, they're so heavy and so awful and they can hardly wheel them."* [Allen]

Participants further stipulated that proper *configuration* of the wheelchair could enhance performance. Adjustments by the clinician, such as position of the rear drive wheels, could influence ease of propulsion, maneuverability, and stability. Frank related his experience returning to work after acquiring his wheelchair: *"I had so many falls because … I'd go and pick something up from the floor and I fell over because the wheels weren't set properly."*

Intrapersonal attributes, such as level of impairment and strength, were perceived as relevant to the process of adapting to wheelchair use and impacted the kinds of mobility skills that were reasonable to acquire. Age-related changes further affected performance and required *continual* adjustment to wheelchair use:

> *"Complications that come about [from] aging in a wheelchair - the shoulders give out, the wrists give out, and so it's trying to adapt to those things … now I have to almost do it a different way again in order to maintain that level of independence you'd like."* [Ted]

Brent noted that some skills acquired earlier in life were now used reluctantly or not at all because older wheelchair users were less physically able and more risk-averse: *"I can't bend over as much as I used to, I can't jump curbs, going up ramps is a little bit difficult 'cause I can't* *lean forward as much as I used to, to get my balance."* Allen articulates his growing concerns about higher-risk activities as he gets older:

> *"I'm afraid of a wheelie … even though I'm [an experienced user] because I'm always thinking 'am I going to get wheeled too far and go right over?'"*

The issue of confidence in one's capacity to learn and perform more advanced wheelchair maneuvers was salient. Louise observed "*You get into situations where there's generally a solution but if you haven't had any experience then you're hesitant, right?"* Self-confidence was linked to internal and external stereotypes of aging. Participants noted that they had their own preconceptions about lacking the capacity to acquire and master advanced skills – these were things that young people did but would be too difficult for older adults. Allen articulates this position, that *"you've got some people who say 'I'm in a wheelchair, I'm old, I can't do anything, I need somebody else along to push me, I can't do it'."*

Confidence and persistence in learning to use the wheelchair were also linked to the psychological and affective predisposition of the individual. Participants related that *acceptance* of the wheelchair was a primary key to improving mobility, and the loss associated with compromised ambulation was closely tied to investment and motivation in learning mobility skills. Frank recalls this emotional transition:

> *"My friends say 'look at him in a wheelchair' and laugh at me, you know? I didn't realize, my god this is a way of life I have to live for the rest of my life … I got myself started this way, and I eventually started to feel comfortable in my own skin*."

Such notions were borne not solely from self-image, but also broader cultural perceptions of what older adults are capable of:

> *"Because [we've] had all these preconceived notions about wheelchairs and what you can and can't do … by being in the world or seeing things or watching TV … [we're] going to think 'oh, I'm never, I'm not doing that'."* [Michelle]

2.3.3 Theme 3: Interdependence

A third emergent theme was the sense of interdependence between those who use a wheelchair and those who don't. Participants reflected on the importance and necessity of *collaborating* with non-users. Several subtle variants on this theme came to light: learning to accept and use assistance; knowing how to instruct the novice helper; and knowing how to ask for help. As part and parcel of embracing the transition to wheelchair use, learning *when* to seek assistance from others was pertinent. Allen recognized situations where the risk of injury was unreasonable, such as icy streets in winter where his wheelchair was prone to slide during transfers into the car, so he chose to stop a passer-by to aid in stabilizing his chair. Participants also identified situations where they might be capable of independent mobility but it was simply easier, safer, or more expeditious to ask for (or accept) assistance. This was perceived as being selective about when and where to expend effort, rather than inability:

> *"I never refuse somebody who is going to push me up a ramp. Why, if somebody is there to push me up a ramp, should I be working - I mean, I can do it, but so what?"* [Allen]

There was overwhelming agreement that it was equally important to learn how to instruct others in providing safe and effective assistance. Taking control and being directive with the helper was identified as critical, particularly in situations where the risk was elevated:

> *"I'll ask people for help myself and they'll approach the [ascending] stairs forwards and I'm thinking 'don't do it that way', so I say 'no, you've got to turn me around, one person here, one person here'."* [Michelle]

Finally, participants spoke about learning *how* to request assistance from others, and advocating courtesy when assistance is offered, even when it was not required or desired. Allen offers this advice:

> *"Wheelchair manners [are important] too - if you don't want [help] to do it, thank the person, accept gracefully and appreciate them … a responsibility to be courteous as a wheelchair person ... because they'll go offer somebody else."*

Furthermore, Michelle speculated that a negative encounter might have future repercussions:

> *"Invariably there are people out there who have offered help to somebody who is disabled and had their head chewed off for it so the next disabled person they see, they're very reluctant – they're just 'Oh I don't need that again, I'm going to walk on by'."*

2.4 Discussion

Despite the relatively high prevalence of wheelchair use among individuals with mobility impairment, participants described the journey of transition as lacking any sort of roadmap or guidance. Many identified feeling isolated and ill-prepared to adapt to changes that necessarily occurred when the wheelchair became a ubiquitous consideration of daily life. The challenge of learning how to operate the wheelchair in a variety of environments and conquer accessibility obstacles was daunting and often discouraged efforts to participate in prior activities. The narrowing of social circles and discriminatory conventions of social engagement often exacerbated this experience. Some wheelchair users identified positive experiences during the initial period of transition, through a supportive community of therapists, peers and experienced wheelchair users within a rehabilitation facility. However, most never had access to such a venue and these disenfranchised wheelchair users were essentially left to their own devices, learning principally through trial and error.

Regardless of whether they received any preparation as novice users, participants universally agreed learning to use their wheelchair demanded they venture into the community. This could be a very difficult choice, given the risks associated and their lack of confidence. However, there was a strong sense that independent mobility was a direct consequence of choosing to conquer real-world obstacles. This involved not only learning skills, but also learning to adapt those skills and problem-solve dilemmas that arose because of the varied nature of environments encountered. The concept of generalizing skills through contextual learning is well supported in the motor learning literature. Studies have demonstrated training that incorporates contextual interference, or variations in skill and situation, produce better retention and improved skill performance in novel situations (Porter & Magill, 2010; Magill, 2011).

That the undertaking of community mobility was tied to personal supports and social resources presented somewhat of a conundrum, since these could operate as both facilitators and barriers to independence. On the one hand, individuals with strong familial supports, like Michelle, needed to break free in order to acquire the necessary skills. Conversely, those without a support system were necessarily ‘thrust into the fire’ and compelled to learn how to manage their wheelchair independently at some considerable risk. While the potential for injury or becoming stranded was high and created considerable anxiety, the impetus to gain mastery and independence could also be a strong motivator, as in the case of Frank.

Participants identified that, rather than any one single factor, multiple variables contributed to optimizing wheelchair use. Attributes of the individual, such as physical ability, self-image and confidence, impacted their capacity to master wheelchair mobility. Recent studies lend support to the relationship between confidence, wheelchair proficiency and community participation (Turner Goins, et al., 2014; Sakakibara, Miller, Eng, Backman, & Routhier, 2013). Participants noted the environment was equally influential for successful wheelchair use. Accessibility of the physical environment, support and acceptance in the social environment, and appropriate selection and configuration of the wheelchair device itself were variables of impact. Finally, participants made influential decisions around engaging (or not) in varying types of activities and occupations, particularly those previously enjoyed. The interplay between these factors – the person, their environment (including the wheelchair device), and the activities they choose to engage in – is synchronous with theoretical models in rehabilitation and research related to mobility among older adults (Turner Goins, et al., 2014). For example, conceptual frameworks in occupational therapy (e.g. Canadian Model of Occupational Performance) (Townsend & Polatajko, 2007) and assistive technology outcomes (e.g. Human Activity Assistive Technology model) (Cook & Miller-Polgar, 2008) situate functional performance as a consequence of the fit between these components. When one component is suboptimal, overall participation can be compromised, despite adequacy in the remaining elements.

Participants made a particular link between the need for support and the social environment. Beyond their immediate network of care providers, they inevitably encountered situations where assistance from strangers was required. These wheelchair users perceived a broader social relationship, where societal interdependence had a mutually beneficial outcome for both the helped and the one being helped. This relationship was cultivated during encounters where wheelchair users asked for or were offered assistance. An intriguing notion raised was the role of courtesy, extending even to the point of civic responsibility. Underlying this perspective, these encounters create an experience or memory that impacted the likelihood the ‘other’ would provide assistance again in the future. A positive perception would leave a lasting impression enticing the helper to offer assistance to others in the future, essentially ‘paying it forwards’. Conversely, a negative encounter was thought to poison the well of future opportunities. In short, these *individual* encounters were thought to reflect positively or negatively on wheelchair users *collectively*.

Whether this perception is indicative of wheelchair users generally, or older adult users specifically, or a generational bias from a time when civic responsibility and civility was more explicitly engendered, is not clear. However, participants felt it was a step towards enhancing *reciprocity* between the ambulatory and wheeled-mobility worlds; that asking, receiving and providing assistance serve to promote collaboration and could, in some sense, offer a mutually-beneficial experience, as Allen notes: *“People are delighted to be able to help someone, it makes them feel good, it makes me feel good.”* Social exchange theory suggests that the mode of exchange between individuals can influence future behaviour, and that rewarded action, such as offering assistance, is more likely to be repeated (Emerson, 1976). Inherent in social exchange theory is the concept of interdependence, where individual human interactions are linked to the broader social structure and a sense of reciprocity from the mutual benefit of these actions (Lawler & Thye, 1999). It has been reported that elders with declining function find it emotionally difficult to ask for or receive assistance (Allen & Wiles, 2014). Those who experience a positive relational exchange with their helper tend to be more accepting of assistance because of the perceived reciprocity in the encounter, even if the benefit to the helper is simple gratitude (Lewinter, 2003).

2.5 Limitations

While this study presents novel and revealing insights into the experience of older adult wheelchair users, some limitations should be noted. The two study sites were quite diverse in many respects (e.g. geography, climate, racial diversity and wheelchair accessibility), but the experiences of older adult MWC users in other cities might be different. The sites were both large urban centres and the experiences may not be reflective of those living in smaller and rural settings. While we did not collect socio-economic data from the participants, they were typically middle-class and mobile; many wheelchair users are financially disadvantaged with limited means of transportation and a more diverse participant group might uncover other experiences.

A focus group approach methodology was used rather than conducting a series of individual interviews, which could have inhibited some individuals from sharing experiences that were divergent from the group. Focus groups provide an opportunity to elicit discussion and topics that might not emerge through individual interviews, and provide a venue for contrast and debate; these competing attributes are inherent in the choice between study designs. The focus group participants at both sites in this study shared freely and providing both common and contrasting experiences; however, the possibility exists that some opinions were muted because of the group setting and social pressure to conform (Kitzinger, 1995).

A recommended size for a focus group is between six and eight participants (Krueger & Casey, 2000). The Winnipeg site had a smaller group than this and the Vancouver site was on the lower end of this range. Considerable effort was made to engage more participants, but confounded by the challenges of the target population. At both sites, individuals had to cancel due to health or transportation issues. The focus groups were quite lively, with considerable dialogue, and ran the full duration of time for which participants had been informed; however, a larger group may have provided broader and more diverse response from, and exchange between, participants. Conducting more focus groups with additional participants could also have provided more in-depth information on the wheelchair transition experience. The retrospective nature of participants' description of their transition, particularly where the process of MWC acquisition had occurred many years prior, may have been influenced by issues of memory and reconstruction of the transition experience over time (Nunkoosing, 2005). Our hope was that the exchange and discourse during the focus groups would heighten or spur recall.

Finally, the participants were a composite of elders newly experiencing the *transition to MWC use* and those experiencing the *transition of aging as a MWC user*; conflating these experiences might have diluted the interpretation and findings of the study. However, obtaining this breadth of experience and explicating commonalities of older adults aging with and transitioning to wheelchair use was informative, including the need to re-learn many aspects of wheelchair use as a result of changing capacity with age. Caution should be exercised in generalizing findings to individuals who are substantially dissimilar to the participants and their situations as described herein.

2.6 Conclusions

The transition from ambulatory to wheelchair mobility can feel like uncharted territory for older adults and their care providers, as only a select few receive training and mentorship. While support is fundamentally important, wheelchair users need to experience real-world encounters to optimize their independence and proficiency with wheelchair mobility skills. The impact of this segue into wheelchair use could have a profound impact on care providers, particularly when they are a spouse or family member. The Canadian health care system identifies a role for the procurement of a wheelchair for older adults with mobility issues and, in some provinces, even provides financial assistance or the wheelchair device itself. However, a stronger appreciation among health care providers and funders for the importance of skills training, particularly in this vulnerable population, could have an impact on the delivery model. Ideally, a targeted training program would be integrated into standard practice, recommended and offered to all older adults prescribed a wheelchair. Training should ideally occur and encourage practice within a community setting and facilitate a problem-solving approach to learning. Wheelchair training programs should intentionally target both the user and their care provider, especially when this is a family member or spouse, so that care providers can provide an appropriate level of support while encouraging independent use.

3. Phase 1 and Phase 2: Development of a wheelchair skills home program for older adults using a Participatory Action Design approach [b]

[b] Two versions of this chapter have been published.
Giesbrecht, E.M., Miller, W.C., Mitchell, I.M. & Woodgate, R.L. Development of a wheelchair skills home program for older adults using a Participatory Action Design approach. *BioMed Research International*. 2014:172434, 1-13. doi: 10.1155/2014/172434.

Giesbrecht, E.M., Miller, W.C., Jin, B.T., Mitchell, I.M. & Eng, J.J. Rehab on wheels: A pilot study of tablet-based wheelchair training for older adults. *JMIR Rehabilitation and Assistive Technologies*, 2(1), e3. doi:10.2196/rehab.4274

3.1 Introduction

In the previous chapter we learned that the transition to MWC use among older adults is difficult and many continue to experience reduced levels of participation as a result. A variety of factors contributed to effective use of the MWC. For example, attributes of the individual such as strength and degree of impairment could be influential. Contextual factors were particularly important, relating to the environment of use. This would include the built environment, such as pseudo-accessible (Ripat & Woodgate, 2012) and inaccessible locations, and challenging terrain; the social environment, such as social attitudes and level of personal assistance; and assistive technology devices including wheelchairs that are low-quality, inappropriate or do not fit the user. Contextual factors may also be personal, such as age and confidence (self-efficacy) with wheelchair use. The participants reported on in chapter 2 articulated the importance of gaining confidence with their wheelchair and how this contributed to greater independence and engaging in community-related activities. Furthermore, peers played an important role in enhancing confidence, whether directly through mentoring or indirectly through observation and association with their own potential success.

Wheelchair mobility skill and proficiency have also been identified as significant contributors to participation (Mortenson, Miller, Backman, & Oliffe, 2012; Phang, Martin Ginis, Routhier, & Lemay, 2012; Kilkens, Post, Dallmeijer, Seelen, & van der Woude, 2003; Hosseini, Oyster, Kirby, Harrington, & Boninger, 2012). Wheelchair skills have been amenable to improvement through training, particularly when delivered in a structured format. For example, there is considerable evidence supporting substantive benefits of the Wheelchair Skills Training Program (Dalhousie University, 2012) in a variety of populations and contexts (MacPhee, Kirby, Coolen, Smith, MacLeod, & Dupuis, 2004; Best, Kirby, Smith, & MacLeod, 2005; Ozturk & Ucsular, 2011). Older adults typically receive little training when they obtain a wheelchair (Karmarkar, et al., 2009; Smith & Kirby, 2011), and whatever training they do receive tends to focus on functions related to hospital discharge (e.g. transferring from the wheelchair to bed or toilet). In chapter 2 older adult MWC users reported experiences of feeling ill prepared because they had received inadequate training. Insufficient training occurs for a variety of reasons, but primarily because therapists have limited time and must focus on pragmatic issues, and resources for follow-up services are restricted (Best, Routhier, & Miller, 2015; Nelson, et al., 2010). This substantive service gap is due to restricted availability and time for clinicians to provide 1:1 therapy, limited content expertise, and challenges for consumers to attend appointments, particularly in rural or remote locations (Best, Routhier, & Miller, 2015).

In chapter 2, it became clear that practice and training in the context of use (i.e., in the community with real life obstacles) was critical for these older adults to become proficient with MWC mobility and to generalize the skills they learned into the activities and environments of daily life. This perspective has been proposed elsewhere in the literature and linked to increased risk for wheelchair-related accidents and injury (Nelson, et al., 2010). Providing training in the community would be desirable, but community-based therapists are typically able to make only one or two visits and their intervention focuses on fitting of the wheelchair and home access, with little or no time to provide mobility skills training. This lack of comprehensive, context-appropriate training is particularly problematic because older adults require more time and training to acquire new motor skills due to age-related changes in motor, sensory and cognitive function (Voelcker-Rehage, 2008; Bonaparte, Kirby, & Macleod, 2004).

An alternative to traditional outpatient rehabilitation, which is cost- and time-intensive, is to deliver these services as a monitored home program. The advantages and effectiveness of rehabilitation home programs have already been reviewed in chapter 1. For rehabilitation home programs targeting motor skills in older adults, maximizing training frequency and practice in the natural context of use are essential elements. Furthermore, specific strategies such as enhancing self-efficacy, increasing complexity over time, and regular monitoring by a trainer improve adherence, frequency, and duration of engagement by program participants (Jordan, Holden, Mason, & Foster, 2010). Older adults may be more reticent to adopt and adhere to home training unless the program is specifically targeted to their learning needs and preferences. Utilizing strategies from the adult learning literature, or Andragogy, (Knowles, 1980; Merriam, Caffarella, & Baumgartner, 2007) as active ingredients can promote program adherence and successful skill acquisition with older adults (Davis & Chesbro, 2003). This is particularly relevant since the program is self-managed and applicability for the user is imperative. The insights into older adults' experience of transitioning to MWC use, including the impact on care providers, were valuable in unearthing issues related to inadequate preparation as well as factors that contributed to positive training experiences. This highlights the importance of leveraging the knowledge and experience of MWC users and their care providers in the development and evaluation of new training interventions. Consequently, involvement of these two stakeholder groups was a key feature in the study design reported on in this chapter.

Alternative and innovative electronic and mobile technology strategies are becoming increasingly important as a platform for delivery of health-related services, often referred to as mobile health or mHealth (Sama, Eapen, Weinfurt, Shah, & Schulman, 2014). The literature is beginning to document the benefits of utilizing mHealth as an augmentative or alternative strategy to traditional in-person, individualized rehabilitation models (Kumar, et al., 2013), demonstrating effective interventions in health literacy (O'Connor, Farrow, & Hatherly, 2014; Watkins & Xie, 2014), self-management (Murray, 2012), and adherence and health behaviour change programs (Webb, Joseph, Yardley, & Mitchie, 2010). However, as outlined in chapter 1, it has thus far been limited in its application to motor-skill training and rehabilitation services. Consequently, this study set out to create and evaluate an mHealth intervention relevant for novice older adult MWC. The project was called *Enhancing Participation In the Community by improving Wheelchair Skills (EPIC Wheels)*. Phase one involved design, evaluation and revision of the training program content and method of delivery. Phase two was a small pilot study focusing on administration and acceptability of the intervention processes to ensure components were well integrated and viable. This chapter reports on these two phases of the project.

3.2 Phase 1: Prototype development

3.2.1 Purpose

The purpose of phase one was to develop a prototype mHealth wheelchair skills training home program for novice older adult manual wheelchair users, including program content and a system of delivery. The specific objectives were to:

1. Engage older adult MWC users in the program development and incorporate stakeholder input throughout the design and evaluation process;
2. Incorporate relevant, evidence-based content that promoted self-efficacy principles and adult learning strategies;
3. Produce an accessible prototype tablet-based intervention program for pilot testing.

3.2.2 Materials and methods

3.2.2.1 Study design

There is an emerging consensus in the field of assistive technology that consumer involvement *during* the process of intervention development is crucial (Demiris, Oliver, Dickey, Skubic, & Rantz, 2008; Lin, Neafsey, & Strickler, 2009; Seale, McCreadie, Turner-Smith, & Tinker, 2002). This is particularly true with older adults, to ensure that a technology "solution" itself does not induce more problems than it resolves (Seale, McCreadie, Turner-Smith, & Tinker, 2002). An additional benefit of involving older adults is the "Design for All" tenet that assistive technology interventions that work well for the elderly are also likely to work better for consumers generally (Seale, McCreadie, Turner-Smith, & Tinker, 2002).

A Participatory Action Design (PAD) was used, which is an approach to innovation development that places high value in the on-going involvement of intended users during design and evaluation elements (Protheroe, Blakeman, Bower, Chew-Graham, & Kennedy, 2010; Ding, Cooper, & Pearlman, 2007; Waller, Franklin, Pagliari, & Greene, 2006). Using a PAD framework, stakeholder evaluation and feedback were incorporated into the development stages of program content and delivery through the use of focus groups (see Figure 3.1). An overview of the PAD approach was provided in chapter 1 and Table 3.1 summarizes the key components and associated activities as carried out in this study. The iterative feedback/revision process began with an **initial prototype,** followed by the development of a **revised** prototype after the first set of focus groups. A **beta** prototype was created after the second round of focus groups for final review and pilot testing in phase 2, and ultimately revised into a **clinical prototype** for evaluation in a feasibility RCT. Figure 3.2 provides a timeline for the study components leading to the development of the final product.

Figure 3.1 **Phased study design**

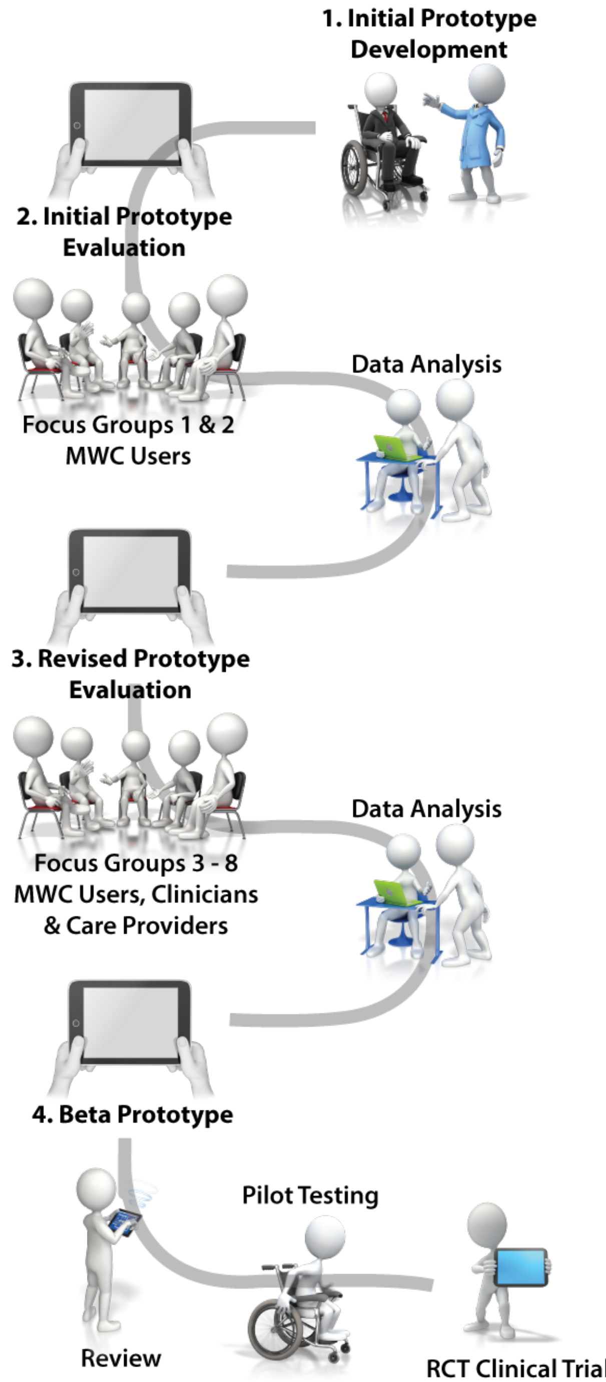
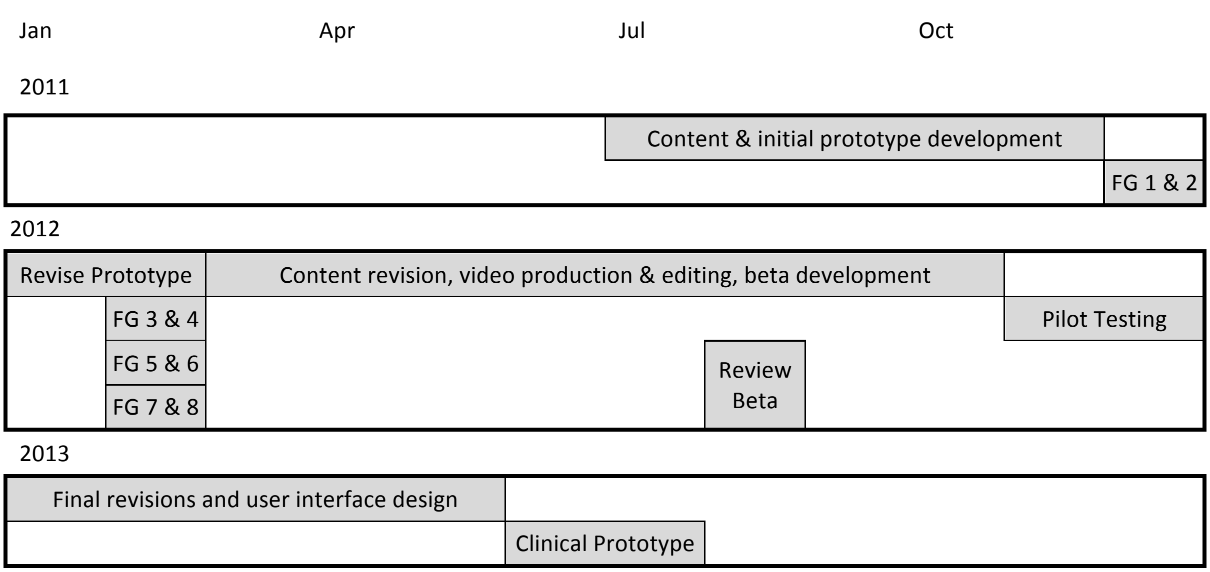


Table 3.1 Key PAD components and associated study activities

Component	Study Activity
Theory driven literature review	Review of MWC skills training, Andragogy and Social Cognitive Theory evidence in ground work stage
Identify user needs	Transition to MWC use (natural history) and focus groups with MWC users
Active involvement of stakeholders; cyclical and iterative process	Involved at multiple points throughout process: initial, revised and beta prototypes; review; pilot testing
Involve multiple stakeholder groups	Incorporated MWC users, care providers and prescribing clinicians
Diverse and representative sample	Male and female participants with various diagnoses; age range 55-83 years; MWC experience 4-60 years
Hands-on, experiential involvement; diverse and real world settings	Direct interaction with prototypes during focus groups and review; pilot-testing in home environment.
Use of multiple methods	Quantitative and qualitative data collection during focus groups; quantitative outcomes and post-study interview in pilot
Prototype development	Multiple prototypes: initial, revised, beta, and clinical version for feasibility RCT

Figure 3.2 Timeline for study components



Focus groups were used to capitalize on participant interaction to elicit needs and preferences, personal experiences, and exploratory solutions “outside of the box” (Seale, McCreadie, Turner-Smith, & Tinker, 2002). Focus groups have proved effective in other comparable participatory rehabilitation intervention studies (Lin, Neafsey, & Strickler, 2009; Seale, McCreadie, Turner-Smith, & Tinker, 2002; Protheroe, Blakeman, Bower, Chew-Graham, & Kennedy, 2010; Eriksson, A, & Johansson, 2000). Including a qualitative approach ensured that older adults provided confirmation that the learning strategies were relevant; practice activities were age-appropriate and achievable; potential for user motivation and adherence was maximized; and the product design considered the technological accessibility needs of an aging population.

A total of eight focus groups were conducted in two cities: Winnipeg and Vancouver. These locations provided diversity in culture, weather, geography, and degree of wheelchair accessibility, and would also serve as research sites for a subsequent clinical trial of the program. All participants provided consent and approval from the university affiliated Research Ethics Board at each site was obtained prior to conducting this study.

3.2.2.2 Participants

Three stakeholder groups in each city were included: experienced MWC users aged 55 and over, care providers of older adult MWC users, and clinicians who prescribed wheelchairs and/or provided wheelchair training for older adults. MWC users were the primary stakeholder group as we were most interested in their perception of the program content and delivery, since adherence to a home program is critical to effectiveness (Jordan, Holden, Mason, & Foster, 2010). The MWC user groups at each site participated in two focus groups (at different points in the program development), while care provider and clinician groups each attended one focus group. The target population for the training program is *novice* users; however, *experienced* users were chosen instead for several reasons. First, it was anticipated that availability and potential for attendance would be high since these individuals would have either acquired mobility skills or developed adaptive strategies over time. It was also more likely that whatever impairment precipitated acquisition of the wheelchair would have stabilized sufficiently that participants would be able to schedule and attend two focus groups. Second, novice users often experience a transitional period of emotional and social adjustment, and engagement in a research study might prove challenging (Barker, Reid, & Cott, 2004; Bates, Spencer, Young, & Rintala, 1993). Furthermore, novice users would likely have more limited experience and perspective to know what it was they *didn't know*. Conversely, experienced users, while somewhat distanced from the "experience" of early adjustment to wheelchair use, would have a more comprehensive understanding of the scope of environmental barriers and could reflect on which barriers were most problematic and which mobility skills had been most important or influential in addressing participation restriction.

The MWC user and care provider participants were recruited using email and postal invitations, public advertisement, and by word-of-mouth. MWC users were at least 55 years of age; living in the community; had used a MWC as their primary means of mobility for at least one year; and have sufficient cognition and English language skills to engage in the focus group process. Care providers were individuals (e.g., spouse, relative or care provider) who assisted or accompanied a MWC user at least 55 years of age while using their wheelchair inside and outside of the home. For the clinician group, occupational and physical therapists who supervise or provide clinical services (e.g., prescribe a wheelchair or provide wheelchair mobility training) to individuals 55 years of age or older at the largest rehabilitation hospital in each city were invited to a lunch-hour focus group. Advertising posters and brochures were distributed to therapists at each site and local rehabilitation managers distributed invitations to their staff via email. All participants provided informed consent prior to participating in this study.

A total of 10 MWC users participated in the focus groups; their demographic attributes have been previously reported in Chapter 2. At the Vancouver site (n = 6), one individual was not able to attend the second focus group due to weather conditions. At the Winnipeg site (n = 4), two participants attended both focus groups while two attended only one focus group. The mean age was 66.8 years (range 55 – 83 years) and mean duration of wheelchair use 31.9 years (range 4 – 60 years). Among the care providers, there were 2 participants at each site (n = 4) and all were female. At the Winnipeg site, Jamie was in her 30s and worked in an intentional community home where she was a care provider for a variety of individuals with a disability, some of who were older adult wheelchair users. Felicia was in her 60s and assisted her husband, who was in his 70s and used both a manual and power wheelchair. In Vancouver, Patricia assisted her husband and Bertha provided care for her daughter; in both cases, the care recipient had also been a participant in the MWC User focus group. A total of 20 clinicians participated in focus groups between the Winnipeg (n = 9) and Vancouver (n = 11) sites.

3.2.2.3 Data collection and analyses:

The focus group procedure has been previously described in Chapter 2, with a brief introduction and audiovisual presentation of the study background, purpose and design; interactive discussion using a semi-structured guide designed for each respective stakeholder group (Appendix A); and opportunity to interact with the training program prototype and provide feedback. Each session was audio-recorded and transcribed verbatim by the research assistant, and both facilitators kept field notes of their experience. A second research assistant verified accuracy of the transcripts against the audio recordings before personal identifiers were removed. Portions of the user and care provider sessions were video-recorded so that we could observe participant interactions with the computer tablet.

A Conventional Content Analysis approach (Hsieh & Shannon, 2005) was used with data from each focus group. The initial coding scheme was informed by concepts and themes from Andragogy and Social Cognitive theory, and the author parsed the content assigning codes to each discrete element, with emergent codes being integrated after each subsequent focus group. The study team met regularly to discuss analysis and to review coding. Any discrepancies were discussed until consensus was reached. An audit trail of the research and analysis process was documented, including all coding procedures (Miles & Huberman, 1994). Participant-collaborators also engaged in this process through debriefing and member checking at the second focus group. Data analyses and intervention development took place concurrently as some participant feedback was self-evident and easily implemented (e.g., size of icons, number of menus) while other revisions required more in-depth analysis (e.g., relevance of activities; appropriateness of training approach).

3.2.3 Results

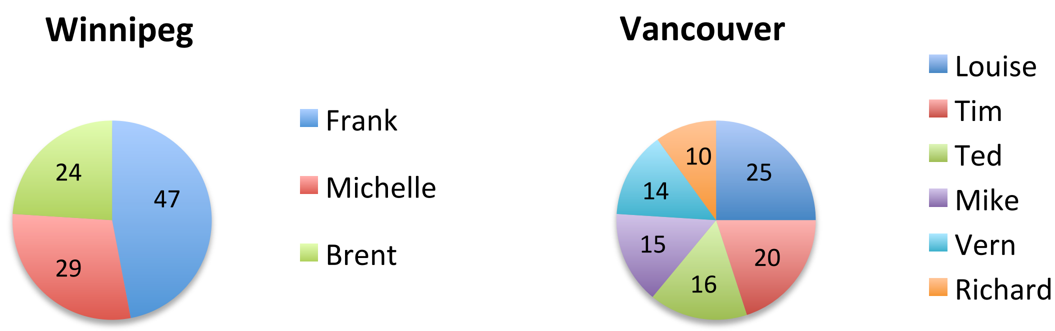
3.2.3.1 Focus group participation

After analysis of the focus group transcriptions, the contributions of each participant were tabulated based on the number of distinct responses (i.e., incidents) and volume of content (i.e., total number of words). This was further delineated into their relative contribution to the discussion (percent of total responses; percent of total content; percent of concepts contributed). The findings are provided in Table 3.2 and Figure 3.3.

Table 3.2 Contributions of individual focus group participants to discussion

Participant	Responses		Content (Words)		Concepts
	Number	% of Total	Number	Per Response	% of Total
Vancouver					
Louise	53	31	1441	27	25
Mike	17	10	846	50	9
Tom	33	19	1153	35	25
Vern	19	11	822	43	12
Ted	25	15	912	36	17
Richard	24	14	595	25	11
Total	171	100	5769	34	100
Winnipeg					
Brent	89	47	1457	16	22
Frank	60	31	2781	46	50
Michelle	42	22	1734	41	28
Total	191	100	5972	31	100

Figure 3.3 Relative contribution to discussion at each site (%)



3.2.3.2 Initial prototype development

A variety of evidence-based resources were used to create the initial content outline, including the Wheelchair Skills Training Program, which is a comprehensive structured curriculum available online (Dalhousie University, 2012). Initially four categories of content were created: safety, wheelchair components, body position, and mobility skills. The mobility skills were structured sequentially and grouped into natural categories, based on underlying prerequisite skills and increasing performance complexity or difficulty. A script was created with the intent of delivering content through a series of short video presentations. Training activities were developed for each curriculum component. To facilitate presentation of a mock program, several preliminary video segments were created. A storyboard was used to outline the desired sequence and configuration of content. The following sections outline stakeholder response and subsequent revision in greater detail.

3.2.3.3 Initial prototype evaluation: MWC users

Participant responses fell into three major themes: *challenges to wheelchair use*; *optimizing strategies for learning skills*; and *critiques of the tablet device*. An expanded diagram of themes and sub-themes is provided in Appendix B. Input from the MWC user group provided confirmation for elements of the EPIC Wheels content and strategies for delivering training, and also resulted in several changes to the initial program prototype.

3.2.3.2.1 Theme 1: Challenges to wheelchair use

The focus group discussion guide explicitly intended to elicit from experienced older MWC users the types of environments and activities that were most problematic, and the skills that were most beneficial to enhancing participation. MWC users indicated maneuvering in confined spaces indoors was difficult, particularly doorways, around furniture in small rooms, and negotiating tight corners. Skills such as tight, accurate turns and alternating forward and backwards movements were critical in these situations. Small elevation changes were also noted, such as doorway thresholds and sidewalk cracks or heaves, which can catch the front casters and initiate a forward tip. Soft or accommodating surfaces, such as grass, carpet and gravel, were particularly difficult for older users with compromised strength. Participants reported ramps and inclines required both effort and control, coordinating hand movements to prevent rollback during ascent and limiting speed during descent. Curbs and steps were identified as substantial barriers to ascend independently and daunting to descend due to the risk of a forward tip.

Participants also identified awareness of how wheelchair components operate as important to efficient use of the wheelchair. Specifically, operating the wheel locks (i.e., "brakes") and positioning of the front casters were important knowledge-based components of wheelchair operation. In addition, participants highlighted the relevance of their position within the wheelchair and the impact on operation and responsiveness. For example, leaning forwards or backwards alters the weight distribution between the front and rear wheels, increasing or decreasing wheelchair stability.

3.2.3.2.2 Theme 2: Optimizing strategies for learning skills

In providing feedback on strategies and factors that impact learning, participants touched on a number of ideas aligned with the principles of self-efficacy. Table 3.3 provides a summary of selected concepts concordant with the four core tenets. The older adult MWC users spoke of the importance of a visual demonstration of each skill. Participants preferred "seeing" the task requirements before attempting performance. For example, getting over a doorway threshold could be broken down into positioning casters upon approach, shifting weight backwards, "popping" the casters off the ground with a quick push, and then forward weight shift while propelling the drive wheels over the threshold. Furthermore, demonstration by an older adult peer was deemed to be particularly helpful. Participants cautioned that seeing only "correct" performance was not sufficient. As Ted states: "*don't always show the successful way … show us a way you could go wrong too,*" suggesting training should also include implications of incorrect performance particularly related to safety. In addition to authentic demonstration models, participants advocated that training should occur in real environments using actual obstacles. Specifically, training should occur in the home or community, where obstacles encountered were truly representative of life situations rather ones as might be constructed in a clinical setting.

In learning mobility skills, participants stated that success was important to bolster enthusiasm and confidence, and that training activities should begin with simple and achievable skills before progressing to more difficult ones. The transition between activities should be graded and the speed slow to ensure safety. Participants recommended an individualized approach focusing on skills relevant to the specific user, with the trainee having some control over which skills are practiced. Providing a rationale for using each specific skill was stressed. For example, the skill should be presented in the context of a particular situation and explain how acquisition of the skill will improve performance or reduce the risk of injury when performing a relevant activity.

Table 3.3 Components of self-efficacy and related MWC user focus group concepts

Component	Participant Concepts
Mastery Experience	• Need to actually attempt skills and venture out in order to learn • Customize the program and grade activities to ensure success • Provide demonstration and information, including what *not* to do • Use a problem-solving approach • Have an expert provide feedback and address barriers to success
Vicarious Experience	• Seeing peers succeed is inspiring • Use real MWC users for demonstrations; perform in a real context of use with real obstacles • Watching others was an effective way for me to learn
Verbal Persuasion	• Encouragement and "push" from others; or else I tend to give up • Having a peer or trainer support; having a mentor • Access to a real person to provide regular communication and encouragement; keep them engaged • Provide a rationale for learning and application of each skills
Reinterpretation of Physiological and Emotional State	• Older adults are often cautious or fearful, reluctant to try skills • A program that is engaging and draws you in so you aren't thinking about the effort • Consider the effects of aging (pain, fatigue) • Embarrassment of using MWC with poor skills • Provide feedback on progress to motivate the user

Participants indicated that training activities needed to be engaging and interactive to promote adherence and overcome initial hesitation that might result from fear, low confidence, or apathy. The importance of the relationship between trainer and trainee was noted, identifying that personal contact, individualized evaluation, and feedback would contribute to greater motivation.

3.2.3.2.3 Theme 3: Critiques of the tablet device

Participants were impressed with the tablet device as a potential training device. In particular, the portability for use in a community context and the capacity for visual demonstration of individual skills and skill components were highlighted. Participants noted the tablet's built-in capacity for video recording trainee performance had great potential for learning. Concern was raised around the potential for the tablet to be lost, misplaced or stolen given it's small size – ironically, one participant returned to the meeting room shortly after the focus group had finished to locate and retrieve their cell phone.

During the demonstration, we indicated that the training content on the tablet would be delivered using the Internet. Participants expressed apprehension about this dependence on Internet connectivity and what might happen if trainees were without Internet access. Finally, there was considerable discussion around receptivity and capacity of older adults to use the tablet technology. In particular, some participants wondered whether older adults would have the cognitive and attention ability to learn to use the tablet in addition to learning wheelchair mobility skills. This discussion generally reflected participants' perceptions about other older adults and, in particular, those in their late 70's and 80's. All of the focus group participants were over 55 and felt this technology would not be particularly challenging or intimidating for them to use; however, some felt that this might not be the case for others older than they were:

> *"My mother just got an iPad and let me tell you I`m spending more time with my mother (laughs) … even her touching the screen to select things is a real challenge … she often gets totally discombobulated … but for someone like me … it's second nature"* [Louise, 61, Spina Bifida]
>
> *"The tablets are neat, but … I guess I've got this sort of idea or intuitive sense that people are going to be older … closer to 70 ... even for me I'm familiar with that kind of stuff but … [for others] it just seems to be easier just to [use a DVD]"* [Michelle, 63, Polio]

In particular, participants wondered whether some older adults would have difficulty navigating through multiple menus and icon options, and become "lost".

3.2.3.3 Changes to initial program prototype

The participants' reporting on common challenges to wheelchair mobility provided confirmation for the content areas proposed in our initial prototype. The specific skills related to addressing environmental barriers, such as propelling straight, turning, and popping casters, were all contained in the training curriculum. The initial prototype had, by design, only a limited repertoire of video content as we anticipated substantial revision. In response to the challenges noted with negotiating small, crowded spaces, we expanded the content related to turning and maneuvering skills. For example, wheelchair casters have an off-center pivot, swinging into a trailing position when initially moving forwards and a leading position when reversing. During these transitions, the wheelchair has a tendency to veer towards one side. A training segment was added specifically addressing this response and how to best control caster swivel. Content was expanded to include explanation of the "mechanics" of turning a wheelchair and broken down into small progressive segments including stationary turns, stopping and turning, moving turns, spin turns, and backward turns. Manipulating body position within the wheelchair to improve stability, safety and responsiveness of the wheelchair became a separate content area early in the program, as it is a prerequisite for many advanced mobility skills. Additional content was also added related to safety, based on participants' feedback. A separate section identifying equipment (i.e., anti-tippers, spotter strap, gloves) was added as well as educational information regarding tips and falls, spotting/supervision, feedback during training, and injury prevention.

For convenience and expediency, the initial prototype included video demonstrations featuring the facilitator. In the subsequent prototype, two individuals over 65 years of age (one male and one female) were recruited to model skill performance and training activities. As suggested in the focus groups, a number of skills were enacted with common *errors* to illustrate how and why unsuccessful performance might occur. These included both naturally occurring and contrived errors. Naturally occurring errors emerged when models were initially unsuccessful attempting a skill and proved useful in demonstrating how to correct mistakes as the models adjusted their approach. Contrived errors were useful as a "Goldilocks" approach to learning (i.e., demonstrating what happens if you turn too soon, too late, and "just right") and addressed the recommendation to link potential consequences with skill performance.

To address concerns about network connectivity, the system was modified so that it could operate with only sporadic Internet access. In particular, video viewing and training could take place with or without being connected; however, brief connections were still occasionally required so that data and messages could be exchanged with the monitoring trainer.

3.2.3.4 Revised prototype evaluation

For the second round of focus groups, which involved MWC users, care providers and clinicians, their responses were again categorized into three general themes: *challenges to wheelchair use*; *optimizing strategies for learning skills*; and *critiques of the tablet training device*. There was overlap between the stakeholder group feedback as well as unique contributions from the three perspectives.

3.2.3.4.1 Theme 1: Challenges to wheelchair use

Most of the situations and environments stakeholders identified (and the requisite skills for performance) were contained within the revised prototype; however, several gaps were identified in the second round of focus groups. The clinicians highlighted the challenges of uneven, undulating, and irregular surfaces for older adult MWC users, which was particularly taxing on their endurance. This included working against gravity pushing both up and downhill, and lost momentum when stopping to overcome small gaps or changes in elevation. There was consensus that performing a sustained wheelie was not an essential or even high priority skill for this user group, but the *transient wheelie* (i.e., popping the casters) was unquestionably a useful and productive strategy to learn.

The care provider groups identified functional upper extremity activities as problematic. This included reaching for objects on the floor and at height, such as operating a ticket kiosk in a public transit station. Using doors was also noted as difficult because it involved manipulating the wheelchair and the door simultaneously, and can be compounded by mechanical closers. One MWC user group proposed inclusion of a section on carrying objects - a skill not previously identified specifically in the literature. Since propulsion is often a bilateral activity, transporting an object (such as a cup of hot coffee) is particularly problematic.

Both the MWC user and clinician groups noted the particular challenges of propelling on snow and ice; this was true at both sites, despite the substantial differences in climate between the cities (mean days of snowfall: Winnipeg 53, Vancouver 11; mean depth of snow between December and March: Winnipeg 15 cm, Vancouver 0 cm). Snow can be particularly soft and conforming to the casters, causing them to become buried and the wheelchair to "snowplow" or stop suddenly, causing a risk of forward tipping. In addition, low friction reduces traction at the rear wheels, resulting in one or both wheels slipping.

3.2.3.4.2 Theme 2: Optimizing strategies for learning skills

The clinician groups identified that in training older adults, memory for new learning is often a challenge and needs to be addressed through increased repetition and breaking skills into smaller steps. While they spoke positively about the content of the training videos, both the MWC user and clinician groups indicated the importance of using lay terminology and avoiding excessive technical jargon. At the same time, MWC users suggested using accurate terminology for the wheelchair components to ensure consistency and clarity throughout the learning process.

Consistent with the MWC users in round one, the clinicians identified value in describing the benefit of each skill for trainees, as well as for family and care providers to secure their support in the training process. The care providers wondered whether there might be a benefit to trainees being able to navigate through individual videos, to rewind or fast-forward depending upon their learning needs and desires. They affirmed the use of games and interactive activities to engage the trainee in practice, such as the "roller coaster" activity that requires trainees to lean backwards, forwards, and sideways in their wheelchair as the roller coaster car ascends, descends, and turns along the tracks. Care providers also highlighted the need for flexibility to select individual skills and activities, rather than having to follow a prescribed sequence.

The clinician groups suggested the training program include not only skills for independent mobility targeting the user, but also including skills and techniques for care providers to assist older MWC user when independent mobility is not feasible. This was particularly true for skills that might not be reasonably achieved independently, such as managing steps or curbs safely.

3.2.3.4.3 Theme 3: Critiques of the tablet device

The clinicians commented that the instruction and demonstration videos were not all of one uniform size and suggested greater consistency and, more importantly, maximizing the size of the video image. Care providers commented that the tablet surface has a significant glare which compromised viewing, particularly when positioned on an angle. The buttons were described as being adequate but somewhat small, and the text was hard to read for some. Likewise, volume was described as adequate but could potentially be problematic for trainees with compromised hearing. Both users and care providers wondered how the tablet might be positioned and supported during training without risk of it falling to the floor and being damaged.

3.2.3.5 Changes to revised prototype

In response to the stakeholder feedback, several additional content areas were introduced. Within the training section related to soft surfaces, we added instruction and video footage on propelling over snow and ice. We also incorporated content specific to care provider (assisted) mobility skills such as getting up and down curbs, steps, and ramps, and using the tipping bar to get over small obstacles. Managing doors (with and without closers) and strategies for carrying objects were incorporated as distinct sections.

Several changes were made to the tablet display and user-interface. Video clips were configured to display in the same size configuration. Navigation buttons (e.g., play, pause, stop) were relocated from below the video image (horizontally) to the right of the image (vertically) to maximize image height and permit a widescreen display. The vertical orientation also permitted larger buttons for easier targeting (Lee & Zhai, 2009), along with decreasing the amount of text and increasing font size to address visual acuity changes with aging.

A training schedule was proposed of 15-30 minutes per day (1-2 session for 15-30 minutes each) at least 5 days per week totaling 75 to 150 minutes per week. These guidelines are based on the National Blueprint consensus document on promoting physical activity for adults over 50 years, which advocates that lifestyle- or endurance-related activity of moderate intensity should be undertaken for at least 30 minutes (in bouts of at least 10 minutes) 5-7 days per week (Cress, et al., 2005). All 3 stakeholder groups affirmed this schedule as reasonable and appropriate for the target population.

To address the potential issues with users becoming "lost" during program navigation, we developed 2 strategies – pre-training and reference material. The EPIC Wheels program incorporates two 1:1 training sessions with an experienced trainer. In practice, these sessions might occur shortly after an older adult obtained their wheelchair. As part of the initial evaluation and training session, we planned to include a 30-minute interactive orientation to the tablet for the user and care provider. Trainees would also receive a printed handbook with instructions for tablet navigation, including screenshots for visual assistance. For simplicity, menus were configured to have 3-8 options related by content area, limiting clutter and distraction without requiring an excessive number of embedded submenus (Caprani, O'Connor, & Gurrin, 2012). We also addressed potential audio issues by including headphones, as augmented audio output increases usability for older adult users of touchscreen technology (Caprani, O'Connor, & Gurrin, 2012).

With the assistance of a rehabilitation engineer, we created a lap-mounted support to enable in-chair viewing and practice while minimizing risk of loss or damage to the tablet. A nylon strap and buckle were integrated into a rigid platform with a neoprene foam base, upon which a commercial tablet holder (Cyber Acoustics IS-4000 Universal Tablet Stand, Vancouver, WA) was mounted using hook and loop fasteners (see Figure 3.4). The tablet could be used in-chair or placed on a table if desired. A training kit was created using common household objects (e.g.

boxes, balls, balloons), at a total cost of less than $20 and able to fit into a grocery bag. The kit would be provided to trainees to support all of the tablet-based training activities.

Figure 3.4 Tablet mounting platform for wheelchair use

Following revision, we met individually with one of the MWC users (Allen) and one of the clinician participants to further review the beta prototype. Both reviewers provided confirmation of the scope and presentation of the training content and usability of the user interface, and no substantive revisions were requested. In particular, the MWC user was pleased with the tablet holder, indicating it was easy to don and doff in the wheelchair and provided a good viewing location with adequate adjustability.

3.3 Phase 2: Beta prototype pilot testing

3.3.1 Purpose

As with many rehabilitation interventions, there was considerable complexity in evaluating the EPIC Wheels program due to the multiple components of administration, various behavioral requirements, and the tailored aspect of the program. The degree of clinical impact may be a consequence of program effectiveness or potentially an issue of implementation; therefore, process evaluation was critical. Best practice suggests that fidelity in the implementation protocol should be established and reported on using a pilot study, as part of a systematic framework for evaluating complex interventions in clinical trials (Craig, Dieppe, Macintyre, Nazareth, & Petticrew, 2008). The intent of phase two was to run a pilot study of the EPIC Wheels procedures to ensure integrity and integration of the study components; fidelity of the intervention protocol and methodological integrity (Rodriguez & Gonzalez-Rothi, 2008); viability of participant adherence or engagement (Johnston & Case-Smith, 2009); and participant acceptance (Portney & Watkins, 2009). Rather than a *feasibility study*, which operates as a mini-RCT focusing on recruitment and primary outcome estimates, a *pilot study* addresses study-related issues of procedural administration, data collection and intervention-specific issues (Arain, Campbell, Cooper, & Lancaster, 2010). Given the small scale, absence of the control group, and potential for changes based on the results, there was no intent to conduct hypothesis testing or include the data in the subsequent phase three feasibility study (Arain, Campbell, Cooper, & Lancaster, 2010; Thabane, Ma, & Chu, 2010). Thabane et al. (2010) propose the use of a framework for evaluation of process, resource, management and scientific outcomes in a pilot study. Using this structure, a comprehensive set of metrics was constructed by which to evaluate each component, including parameters for confirming feasibility. Consequently, the specific study objectives of phase 2 were to conduct a pilot study to determine whether:

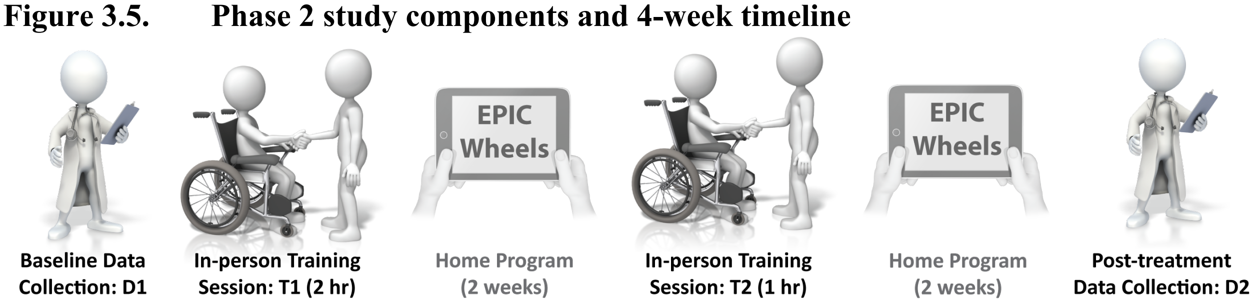
1. The EPIC Wheels program could be administered accurately, effectively and safely in accordance with pre-determined metrics;
2. Participants would adhere to the prescribed training protocol;
3. The EPIC Wheels program was acceptable and beneficial;
4. Additional changes or enhancements to the EPIC Wheels program were indicated.

3.3.2 Materials and methods

3.3.2.1 Study design

Based on clinical consensus during phase 1, a four-week timeline was constructed to administer the program (see Figure 3.5). Acceptable time intervals for each milestone were identified in advance. Participants attended a baseline data collection appointment [D1] and then scheduled the first in-person training appointment [T1] within 7 days. After 14 days (± 2 days) of home training with the tablet, participants would attend a second in-person training session [T2]. After another 14 days of home training, the program was complete and post-treatment data was collected [D2] within 42 days of D1. All data collection and in-person training occurred in a centrally located wheelchair-accessible clinic.

Figure 3.5. Phase 2 study components and 4-week timeline



3.3.2.2 Participants

Given the purpose of methodological evaluation, a sample size calculation was not indicated. Pilot studies typically involve a small sample, with 2-4 participants generally being sufficient to verify procedural feasibility (Portney & Watkins, 2009). We selected a purposive sample of two divergent participants – one experienced and one novice MWC user. The experienced user (participant 1) would provide perspective on the applicability and relevance of the program and bring a larger spectrum of skills, enabling the trainer to anticipate how to adjust the training process accordingly. The novice user (participant 2) would be reflective of the target population. Participant 1 was a 60-year-old single male with a T9 spinal cord injury who had been a MWC user for 485 months and a competitive wheelchair athlete earlier in life. He was recruited through previous contact in phase 1 of the EPIC Wheels project, where he had expressed interest but was unable to participate in the program development. Participant 2 was a 73-year-old married male with left above-knee amputation who had been a MWC user for 3 months, and was recruited through public advertisement. Both participants had home computers and a basic level of computer literacy but neither owned a tablet device. Approval for the study was obtained from the University of Manitoba Health Research Ethics Board (#H2012:069) and registered with clinicaltrials.gov (#NCT01644292). Participants completed a consent form that clearly articulated this was a pilot study, with the intent of evaluating study procedures and participant acceptability.

3.3.2.3 Intervention description

The EPIC Wheels intervention was composed of two brief in-person education sessions with an expert trainer and four weeks of monitored home training conducted via a computer tablet. The first education session involves one hour of individualized assessment of specific mobility-related wheelchair skills and one hour of orientation to the tablet and software program. The participant was provided with a password-protected 10” Android tablet configured for single-function use (i.e., only the EPIC Wheels program was accessible) along with a pre-synchronized mobile Wi-Fi device to provide Internet access. Two different tablets (Motorola™ XOOM and ASUS™ TF300) and mobile Wi-Fi devices (Huawei™ E587 and Sierra AirCard™ 763S) were used intentionally to ensure a spectrum of device compatibility and functionality.

The tablet home-program incorporated a variety of training components provided in video format. Participants viewed videos from one to five minutes in length that provide education and demonstration of specific wheelchair mobility skills. Additional videos required participants to practice demonstrated skills for a prescribed period of time using an on-screen timer with a start/stop function. Other videos incorporate interactive games and activities where participants performed maneuvers in response to, or synchronous with, the video content. The training videos were structured to encourage repetition and variation of skill performance consistent with motor learning principles. Skills were broken down into sub-components and progressed from simple to complex. The initial section contained five “chapters” with detailed information and instruction related to safety, injury prevention and care provider “spotting”; subsequent sections were inaccessible until the safety section was completed. The remaining four sections covered wheelchair components and body positioning; propulsion strategies; basic skills, such as turning around and negotiating obstacles; and advanced skills, such as ascending and descending thresholds and inclines, crossing gaps and soft surfaces, negotiating doorways, and managing curbs and stairs.

Trainees were instructed to practice at home 4-5 days per week in 15-30 minute sessions, for a minimum total of at least 75 minutes each week, but encouraged to try for 150 minutes. All tablet activity was internally recorded and uploaded to a secure server, which the trainer could access online. Every 24 hours, when the trainee engaged the program, two prompting questions were posed, requiring a response. The first question was "*Did you have any tips or falls?*"; if the response was yes, trainees received an additional prompt to contact their trainer. The second question was "*Since your last session, did you do any training on your own?*" If trainees selected yes, they received an additional prompt to input the number of minutes spent practicing without the tablet (in 5-minute increments). Trainer and trainee could exchange voice messages from their respective computer and tablet. Monitoring the data, the trainer could initiate contact if concerns arose (e.g. if there was no training activity for 2-3 days) or adapt content of the second education session (e.g. if the trainee was advancing quickly through the progression of skills). After two weeks of home training, the trainee attended a second in-person education session 1 hour in length. The trainer reviewed home program activities and provided additional, more advanced skills training, with the trainee continuing their home program for another two weeks.

As there are inherent safety risks with wheelchair use, primarily related to tips and falls, several safety strategies were employed. Participants were encouraged to bring a care provider to the in-person training sessions and have them supervise higher-risk training activities at home. Safe "spotting" and supervision instruction was provided at the first training session along with a spotter's strap (to prevent rearward tips) for home use. In addition, the introductory six-part Safety section must have been viewed in its entirety before trainees could advance to subsequent content.

3.3.2.4 Data collection and analysis

Dates for completion of each study component were documented and intervals calculated. The study tester administered D1 and D2 in accordance with a detailed protocol binder and corresponding checklist. The first author confirmed procedural and scoring accuracy via video recordings; any discrepancies or errors were reviewed with the tester and additional training provided if necessary. If procedural issues arose, these were documented and protocols modified. The principal clinical outcomes of the intervention were wheelchair skill capacity and safety, as measured by the Wheelchair Skills Test [WST 4.1] (Dalhousie University, 2012), as well as wheelchair-specific self-efficacy, as measured by the Wheelchair Use Confidence Scale [WheelCon-M 3.0] (Rushton, WC, Kirby, Eng, & Yip, 2011). The WST is a standardized, performance-based measure of 32 skills. Skills are evaluated dichotomously (pass = 1; fail = 0) on a Capacity sub-scale and a Safety sub-scale, with each sub-scale scored between 0-32. The WheelCon-M is a 65-item questionnaire in which respondents rate their confidence using a wheelchair in various activities and environments on a scale from 0 ("not confident") to 100 ("completely confident"). A mean confidence score, between 0 and 100, is calculated by dividing the total by the number of responses.

The trainer administered T1 and T2 in accordance with a detailed protocol binder and corresponding checklist, with the first author again confirming accuracy via video recordings and addressing issues with the trainer or revising the protocol. The study trainer and completed a post-treatment evaluation form and interview with the first author.

The EPIC Wheels software documented all tablet interactions with a time stamp and uploaded this data to the trainer website on a secure server. Training activity data (in minutes) were tabulated for each day and imported into an Excel spreadsheet. From this data, we were able to calculate the total number of days and minutes of training; mean number of days per week in training; minutes per week training; and minutes per training day. Responses to the daily safety question prompt “Did you have any tips or falls” are also recorded. When technical issues arose with the tablet or mobile Wi-Fi device, trainees contacted their trainer via the tablet voice-messaging feature. If the trainer was unable to resolve the issue, the first author attended to the trainee’s home to troubleshoot the problem and document how it was resolved. Based upon the data analysis and feedback from trainer and trainees, the development team explored any further changes or revisions that could improve functionality or feasibility of the program.

After finishing all data collection at D2, trainees completed a 9-item post-treatment questionnaire evaluating elements critical to rehabilitation intervention development (Zauszniewski, 2012; Tate, 2006) on a 4-point Likert scale from 1 (strongly disagree) to 4 (strongly agree). Following this, an exit interview was conducted to obtain additional qualitative feedback about the participant’s experience. The interviews followed a semi-structured format 15-20 minutes in length. In addition, Participant 1 shared written feedback related to program content, which he had brought to the D2 session.

The trainer completed a post-treatment questionnaire after finishing with each participant. Five dichotomous questions (yes/no) related to clarity, timeliness, issues with and major/minor deviations from the intervention protocol, and an option for narrative explanation. An informal exit interview was conducted with the trainer after Participant 2 had finished the study, approximately 15 minutes long and employing an unstructured format. The trainer was invited to share her experience with the training intervention and explicate both benefits and shortcomings.

3.3.3 Results

3.3.3.1 Accurate, effective and safe administration of the program

All study components were completed within the prescribed time allocations (see Table 3.4).

Table 3.4 Phase 2 completion times (days) for study components

Event Interval	Evaluation Metric	Participant 1	Participant 2	Outcome
D1 – T1	≤ 7 days	5	6	Confirmed
T1 – T2	14 ± 2 days	14	13	Confirmed
T1 – D2	28 - 35 days	28	29	Confirmed
D1 – D2	≤ 42 days	33	35	Confirmed

Administration of the data collection sessions (D1 and D2) was consistent with protocol guidelines (see Table 3.5). With participant 2, there was insufficient time to administer the WST twice at D1. As a result, the protocol was revised to a single WST administration.

The in-person training sessions (T1 and T2) were conducted within the specified parameters (see Table 3.6). The trainer indicated no major/minor deviations or issues with administering the intervention and confirmed satisfactory timeliness and clarity of process with both participants. At T1, the Wi-Fi device was not set-up until after the tablet program orientation; consequently, the trainer was unable to demonstrate the daily prompting questions, and instead relied on verbal instruction along with illustrations from the printed user guide.

Table 3.5 Administration of data collection procedures

Component	Evaluation Strategy	Evaluation Metric	Outcome
Administration consistent with protocol binder	D_1 and D_2 video recorded; reviewed within 3 days	Any errors or issues noted and addressed or protocol revised	Confirmed
	Protocol checklist	All items completed and checked	Confirmed[a]
Administration of outcome measures	Measures re-scored by PI via video recording	Errors or issues noted; addressed with tester or additional training	Confirmed
Administration burden	Tester documented time to administer; PI confirmed via video recording	D_1: 120 ± 10 min P1 = 122 min P2 = 114 min D_2: 60 ± 10 min P1 = 51 min P2 = 69 min	Confirmed[a]
Safety	Adverse events reported	No adverse events	Confirmed

[a] Modification made to the D1 protocol to administer the primary outcome (WST) once, rather than twice, to reduce burden and administration time.

Table 3.6 Administration of the in-person training procedures

Component	Evaluation Strategy	Evaluation Metric	Outcome
Administration consistent with protocol binder	T_1 and T_2 video recorded; reviewed within 3 days	Any errors or issues noted and addressed or protocol revised	Confirmed
	Protocol checklist	All items checked and completed	Confirmed[a]
	Breaks from protocol	No breaks, else protocol revision	Confirmed
Administration burden	Trainer documented time to administer; PI confirmed via video recording	T_1: within 120 ± 10 min P1 = 123 min; P2 = 101 min T_2: within 60 ± 10 min P1 = 60 min; P2 = 70 min	Confirmed
Safety	Adverse events reported	No adverse events	Confirmed
Trainer Acceptability	Post-T_2 Questionnaire: - Major/minor deviations - Protocol is clear - Reasonable time - Issues with protocol	 NO (or revise protocol) YES (or revise protocol) YES (or revise protocol) NO (or revise protocol)	Confirmed

[a] Modification made to the T1 protocol to set-up the WiFi device prior to tablet training to enable demonstration of the prompting questions.

3.3.3.2 Training protocol adherence

With respect to adherence to the home program expectations, the frequency of training (days spent training each week) was 4, 3, 4 and 4 (total = 15 days) for participant 1 and 6, 5, 3 and 6 (total = 20 days) for participant 2. The intensity of training (mean minutes per training day) was 36.9 minutes for participant 1 and 30.4 minutes for participant 2. In terms of training dosage, participant 1 spent a total of 553 minutes in home training (Mean = 138.3 minutes/week) while participant 2 spent a total of 608 minutes training (Mean = 152.0 minutes/week). Both participants exceeded the minimum of 75 minutes per week and participant 2 met the preferred threshold of 150 minutes. Training time was further delineated (see Table 3.7) into education and practice (video-related training with the tablet); timed training activities (tablet timer used during training activity); and non-tablet training (independent training retrospectively documented on the tablet). Neither participant reported any adverse events or injuries during home training; there were no affirmative responses to the prompting question "*did you have a tip or fall*".

3.3.3.3 Program benefit and acceptability

The principal clinical outcomes of wheelchair skill capacity and safety as well as wheelchair-specific self-efficacy are presented in Table 3.8. Participant 1 (i.e., ,the experienced MWC user) demonstrated no change in wheelchair skill and safety, but his self-efficacy score increased by 5.9%. Participant 2 (i.e., the novice MWC user) had improved scores in skill capacity (12.5%), safety (3.2%) and self-efficacy (7.2%).

Table 3.7 Delineation of home program training time (minutes)

	Education & Practice	Timed Activities	Tablet Total	Non-Tablet Training	Grand Total
Week 1					
Participant 1	71	8	79	10	89
Participant 2	110	55	165	65	230
Week 2					
Participant 1	97	31	128	40	168
Participant 2	47	24	71	0	71
Week 3					
Participant 1	103	34	137	20	157
Participant 2	67	0	67	30	97
Week 4					
Participant 1	110	29	139	0	139
Participant 2	169	16	185	25	210

Table 3.8 Wheelchair skill capacity, safety and self-efficacy scores (%)

Measure	**Participant 1**		**Participant 2**	
	Baseline	Post-intervention	Baseline	Post-intervention
WST – Capacity	24 (75.0%)	24 (75.0%)	18 (56.3%)	22 (68.8%)
WST – Safety	32 (100.0%)	32 (100.0%)	29 (90.6%)	30 (93.8%)
WheelCon-M	79.3	85.2	63.9	71.1

A summary of participant responses to the post-treatment questionnaire is detailed in Table 3.9. During the post-treatment interview, participant 1 indicated the program was "excellent" and would have been beneficial to him during his initial transition to wheelchair use. He stated the training activities were "fun and engaging", some of which he had modified on his own to increase the complexity and challenge given his existing level of skill proficiency. One observation he made was the uncertainty around how far he was through a given training video. Videos were limited to play, pause and stop functions and the participant didn't know how much running time had passed or was remaining. Participant 2 reported a number of areas of specific skill improvement including propelling over high resistance surfaces and maneuvering around corners. He highlighted the comfort and ease he now had with "popping his casters" to get over small obstacles in his home and community, and reflected on how this had seemed an impossibility to him during the baseline assessment.

During the exit interview, the trainer highlighted the value of being able to monitor participant training activities online to identify potential problems (e.g. no training activities for several days) and adapt the intervention content and goals based on participant progress. However, the trainer identified that data was collated into daily totals and did not explicate multiple sessions within a given day. In addition, the details of training activity (i.e., specificity and frequency of which components participants engaged in) were not available. These shortcomings were identified as a limitation to capturing a full picture of participants' training activity. Participant 2 reported several occasions when the voice message function failed to send and receive messages, compelling him to contact the trainer via telephone. The trainer also identified extended time periods between participant practice data uploading to the website. This also proved to be frustrating for the participant because his training time was not included in the progress window. Two additional visits were made to the participant's home to diagnose an issue with the Wi-Fi timing out, resulting in the tablet losing Internet connectivity. Revision to the tablet and Wi-Fi configuration settings resolved this issue.

Table 3.9 Post-treatment questionnaire responses by participant 1 and 2

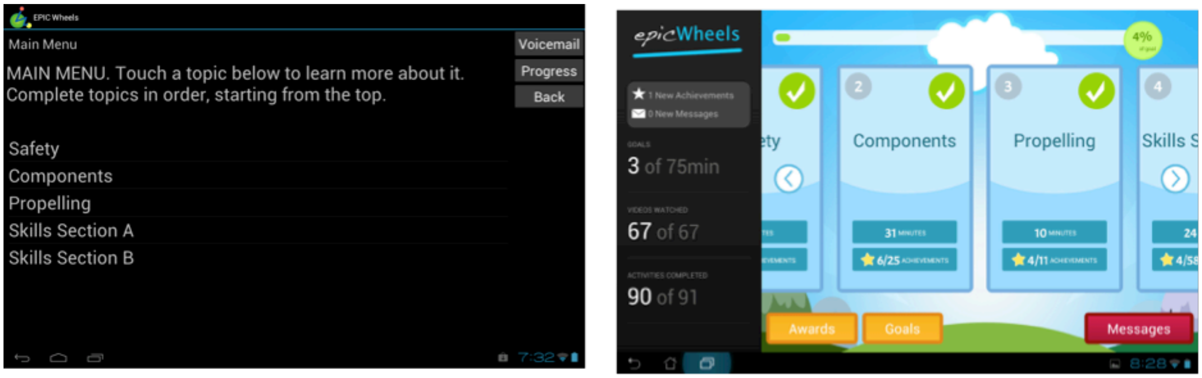
Item	Strongly Agree	Agree	Disagree	Strongly Disagree
Training is valuable or important	P1, P2			
Method of training was reasonable and appropriate	P1	P2		
Skills taught were reasonable and appropriate	P1	P2		
Trainer was reasonable and appropriate	P1, P2			
Expectations were manageable and practical		P1, P2		
Components of program provided as described	P1	P2		
I was able to perform or improve skills taught	P1	P2		
I did not experience injury or undue physical/mental stress	P1	P2		
Program was successful in improving my skills	P2	P1*		
Total	10	8	0	0

P1 = Participant 1; P2 = Participant 2
* This participant self-modified some of the activities to increase the challenge/difficulty

3.3.3.4 Changes and enhancements to the program

While neither trainee identified overwhelming concerns with the user interface, conveying participant practice data and progress was an issue for both trainee and trainer. Improved navigation of the program and individual training videos were also identified as desirable. While both participants rated all components of the post-treatment questionnaire as at least satisfactory, additional information and improved aesthetics might further enhance adherence and usability in the subsequent trial, which would be reflected in future evaluations. Consequently, several modifications were made to the home program. The user interface was upgraded with a more colorful and dynamic appearance, consistent with other consumer applications (Figure 3.6).

Figure 3.6 Trainee interface pre- and post-pilot versions



Participant progress information was provided in constant display, rather than having to open a new window, and included not just the number of minutes practiced but the number instructional videos viewed, activities completed and a progress bar for the current training week (Figure 3.7, red highlights). Following completion, training components now display a visual check mark (to simplify navigation to the current training activity) and a gold star (Figure 3.7, blue highlights). The gold stars cumulatively earn progress awards, which are delivered to the participant and can be viewed in a dedicated Awards window (Figure 3.7, green highlight and Figure 3.8).

Figure 3.7 Participant progress display pre- and post-pilot versions

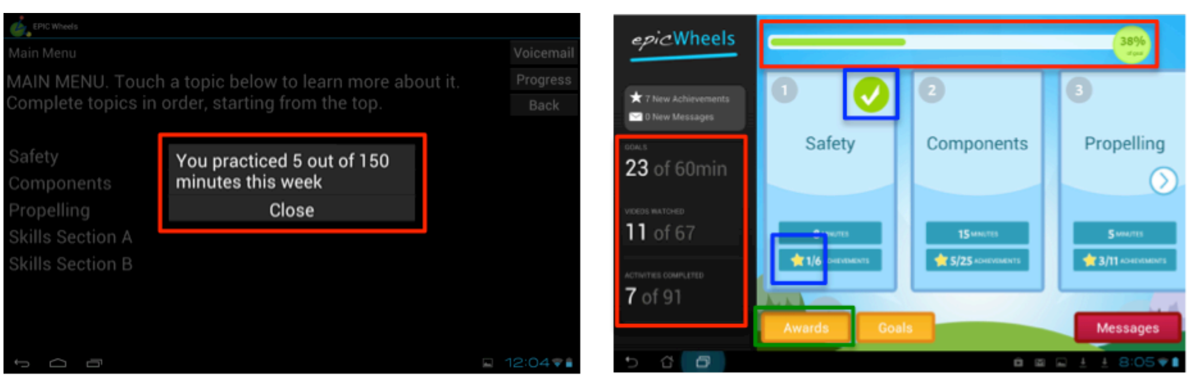
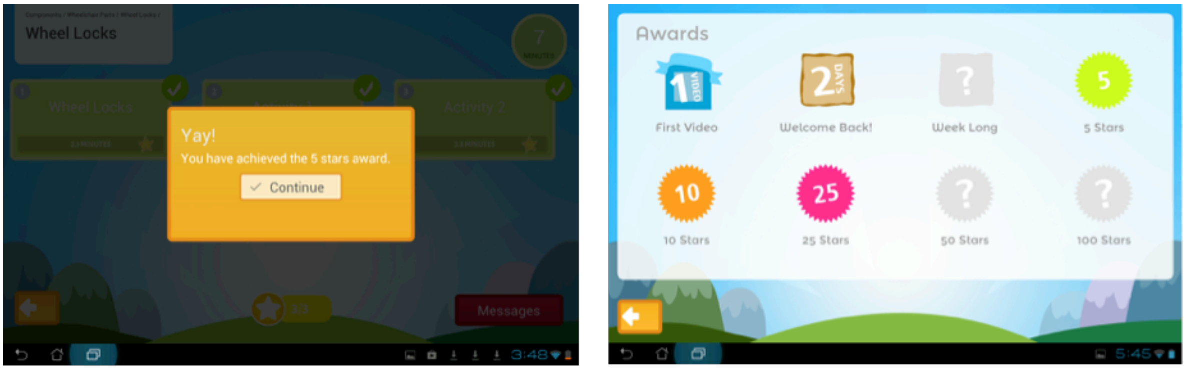


Figure 3.8 Award pop-up with awards earned windows in post-pilot version



The window for displaying training information and activities was modified to improve appearance and easier navigation (Figure 3.9). In particular, a "scrubber bar" was introduced to identify progress through the activity and allow trainees to easily navigate forward and backward. For timed training activities, the monochrome Start/Stop button was replaced with a larger, colourful button with more detailed directions and a clock with running time. It is anticipated that these modifications will provide better visibility and comprehension for older adult users, and promote greater adherence to the suggested training time.

Figure 3.9 Training activity window with timer pre- and post-pilot versions

Based on trainer suggestions and discussion among the study team, the format and content of the trainer website was modified to improve usability and appearance. The original site displayed a simple table with only total minutes spent in tablet activity on active training days, and a running total (Figure 3.10). The revised site displayed multiple session on a given day in table format, as well as a quick view graphic breakdown for the types of training done (e.g. viewing educational videos, engaging in training activities, practice without the tablet). By scrolling down the page, the trainer can view additional graphic and tabular data explicating trainee usage for each home-training session (Figure 3.11). For each training component the number of days accessed, time accessed, total views, length of time viewing, and associated time practicing is now available.

Figure 3.10 Trainer website pre- and post-pilot testing versions

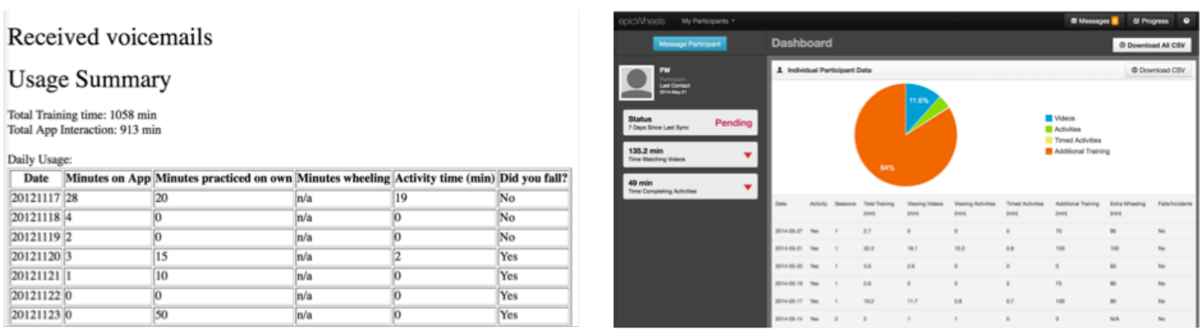
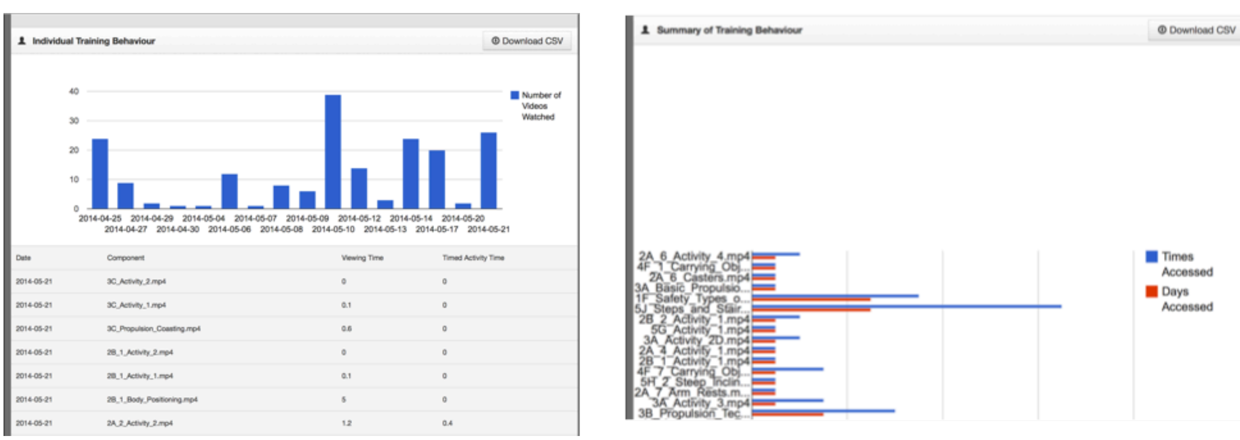
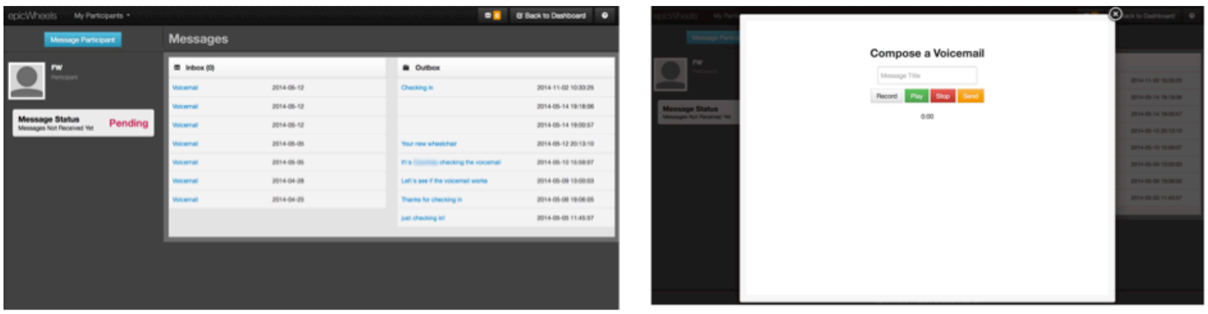


Figure 3.11 Trainer website features



The voice-messaging software was restructured to utilize a more robust commercial application that did not require extensive configuration to the trainer's computer and provided more efficient and reliable performance. The trainer website was also revised to incorporate a simple and intuitive voice-message user application that included the option of a subject line (Figure 3.12).

Figure 3.12 Trainer voice messaging applet



3.4 Discussion

The objectives of phase one, including development of a viable prototype, were successfully achieved. Older adult MWC users were engaged throughout the design and implementation process and all stakeholder groups provided substantial contributions to development the prototype. Focus groups were particularly useful as they facilitated interaction and discussion among participants. The contributions by participants were well distributed and relatively equitable. The dialogue was often animated and engaging; there was generally consensus in the discussion but this did not preclude debate. While this made analysis more challenging, the outcome was a richer and more comprehensive product with greater potential for application to a broad audience.

The PAD framework proved to be a valuable approach to creating the EPIC Wheels program. We were able to engage consistent stakeholder in put over time. For example, all but two of the MWC users were able to attend both focus groups and a representative from the MWC user and the Clinician group were involved in the final review process. In addition, one MWC user who was expressed interest but was not able to participate in the focus groups served as a phase two pilot study participant. The iterative consultation process provided critical input into the evolving content and user interface. Incorporating a number of stakeholder groups provided validation for relevance and appropriateness of the included content. The MWC users confirmed the scope of skills included was comprehensive. They also contributed to inclusion of additional material, such as the task of carrying an item while propelling a wheelchair, which had not been included in any existing structured training program (Dalhousie University, 2012). Care providers negotiated that training content around some high-level skills (e.g. wheelies and ascending steps) be restructured with assisted, rather than independent, strategies. The clinician groups confirmed skills that were most enabling and often neglected among older adults, such as transient wheelies, and provided input on teaching strategies.

The critiques and recommendations by stakeholders proved to be consistent with, and confirmatory of, the theoretical bases with which EPIC Wheels was created. Key components of self-efficacy, as proposed in Social Cognitive Theory (Bandura, 1997), were evident. The sequencing of skills from basic to advanced and the inclusion of multiple training activities for each skill graded from simple to complex provided opportunity for successful skill performance, or *mastery experience*, which has the strongest influence on self-efficacy (Bandura, 1986). Early success experiences induce confidence that more difficult skills are attainable, and enhance perseverance among trainees. Progress was monitored by trainers, who encourage skill advancement following successful performance but before proficiency, creating a “just right” challenge as proposed in the occupational therapy literature (Law, 2002; Nilsson & Durkin, 2014). The recommendation to include age-appropriate demonstrators of both sexes corresponds to *vicarious experience*, or the observation of a comparable peer achieving success in a given skill, which is the penultimate factor influencing self-efficacy (Bandura, 1986). Knowles (1980) also promotes the value of modeling to provide a rationale for older adults to pursue a specific skill, as it has been associated with improvement in skill performance (Callahan, Kiker & Cross, 2003). A third component is the encouragement of meaningful others, or *verbal persuasion*. Stakeholders advocating for regular monitoring and follow-up by the trainer and for inclusion of spotting, training and feedback strategies specifically for care providers in the EPIC Wheels program were particularly relevant in this regard. Finally, appropriate management and interpretation of one’s *physiological and emotional state* is important to wheelchair self-efficacy. Confidence can be impeded by both physical symptoms, such as pain or fatigue, as well as emotional states such as anxiety, stress and mood. The recommendation to include games and engaging training activities was intended to increase motivational investment while distracting trainees from the physical demands of performing mobility skills. We also included information on self-monitoring physical expenditure, including information on the BORG Perceived Rate of Exertion scale (Borg, 1998) and parameters for not exceeding the recommended level of “somewhat hard” during training, based on best practice guidelines (Cress, et al., 2005).

Stakeholders also provided input that aligned with Andragogical principles. Adult learners, particularly older adults, prefer an autonomous and self-directed approach that is goal-oriented and respectful (Davis & Chesbro, 2003). Trainees could control the time and location of training activity and receive continuous updates on the number of components completed and total time spent in practice. Flexible navigation ensured trainees could control which specific skills they wanted to work on, advancing when they felt ready and revisiting material if desired. Trainers assisted in prioritizing skills most relevant to trainee goals and activities of interest. Providing a rationale for each skill in relation to specific occupations of interest, inclusion of typical daily activities and commonplace equipment for practice, and demonstration of incorrect performance with the resultant hazards offered a practical and life-experience approach to learning consistent with Andragogical principles. Use of a computer tablet involves some new learning, and age-related declines in memory and fluid intelligence may impact use. These issues were addressed through self-paced training structured for success experiences to build confidence and adapting the interface design for familiarity and ease of use with minimal memory requirements (Callahan, Kiker, & Cross, 2003; Jay & Willis, 1992).

Using the prototype developed, the results from phase two demonstrated that, with minor revisions, the EPIC Wheels program could be implemented in a clinical trial. Study feasibility depends upon procedures being consistent and efficient. The administration of all data collection and treatment intervention procedures fell within the prescribed timelines for both pilot participants. Data collection was conducted accurately with no safety concerns or incidents. The original plan was to administer the primary outcome (WST) twice at baseline to optimize stability of the measure, increase precision, and control for a learning effect (Friedman, Furberg, & DeMets, 2010). However, we chose to modify the protocol to a single administration as the implications for participant burden and potential for fatigue to impact performance on both the physical and questionnaire measures was deemed a greater risk. Similarly, the training intervention was administered accurately with no incidents or injuries. A minor protocol revision was instituted following the pilot study. The trainer would now initiate Wi-Fi connectivity prior to the tablet orientation to ensure the daily prompting questions appear, allowing the trainer to physically demonstrate this feature rather than merely describe it. In summary, the procedures for data collection and intervention administration were accurately, efficiently and safely conducted within the anticipated timelines.

Viability of the EPIC Wheels program with multiple Android tablet and mobile Wi-Fi devices combinations was confirmed. Intermittent connectivity issues with the mobile Wi-Fi devices required troubleshooting during the home training component of the study until a satisfactory configuration was obtained. As a result, tablet/Wi-Fi device specifications were documented to optimize setup for future participants. In addition, printed user guides were created for each tablet/Wi-Fi device combination. Ideally, using a participant's home Wi-Fi would eliminate most potential connectivity problems as well as the cost of renting a mobile Wi-Fi device (~$10/month). However, this requires configuration of tablet settings in-home, which can present several barriers. First, the tablet is configured as a single application device preventing participants from accessing other applications or tablet settings. This restriction can be overridden, but would require either a study administrator to visit the participant's home and make these adjustments (potentially requiring participants to reveal a security password), or convey these procedures to the participant. The latter option would necessitate the participant or surrogate possesses the capacity to operationalize the changes or study personnel to provide continuing technical support from a distance, and would increase the potential for additional untoward modifications or alternate use of the tablet. Second, home Wi-Fi availability is not ubiquitous, particularly among the target population of older adults. This was a concern raised by participants in phase one of this study. A recent survey estimates that in the United States, only 47% of seniors have high-speed Internet connectivity in their home (Pew Research Center, 2014). An alternative solution would thus be required for individuals without Internet access, as well as those with connectivity but no Wi-Fi service.

A second objective of phase two was to ensure the expectations of the home training program were reasonable and safe, and that participant adherence was feasible. Without confirming these elements, a valid evaluation of the intervention as intended in the subsequent RCT would be jeopardized. The participants agreed that the program expectations were reasonable and did not create undue stress or anxiety. Both participants met or exceeded the targeted parameters of adherence; participant 1 was slightly under the desired frequency of days practicing but exceeded the minimum session intensity and dosage metrics. Both participants spent nearly twice the minimum recommended time engaged in the mHealth program, training a total of approximately 10 hours over four weeks. Participant 1 had fewer practice sessions and spent slightly less time overall with the home program. However, given his level of proficiency with wheelchair use he may have been less motivated to engage in watching and practicing skills he had already mastered. Frequency of practice is a critical component in developing a motor skill (Schmidt, 1991). One advantage of using an mHealth (tablet-based) application, rather than a web-based program accessible only via a computer, is the flexibility it offers for participants to practice in varied contexts (O'Connor, Farrow, & Hatherly, 2014). The revision of the EPIC Wheels program to download all materials directly onto the device eliminated the need for Internet connectivity during training, and enabled further opportunity to practice at any time in any location. Neither participant reported any adverse events, including tips or falls; each agreed they did not experience undue mental or physical stress and the program methods and expectations were reasonable.

Adherence to the training program is closely linked to user perceptions of benefit and acceptability. Feasibility of an mHealth intervention with older adults depends upon whether participants will accept and persist using the mobile device and associated application. Not coincidentally, phase one participants had raised a concern about older adults' willingness and ability to learn and adopt tablet use. *Performance expectancy* is the strongest correlate of use behaviour. Both participants reported a belief that the program was valuable and successful in improving their wheelchair skills, suggesting that this belief had been engendered. The participants commented on the relative ease in operating the tablet and navigating the home program. *Effort expectancy*, or ease of use, is a key component of *initial* acceptance of information technologies (Venkatesh, Thong, & Xu, 2012). It is likely that investing one hour of orientation to the tablet during the first training session contributed to the smooth transition to home use. Inevitably, one would expect some issues in usability to arise, whether device- or user-related. Creating *facilitating conditions*, or having technical supports in place, influences both the intention to use a mobile device as well as use behaviour directly (Venkatesh, Thong, & Xu, 2012). Furthermore, the impact is moderated by both age and device experience, meaning our participants would require greater levels of support (Venkatesh, Thong, & Xu, 2012). The in-home visits (to correct the connectivity problems), tablet orientation session, bi-weekly follow-up phone call, and the voice messaging feature were all strategies employed to provide these conditions. The participants' affirmation of the trainer and the multiple follow-up strategies described above provide support for the impact of positive *social influence* on persistence with using the tablet program. Finally, both trainees described the mHealth platform as engaging and entertaining. The perceived enjoyment of a mobile device application, or its *hedonic motivation*, has be identified as being at least as influential as performance expectancy, although this effect is moderated down with age. It would be reasonable to assume that practicing most any motor skill repeatedly becomes mundane, and keeping the trainee engaged or even entertained plays some role in persistent use behaviour. In the program development phase, based on the recommendation of the older adults MWC users, we employed an individual with performance experience to narrate the video voice-overs. We also integrated a number of interactive games and activities with animations to provide a more entertaining and immersive training experience. In viewing the weekly tablet usage data, a positive trend was apparent with both participants, suggesting that the various determinants of intention to use contributed to creating a *habit* behaviour. Both trainees had higher rates of use in the final week than the initial week, and a positive trend was suggested by the weekly practice data. Whether this habituation was the result of increasing automaticity of action (i.e., participants developed a routine of using the tablet program) or whether they learned the benefit of regular usage and made a conscious intent to engage in tablet-based training is unknown; however, the underlying theoretical rationale for creating such habits is still a matter of some debate in the literature (Venkatesh, Thong, & Xu, 2012).

Uptake of the eHealth application by the trainer is also a concern, as the literature identifies that occupational therapists have been reluctant to incorporate information technology in their practice (Schaper & Pervan, 2007). The trainer confirmed that the time allotted to deliver the training program was adequate for both participants (both of whom had no previous tablet experience). The trainer indicated that the website provided useful and relevant data for basic monitoring of trainee progress; however, additional detail about the specificity of training activities and multiple daily sessions would be desirable. Delays in data upload to the website were concerning as the trainer could not ascertain whether the participant was not actually engaging in any training or whether this data was simply not being reported. The voice-messaging issues proved to be frustrating for the trainer as well, but having a member of the research team available to attend to the participant's home and resolve such technical issues alleviated much of this concern. A recent study by Liu et al (2014) examined occupational therapists' acceptance of intervention-based technologies in the workplace. The authors found a statistically significant relationship between behavioural intention and performance expectancy (β=0.585, p=0.000) as well as facilitating conditions and technology use (β=0.625, p=0.000); however, no significant relationships were observed for effort expectancy or social influence. These results would support the study findings that our trainer was not discouraged by the challenges encountered, but rather embraced the supports provided by the research team and the positive impact the program appeared to have for the participants to engage and persist with the intervention.

While evaluation of clinical outcome was not the primary purpose of the pilot study, the objective measures of program benefit were promising. Participant 1 was an expert MWC user and, as expected, did not improve in skill capacity or safety. However, he did show a small improvement in self-efficacy even after 40 years of experience. Participant 2, who was a novice user and representative of the target population, demonstrated improvements in skill capacity, safety and self-efficacy. The improved wheelchair skill scores suggest that the EPIC Wheels intervention could be effective in achieving the desired outcome. Furthermore, the improvement in self-efficacy seen in both participants supports the theoretical basis of the training program using Social Cognitive Theory constructs. Current evidence suggests that, in addition to wheelchair skill capacity, higher self-efficacy is positively associated with frequency of participation among older wheelchair users (Sakakibara, Miller, Eng, Backman, & Routhier, 2013). These positive evaluations regarding the EPIC Wheels intervention appear reasonable, given that both participants experienced improvement in self-efficacy and the novice MWC user increased his capacity and safety with wheelchair use. Since most telerehabilitation and mHealth interventions target behavioral or cognitive skills and strategies, this pilot study was particularly useful in providing initial evidence to support mHealth application to motor skill improvement.

3.5 Limitations

Several limitations identified in chapter 2 are also relevant in this study. Using two separate sites to access all three stakeholder groups provided diverse perspectives and opportunity for data triangulation; however, additional and non-urban sites may have offered a more comprehensive evaluation during the development stage. The rationale for using experienced MWC users and care providers for experienced MWC users is articulated in the methods section. Involving novice MWC users and their care providers could have provided additional insights into what might be most useful in a training program during this transitional period. The use of individual interviews, rather than a focus group format, might have provided more detailed responses and allowed greater freedom for participants to articulate critical or divergent opinions from the social norm (Kitzinger, 1995). One might equally argue that the group setting provided a safer venue for participants to verbalize critical views, where stakeholders outnumbered investigators, rather than a setting where they were meeting individually with investigators. Focus groups do pose a threat to the opportunity for individuals to fully participate, depending upon whether some individuals dominate the exchange. The data provided in Table 3.1 and Figure 3.3 suggest that among the MWC user group there was relative parity in both verbal participation and contribution of ideas.

As mentioned in the previous chapter, Krueger and Casey (2000) recommend 6-8 participants as an optimal number for focus groups to balance the group dynamic of generating exchange and discourse with the opportunity for sufficient individual engagement and sharing. While the development stage incorporated a comprehensive number of stakeholder groups, the smaller number of participants, particularly in the care provider groups, could have limited the scope of issues identified in the implementation and acceptability of the mHealth intervention. Recruitment of care providers was challenging. We explored many avenues to access this group, such as advocacy groups, disability organizations and MWC users who we encountered in our recruitment for the MWC user group. Because the timing of all three stakeholder focus groups fell within a restricted window, to accommodate the evaluation and feedback process, we were compelled to move forwards with the care provider focus groups as they were composed. The clinician groups were somewhat larger than the recommended size and this might have prevented participants from full opportunity to share their perspectives within the timeframe of the session.

The pilot-testing phase was conducted with two participants, one novice and one experienced user. Increasing the number of pilot participants, particularly the number of individual from the target population of novice MWC users, might have provided additional information and uncovered other issues requiring modification before moving into a feasibility study. The evaluation structure and questionnaires were developed in-house with specificity to address usability and implementation issues of concern; however, the use of validated evaluation formats and measures would enhance the generalizability of results and future studies should endeavour to employ them. I conducted the post-intervention interviews with participants and they may have been reluctant to express concerns or criticism because of the relationship established during the study. A more extended interview with a structured guide or a series of interviews throughout the pilot study might have elicited additional information from participants related to program attributes and factors contributing to success. Participant 2 subsequently provided a separate interview with a public access television station and expressed a comparably positive evaluation of the EPIC Wheels program [link to YouTube video].

3.6 Conclusion

A Participatory Action Design process proved valuable in the development and refinement of a tablet-based wheelchair skills home training program. The involvement of older adult wheelchair users, as well as care provider and clinician stakeholders, was critical to achieving a product that was both comprehensive and acceptable to the target users. The contributions of these research partners confirmed the underlying theoretical principles of self-efficacy and adult learning theory upon which the program was developed. The pilot study confirmed feasibility of administration, with minor adjustments to the protocol. The two participants reported positive impressions of the intervention and uptake of the mHealth program was promising as factors consistent with theoretical determinants of mHealth use behaviour were apparent and program adherence was acceptable. The clinical prototype that emerged from the phase one development study and evaluated in the phase two pilot study was sufficiently robust to move forwards with a feasibility randomized controlled trial study.

4. Phase 3: Feasibility evaluation of the EPIC Wheels program[c]

[c] A version of this chapter has been published.
Giesbrecht, E., Miller, W.C., Eng, J.J., Mitchell I.M., Woodgate, R.L., and Goldsmith, C.H. (2013). Feasibility of the Enhancing Participation In the Community by improving Wheelchair Skills (EPIC Wheels) program: study protocol for a randomized controlled trial. *Trials, 14*, 350. doi:10.1186/1745-6215-14-350.

4.1 Introduction

Whyte et al (2009) advocate for a systematic approach to evaluation in rehabilitation, to ensure that interventions are well founded before undertaking costly clinical trials. The findings of the EPIC Wheels development study, reported in the chapter three, indicated that the tablet-based training program content and delivery method were acceptable to two pilot study participants: a new MWC user and an experienced MWC user. The involvement of the various stakeholder groups throughout the process of program development and initial evaluation, using a Participatory Action Design approach, was an important factor in achieving an acceptable and useful outcome.

The use of a computer tablet to deliver the home training program offers advantages of portability, audio-visual versatility, flexible configuration and real-time updating. Using a tablet involves some new learning, and age-related declines in memory and fluid intelligence may restrict uptake. These issues are addressed through self-paced training, structures for success experiences to build confidence, and by adapting the interface for familiarity and ease of use with minimal memory requirements (Callahan, Kiker, & Cross, 2003; Jay & Willis, 1992). Consumer, care provider and clinician input was incorporated during EPIC Wheels program development to ensure the delivery format addresses these concerns. In addition to finding both objective and subjective benefits from the EPIC Wheels intervention for the two pilot study participants, the protocols for administration of the data collection and intervention procedures were deemed acceptable. In addition to the clinical impact of a rehabilitation intervention, an economic evaluation of its delivery is also an important consideration. The Health Utilities Index (HUI) is a health-related quality of life measure that can provide data to ascertain cost-effectiveness (Canadian Agency for Drugs and Technologies in Health, 2006); however, prior to undertaking such an evaluation, we need to determine whether this measure can be administered efficiently and capture a measurable change with this specific population and intervention. Given the pilot study's confirmation of the viability of the EPIC Wheels program and its implementation reported in the previous chapter, the next logical step was to conduct a feasibility randomized controlled trial (RCT).

A feasibility study is intended to establish viability of the study design, testing and intervention delivery procedures, and potential recruitment and retention rate estimates, as well as obtain some quantitative estimate of measureable change and determine the acceptability and perceived benefit of the intervention in preparation for a larger clinical trial (Thabane, Ma, & Chu, 2010; Arain, Campbell, Cooper, & Lancaster, 2010). Prior to undertaking a large-scale clinical trial, which can be expensive and time-consuming, an evaluation of feasibility is prudent. A feasibility study can confirm whether the procedures are sufficiently robust and if the recruitment rate is adequate for a subsequent study. An estimation of the treatment effect can be undertaken through the collection of outcome measure data to determine whether an intervention has potential benefit (Bowen, et al., 2009), although such clinical findings are typically treated cautiously due to the small sample size and preliminary nature of the investigation (Arain, Campbell, Cooper, & Lancaster, 2010). Accordingly, the phase 3 EPIC Wheels feasibility RCT was undertaken to address these three priorities of administration feasibility, clinical outcomes and perceived impact, with chapters 4, 5 and 6 addressing these issues in sequence.

Historically, feasibility studies have incorporated a diverse variety of evaluative factors (Arain, Campbell, Cooper, & Lancaster, 2010), with wide variability and little consistency between studies (Thabane, Ma, & Chu, 2010). Such studies should incorporate specific criteria upon which feasibility is evaluated. Van Teijlingen et al (2001; 2002) have proposed some structural organization and variables for consideration in the construction of a feasibility study design. Accordingly, this study incorporated the categories of process, resource, management and treatment outcomes as a framework to capture the critical elements of study feasibility, as recommended in the literature (Thabane, Ma, & Chu, 2010).

The purpose of this chapter is to report on feasibility related to conducting the EPIC Wheels study. The specific objectives are to evaluate and report on the following feasibility indicators:

1. Process issues related to recruitment, consent, retention and adherence;
2. Resource issues related to data collection burden, training burden, and use of the Health Utilities Index;
3. Management issues related to equipment reliability, participant processing and treatment administration; and
4. Treatment issues related to safety, dose-specific response, and perceived benefit.

4.2 Methods

4.2.1 Study design

One value of a randomized controlled trial is the strength of design to establish that a participant benefit is due to the *specific* treatment rather than treatment generally (e.g. a placebo benefit or improvement that results from engaging in some activity or interaction with a therapist) through the use of a control group (Moffett, 1991). In the case of the EPIC Wheels intervention, several confounding factors could potentially impact mobility-related outcomes for the study participants. The premise that the intervention was focused on wheelchair mobility could, in and of itself, motivate participants to attend to wheelchair activity and operation, much like the arrival of New Years Day can initiate increased exercise activity for some individuals. The attention from, and interaction with, a trainer could also increase participant motivation and elevate their mood, potentially increasing their attention to wheeling activity.

The use of a tablet device as part of the EPIC Wheels intervention could have an influential impact if participants were engaged by this new technology and increase attention to the intervention because of the delivery method. Consequently, the control group intervention was configured to address these specific variables by closely matching the number, duration and type of contacts with the trainer and providing a parallel intervention via a computer tablet (Portney & Watkins, 2009). The specific intervention provided to the control group was designed to have a conceivable impact on their wheelchair mobility skills. There is substantial research related to the use of cognitive and commercial computer games to effect clinical benefits in rehabilitation, although the results are generally task-specific and the generalizability to functional benefits is more equivocal (Kueider, Parisi, Gross, & Rebok, 2012; Pichierri, Wolf, Murer, & de Bruin, 2011). Thus, cognitive training using computer games provided a conceivable intervention to improve wheelchair mobility skills, thereby achieving some degree of clinical equipoise. However, because the treatment group participants were required to perform specific tasks *with* their MWC (which the control group participants were not), an argument could be made that any benefit realized through EPIC Wheels might simply be the result of increased MWC use, rather than specific program content or delivery strategy (i.e., the active ingredients). To address this dilemma, an expectation of increased wheelchair use was introduced as a second intervention variable, such that participants would be randomly assigned to treatment/control and also extra-wheeling/no extra-wheeling. This additional factor would enable between-group comparisons for the primary factor (i.e., EPIC Wheels or cognitive training) and a secondary factor (i.e., extra wheeling or not), as well as a potential interaction (e.g. does additional wheeling enhance or diminish the impact of the EPIC Wheels intervention) (Portney & Watkins, 2009).

This study used a two-site pre-post RCT design to compare differences in mobility-related outcomes for older adult wheelchair users between an EPIC Wheels (treatment) group and a cognitive training (control) group, introducing "extra wheeling" as a second factor. A 2 x 2 factorial design randomly assigned subjects using a 1:1:1:1 allocation ratio between four groups: EPIC Wheels, EPIC Wheels + extra wheeling, cognitive training, and cognitive training + extra wheeling. To support balance between groups and masking of assignment, a central computerized randomization algorithm was designed by a statistician, with an undisclosed block size and stratified by site with a target of 22 participants at each site. After enrolment, a Tester collected baseline data, after which the site Coordinator contacted the statistician to obtain group assignment. Once allocated, an initial in-person training session was scheduled for each participant with the group-specific Trainer, followed by a 1-month home training program. A second in-person training session was conducted at the mid-way point (i.e., after 2 weeks of home training) and the Tester re-administered outcome measures after the home program was complete (see Figure 4.1). To address bias, subjects were instructed not to discuss their program; separate Trainers were used for the treatment and control groups at each site; and Testers were blinded to group allocation. A summary of the four intervention groups and associated components is provided in Figure 4.2.

This study was approved by the Research Ethics Boards at the University of British Columbia (Approval #: H12-02043) and the University of Manitoba (Approval #: H2012:330), as well as the Research Review Committee for regional health authorities at each site, and was registered as a clinical trial (ClinicalTrials.gov #NCT01740635). All study participants, including their care provider, provided informed consent prior to enrolment. The study was funded through a peer-reviewed operating grant from the Canadian Institutes of Health Research (#MOP-123240).

Figure 4.1 Feasibility RCT study design

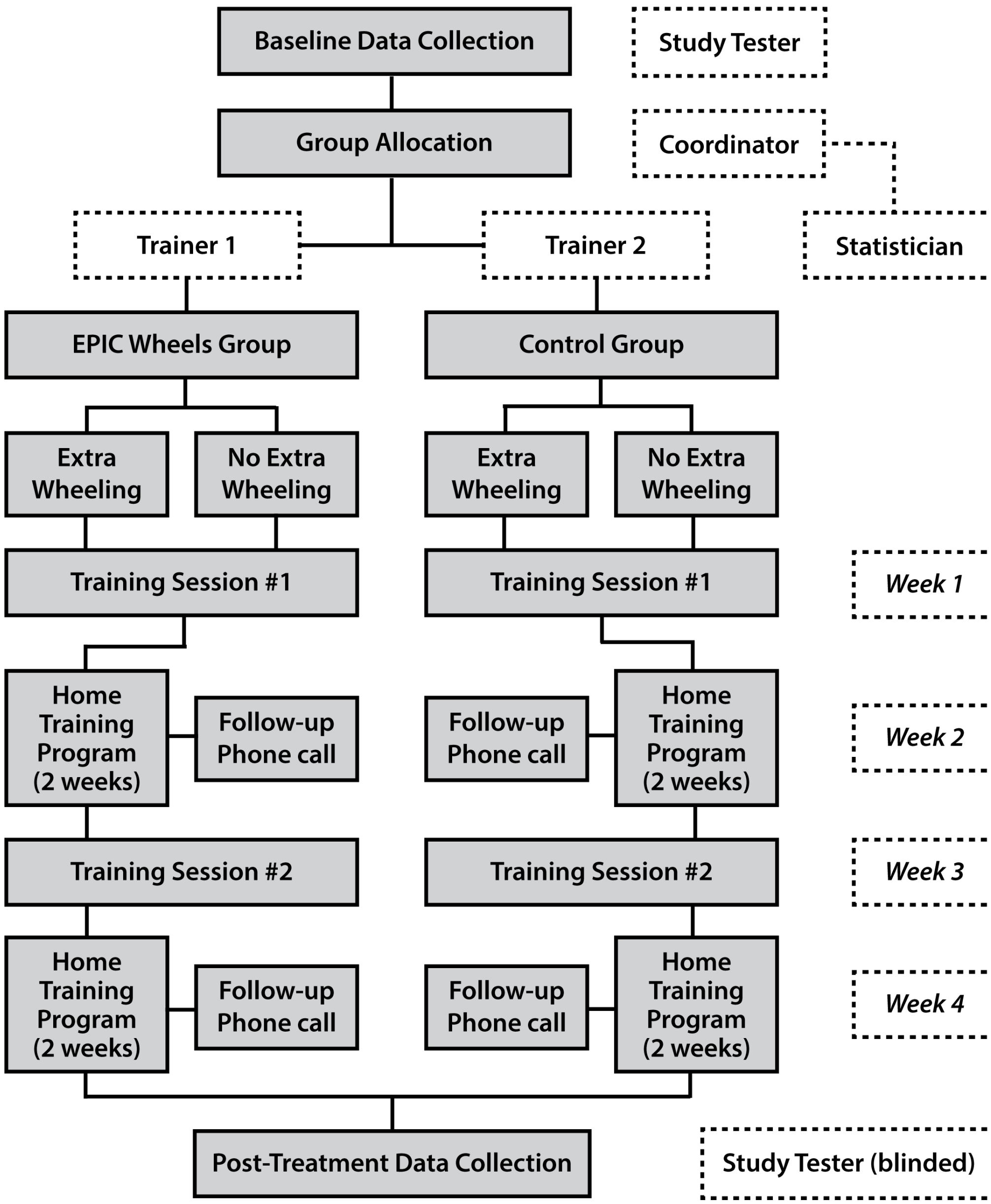


Figure 4.2 Summary of intervention groups and associated components

EPIC Wheels	**EPIC Wheels + Extra Wheeling**	**Cognitive Games**	**Cognitive Games + Extra Wheeling**
2 x 1:1 sessions with Trainer 2 follow-up phone calls 4 weeks home training • 300+ minutes practice	2 x 1:1 sessions with Trainer 2 follow-up phone calls 4 weeks home training • 300+ minutes practice • 300+ minutes extra wheeling	2 x 1:1 sessions with Trainer 2 follow-up phone calls 4 weeks home training • 300+ minutes practice	2 x 1:1 sessions with Trainer 2 follow-up phone calls 4 weeks home training • 300+ minutes practice • 300+ minutes extra wheeling

4.2.2 Participants

Community-dwelling MWC users living in two Canadian cities (Winnipeg and Vancouver) were recruited on a volunteer basis between March 2013 and September 2015. Initially, to optimize the impact of the treatment, individuals with less than one year of MWC use were recruited. Novice users are still developing routines and patterns of wheelchair use and potentially more amenable to adapting their mobility techniques (Coolen, et al., 2004). Due to slow recruitment, this criterion was adjusted to <2 years of use and then subsequently removed altogether. Initially, subjects were restricted to those ≥ 55 years old, but this criterion was also modified to ≥ 50 years old to address recruitment issues. Additional inclusion criteria required participants to live in the community within the metropolitan boundaries of each city; self-propel a MWC ≥ 1 hour/day on average; and use their MWC for mobility inside and outside their home. There were no specific diagnostic criteria for enrolment; however, due to the training content in the EPIC Wheels intervention, subjects were required to use both hands to propel their wheelchair (with or without use of their lower extremities). Individuals were excluded if they could not communicate and complete study questionnaires in English; anticipated a health condition or procedure that contraindicated training (e.g., surgery scheduled which would impair physical activity); or were receiving outpatient therapy that specifically included wheelchair mobility training. Participants were encouraged, but not required, to have a care provider present during the in-person and home training sessions.

To address the feasibility indicators, the number of participants should be large enough to represent the target population and assess the feasibility criteria (Tickle-Degnen, 2013). While the principal focus of the study was feasibility evaluation, a sample size calculation was undertaken to detect a statistically significant difference between groups on the primary clinical outcome (i.e., WST-C) and provide a reasonable estimate of a treatment effect, as this outcome is expected to be used in subsequent EPIC Wheels studies. Based on this calculation, a total study N of 44 was planned (n = 11 for each of the four groups); additional details for the sample size calculation are provided in chapter 5 and in Appendix C.

4.2.3 Procedure

All subjects attended an initial session with their respective Trainer for 90-120 minutes, including orientation to the computer tablet. Subjects were provided with a prepared study tablet and printed reference handbook to engage in their home training program for 2 weeks. They were instructed to perform a minimum of 75 minutes of home training per week, but encouraged to attempt 150 minutes/week. After 2 weeks, subjects attended a second session with their Trainer for 60 minutes and then continued with their home training program for an additional 2 weeks. To prevent attrition, the Trainer would make follow-up telephone contact at the end of weeks 1 and 3 to address any issues, provide encouragement and promote adherence (Jette, et al., 1998; Tinetti, et al., 1994).

4.2.3.1 Extra wheeling

The activities in the EPIC Wheels program required trainees to engage in wheelchair activity that they might not otherwise undertake. While it is unlikely that such additional wheelchair use alone would substantially increase skill acquisition or proficiency, to address this potentially confounding variable subjects were randomly allocated into Extra Wheeling or non-Extra Wheeling subgroups (see Figures 4.1 and 4.2). Subjects in the Extra Wheeling sub-groups were asked to perform 75 minutes of unstructured wheelchair wheeling per week *in addition to* their training regime. Extra wheeling was defined as any type of independent propelling participants performed in their wheelchair that was not typically in their normal course of daily activities. For subjects in the Extra Wheeling group, the training tablet presented a prompting question approximately every 24 hours asking how many minutes of extra wheeling they have performed. Subjects could toggle up or down in 5-minute increments (range of 0- 100 minutes) and enter their data before the tablet returned to the training window.

4.2.4 Intervention

4.2.4.1 EPIC Wheels group

EPIC Wheels Trainers were occupational therapists with ≥ 5 years of clinical experience in wheelchair provision/training and received a 2-day comprehensive orientation to wheelchair skills training. Each treatment session was administered using a protocol and checklist. The Trainer provided approximately one hour of instruction, which included demonstration and feedback on participant performance. Skills were progressed according to the participant's current level of function. At the end of one hour, Trainers selected a sub-set of skills and training activities to recommend for the home training program based on ability, safety, and relevance for the subject. The EPIC Wheels home program includes a comprehensive, structured library of educational material and training activities, organized in a hierarchy from simple to complex (Appendix D).

The home program component was delivered using a 10" android computer tablet. The tablet was configured as a single-function device through the use of a dedicated launcher application (i.e., trainees could not access other tablet functions or applications). The EPIC Wheels program was menu driven and interactive, using a touch-screen interface. Training was provided in a multi-modal format with illustrations and videos, allowing detailed step-by-step guidance and slow-motion demonstrations. Female and male actors, both close to 70 years of age, were used as age-appropriate demonstration models in the videos to provide vicarious experiences, consistent with principles of social cognitive theory. Practice activities could be clearly demonstrated in video format and included imitative, function-based, and interactive game-related activities (e.g. push the drive wheels in opposite directions as demonstrated in the video to perform a spin turn; enter the bathroom and then exit using a spin turn; while watching an animated elevator door on the tablet, perform a spin turn in a confined space before the "door" closes). Subjects also received a small mobile Internet device that was pre-configured to provide Wi-Fi connectivity for the tablet (i.e., for voicemail and data transfer/update capability). Subjects were instructed to periodically bring the tablet within close proximity to the Internet device (~ 50 feet) to establish Internet connection; however, the EPIC Wheels program itself operated independently and did not require Internet access for training purposes.

The tablet was mounted on a rigid platform with a simple strap that wraps around the subject's thighs for in-wheelchair use (see Figure 3.4 in chapter 3). A "Progress" icon provided daily updates on the number of minutes practiced per week, as well as percentage of the weekly goal, to reinforce adherence. This progress information was a subset of the data uploaded regularly to the trainer's website. Messages could be exchanged between subject and trainer using a voicemail function in the EPIC Wheels program on their tablet and website, respectively. Trainers monitored each subject's training activity by periodically visiting the website, at their convenience. The trainer could use this information to identify adherence issues and address these through voicemail, the bi-weekly follow-up phone call, or at the second training session. Trainers could also revise the home program by introducing more advanced skills at the second training session, based on how the subject progressed through the program content.

4.2.4.2 Control group

Control group subjects also attended 2 sessions with their Trainer and received a single-function tablet pre-loaded with a variety of cognitively challenging computer games. Nine different games addressed problem solving (e.g. Tetris, Cogs); word, math and memory challenges (e.g. Scrabble, Sudoku); and dexterity/response skills (e.g. Marble Saga, Cut the rope). Each training session was administered using a separate protocol and checklist. During the first session, the Trainer discussed the potential benefits of computer game training on cognition and motor function, and how these might positively impact wheelchair mobility. Trainers provided an orientation to the cognitive games and operation of the tablet device. During the second session, the Trainer discussed the subjects' current community activities and experience using the wheelchair via a structured discussion guide, and provide verbal information related to barriers encountered as well as any additional review or training related to the cognitive training games. The control group trainer had additional reference material related to strategies for maintaining participant enthusiasm and adherence as we had anticipated these participants might be more at risk for dropout (Appendix I).

4.2.5 Training schedule

The home training schedule for both groups targeted 1-2 sessions/day, 15-30 minutes in length, at least 5 days per week (150 minutes/week recommended, with a minimum of 75 minutes); the rationale for this was provided in chapter 3. The recommended training time is at least comparable to 1:1 training time in other clinical studies using structured wheelchair skills training, where a significant improvement in skill capacity was observed (Karmarkar, Collins, Kelleher, Ding, Oyster, & Cooper, 2010; Garber, Bunzel, & Monga, 2002; Smith & Kirby, 2011). A study of a home-based training program for improving hand function among stroke survivors (n = 77; m = 57 years), which obtained 96% compliance for 1.3 hours of training per day, 7 days per week over 5 weeks (Alon, Sunnerhagen, Geurts, & Ohry, 2003) provided some evidence that the proposed training demands were achievable. Participants allocated to Extra Wheeling were instructed to perform a minimum of 75 minutes of extra wheeling per week, in addition to the training program expectations noted above.

4.2.6 Precautions for safety

To reduce the risk of injury and adverse events for participants and their care providers, several precautionary measures were implemented in the study protocol. The EPIC Wheels program incorporated extensive safety-related material, including teaching the safest mobility strategies; use of safety equipment; recognizing unsafe situations; and seeking assistance when skills are insufficient to address environmental barriers. At the initial training session, subjects were provided with protective wheeling gloves. Care providers were encouraged to attend and participate in both training sessions and to supervise home training activities. At the initial EPIC Wheels training session, a fitted spotter's strap was provided with demonstration of care provider use to prevent wheelchair tips. Operating a wheelchair in the community carries innate risks that cannot be entirely eliminated. The EPIC Wheels program included education and training designed to minimize the risk of a fall or injury that subjects might have been exposed to in their everyday use of a MWC had they not received this program. Any unsafe performance observed during training was addressed immediately with corrective feedback. Subjects were encouraged to contact the study Coordinator immediately if they experience unusual discomfort, pain or physical symptoms. A Data and Safety Monitoring Board (DSMB), consisting of a statistician, a physiatrist, and a physical therapist, was struck and convened (meeting date January 22, 2014) to review accumulating indicator data and advise the investigators regarding safety issues, evidence of benefit, and need for modification to the study design (DeMets, 1998).

4.2.7 Data collection

At baseline, wheelchair device characteristics, such as wheelchair type, size and safety equipment, were collected using a modified Wheelchair Specification Form (Dalhousie University, 2012) (Appendix E). Descriptive participant characteristics (Appendix F) including age, sex, marital status, highest level of education, primary diagnosis related to MWC use, length of time using the MWC, and propulsion method were collected along with cognitive status measured using the Standardized Mini-Mental Status Exam (Molloy, Alemayehu, & Roberts, 1991). Handgrip strength has been demonstrated to be an accurate surrogate measure of overall strength (Bohannon, 2008) and was measured using a Jamar™ 5030J1 dynamometer (Sammons Preston Rolyan, Chicago, IL). The clinical outcome measures were collected at DC1 (baseline) and DC2 (post-treatment, as soon as possible following the end of the 4-week home training). These measures included the Wheelchair Skills Test Capacity (WST-C) and Safety (WST-S);

Wheelchair Use Confidence Scale (WheelCon); Wheelchair Outcome Measure (WhOM) Indoor and Outdoor subscales; Life-Space Assessment (LSA); Wheeling While Talking (WWT) test; and the Health Utilities Index (HUI). A detailed description of the clinical outcomes is provided in chapter 5 and copies of these measures, where possible, are provided in Appendix G. EPIC Wheels participants also completed a post-treatment questionnaire. The relevant data collected to evaluate the objectives addressed in this chapter (i.e., feasibility indicators) are provided in the following section.

4.2.8 Feasibility indicators

A priori measurement criteria were developed for the feasibility indicators (see Table 4.1); these criteria served as our hypotheses for establishing study feasibility. Each indicator was evaluated as “achieved”, indicating the protocol was sufficiently robust to move forwards with a larger RCT with only small or no adaptation required, or “revise”, indicating a need for more substantive change before proceeding. The number and extent of objectives requiring revision would determine whether feasibility study data could be conflated with those generated in a larger subsequent RCT.

Process components reflect the feasibility of the various steps involved in undertaking the study. The site coordinators made on-going documentation of participant inquiries, responses, recruitment, appointment scheduling and attendance. Adherence was assessed using EPIC Wheels tablet usage data (i.e., time spent in home program training) uploaded to a server and saved as a .csv file (i.e., Excel compatible). Usage data included session frequency, length of time in minutes accessing program components (e.g. instructional videos, training activities, and

Table 4.1 Feasibility indicators, proposed criteria and outcomes

Feasibility Component	Indicator	Criteria	Outcome
Process			
Recruitment rate	# of subjects recruited	3 subjects/month/site: Total of 44 over 8 months	Revise
Consent rate	% of subjects consenting	< 10% subject refusal	Revise
Retention rate	% of subjects with DC2	Complete data collection for > 80%	Achieved
Treatment adherence (EPIC Group)	Attend both training sessions	> 85% of subjects	Achieved
	Meet minimum practice time guidelines	> 85% of subjects	Achieved
(Control Group)	Both training sessions conducted	> 85% of subjects	Achieved
Resources			
Data collection: Subject & Tester burden	DC1 duration	> 85% of subjects complete in ≤ 2 h	Revise
	DC2 duration	> 85% of subjects complete in ≤ 1.5 h	Revise
Collection of HUI data	Administration	Mean HUI administration is < 10 minutes	Achieved
	HUI pre/post score	Statistically significant change between T_1 & T_2	Achieved
Trainer burden	Time spent with subject in training intervention	Mean time spent per subject is ≤ 2 hours for T1 and ≤ 1 hour for T2	Achieved

Management			
Participant processing time	Time from data collection to treatment	Mean time is ≤ 10 days at each site	Revise
Tablet reliability	Downtime due to technical or mechanical issues	> 90% of subjects are not without a tablet for > 2 days	Achieved
Equipment loss/damage	Tablet is lost/unusable	< 2 tablets lost over study	Achieved
Treatment administration issues	Post-treatment Evaluation Form (Study Trainer)	Any issues identified modifiable without substantial changes to the protocol	Achieved
Treatment			
Safety (Data Collection & Training)	Adverse events during assessment or training	No major injuries or adverse events reported	Achieved
Safety (Home program)	Adverse events during home training	No major injuries or adverse events reported	Achieved
Dose level response	Correlation between training time and change score	Minimum practice time guidelines sufficient for a treatment effect	Achieved
Perceived benefit	Post-treatment Participant Questionnaire	> 85% of responses will be "strongly agree/agree"	Achieved

games) and time spent training without the tablet (manually inputted on the tablet by participants). These data were collated to obtain weekly and total study period totals, and compared with the minimum (75 and 300 minutes, respectively) and preferred (150 and 600 minutes, respectively) practice guidelines.

Resource components relate to time and budget demands. The testers completed a data collection protocol checklist (Appendix J) at DC1 and DC2, and documented administration time for each outcome measure. We were interested in evaluating use of the Health Utilities Index (HUI) because of its potential application for cost-benefit analysis in future studies, specifically related to the length of administer time and potential sensitivity to change with a wheelchair skills training intervention. Trainers completed protocol checklists at T1 and T2 (Appendix K & L) including administration time. The administration time data was transcribed into a spreadsheet for comparison with the proposed criteria.

Management components deal with personnel, equipment and data issues. The site coordinators documented the time between data collection and training appointments, and any equipment issues during training. Trainers indicated any protocol deviations on the checklists and completed a Post-treatment Evaluation Form (Appendix M) after EPIC Wheels participants had completed all training. Treatment components relate to assessment of safety, dose-specific response, and evaluation of treatment benefit. Adverse events were documented using the protocol checklists for data collection and in-person training, and via daily tablet prompts during home training. The tablet usage data, identified in the process section above, was used to explore potential benefits of higher treatment dosage (i.e., more training time) using the minimum and preferred training time thresholds. Perceived benefit for the EPIC Wheels participants was assessed using a Post-treatment Questionnaire (Appendix H) at the DC2 appointment. Additional exploration of the treatment benefit, as reflected by between-groups comparison of clinical outcome measures, is undertaken in chapter 5.

4.2.9 Data Analysis

For Process components, the rates for recruitment, consent, retention and adherence (i.e., session attendance and home practice time for EPIC Wheels participants) were calculated on the basis of simple frequency counts. For Resource components, frequency counts were used to determine subject/tester burden and trainer burden was determined by mean training session duration. For the HUI measure, mean administration time was calculated and HUI scores for EPIC Wheels participants were compared pre- and post-intervention using a paired *t*-test. For Management components, simple counts were used to tabulate tablet issues; downtime days; days between data collection and treatment initiation; and substantive protocol issues. For Treatment components, adverse events and questionnaire responses were tabulated as simple counts. Descriptive statistics for tablet-specific and total home training time were used to explore potential associations between treatment dosage (i.e., minutes of training) and clinical outcome change scores for EPIC Wheels participants using the Pearson correlation statistic. In addition, differences in change score between EPIC Wheels participants achieving the preferred (higher) training dose and those who did not were compared using independent *t*-tests. Given that this was a feasibility study, all *t*-tests were conducted with $\propto$ set at 0.10 to ensure a potentially beneficial treatment effect did not go undetected (Type II error).

4.3 Results

4.3.1 Participants

A total of 15 participants were enrolled in the study (Vancouver n = 9; Winnipeg n = 6). One participant (W02) from the EPIC Wheels group withdrew due to health issues that arose shortly after enrolment; he did not engage in tablet training, attend the second in-person training session or attend the post-intervention data collection. This participant was contacted bi-monthly over a period of 18 months in an attempt to resume training, at which point he conceded to withdraw from the study. A CONSORT flow diagram for recruitment is provided in Figure 4.3. A summary of participant demographics is provided in Table 4.2; detailed demographic information and participant wheelchair specifications are provided in Appendix N and O, respectively.

Figure 4.3 CONSORT flow diagram for participant recruitment

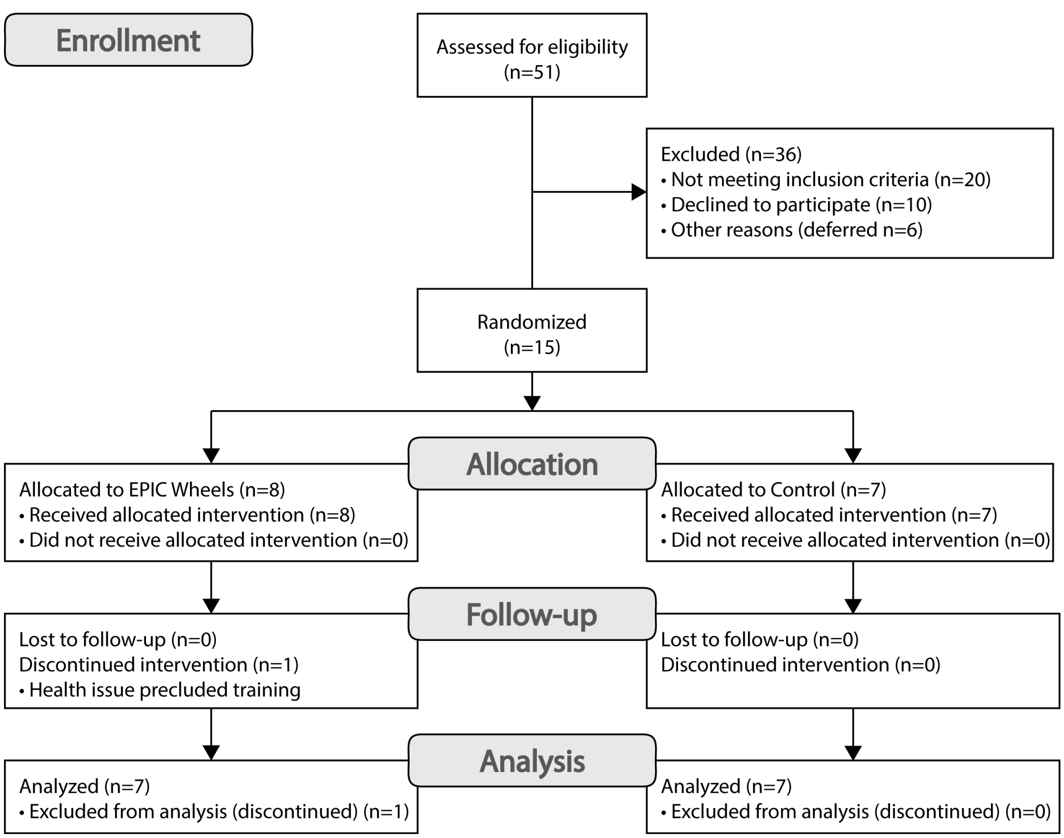


Table 4.2 Participant demographics: N (%) or mean ± sd

Demographic	Winnipeg	Vancouver	Total
Participants	6	9	15
Age in years [Mean ± sd]	71.0 ± 7.6	63.7 ± 10.5	66.6 ± 9.9
Sex [Male]	4 (67%)	8 (89%)	12 (80%)
Marital Status			
Married	4 (67%)	4 (44%)	8 (53%)
Separated	1 (17%)	4 (44%)	5 (33%)
Single	1 (17%)	1 (11%)	2 (13%)
Living Situation			
Alone	2 (33%)	5 (56%)	7 (47%)
Not alone	4 (67%)	4 (44%)	8 (53%)
Education			
Post-secondary	3 (50%)	6 (67%)	9 (60%)
High school	2 (33%)	1 (11%)	3 (20%)
< High school	1 (17%)	2 (22%)	3 (20%)
Health Condition			
Parkinson's Disease			2 (13%)
Multiple Sclerosis	2 (33%)	1 (11%)	3 (20%)
Lower Limb Amputation	2 (33%)	1 (11%)	2 (13%)
Cerebral Vascular Accident	1 (17%)		1 (7%)
Orthopedic injury	1 (17%)	3 (33%)	3 (20%)
Arteriovenous Malformation		1 (11%)	1 (7%)
Spinal Cord Injury		2 (22%)	2 (13%)
Arthritis		1 (11%)	1 (7%)
Propulsion method[a]			
2 H + 2 F	4 (67%)	2 (22%)	6 (40%)
2 H + 1 F	1 (17%)	1 (11%)	2 (13%)
2 H	1 (17%)	6 (67%)	7 (47%)
MMSE[b] Score	29.2 ± 0.8	27.4 ± 2.4	28.1 ± 2.1
Months of MWC use	8.0 ± 6.6	22.2 ± 26.0	16.5 ± 21.3
Grip Strength (pounds)[c]	51.9 ± 25.1	64.3 ± 29.7	59.3 ± 27..7

[a] H = hands; F = feet
[b] MMSE = Mini-Mental Status Examination
c Mean of three trials with right hand

4.3.2 Process Indicators

A total of 15 participants were recruited at two sites over a period of 31 months (March 2013 – September 2015) for an average of approximately one participant every two months. A total of 51 individuals were contacted with regard to participation in the study, 20 of who were deemed ineligible. Among the 31 individuals who met the eligibility requirements, 15 were enrolled; 6 expressed interest and were pending enrollment; and 10 declined to participate for a confirmed consent rate of 48.4% (and potentially 67.7%, depending upon those pending). Of the 15 individuals who consented to participate, 14 completed both data collection sessions, for a retention rate of 93.3%. A wide variety of recruitment strategies were employed over the course of the study. Table 4.3 provides a summary of recruitment activities along with the number of participants enrolled in each category.

Table 4.3 Recruitment activities by category (Participants enrolled)

Media	Advertisement	Clinical Contacts
Television: ShawTV interview CTV Morning Show **Websites**: Investigator websites ICORD, VCHRI Craigslist, Kijiji Arthritis.ca **Social Media**: Facebook, twitter, YouTube **Print Publications: (2)** OT Now (CAOT) Community newspapers Seniors newspapers Senior centres newsletters	**Presentation at Expos**: **(1)** Abilities expo, Connectra, Library Seniors Day Geriatrics Services, Seniors housing & lifestyle **Advocacy Groups: (6)** Canadian Paraplegic Assoc Arthritis Society Can Assoc Retired Persons MB Society of Seniors **Government agencies:** MB Housing/CMHC Public Libraries **Wheelchair Vendors** **Direct Mail (3)**	**Presentations to health care facilities: (3)** Vancouver & Winnipeg (45+ facilities) **MB Wheelchair Services**: RA telephone recruitment 100+ individuals receiving a MWC in past 2 years **Hired:** RA at each site OT at each site for dedicated recruitment activities with clinical and community connections **Seniors Webcast** Safe MWC & scooter use

Six of the 7 control group participants (85.7%) and 7 of the 8 EPIC Wheels participants (87.5%) attended both training sessions. For EPIC Wheels participants, a summary of the home training guidelines and performance data is summarized in Table 4.4 and detailed training activity in Table 4.5. Among the EPIC Wheels participants who completed the study (n=7), 85.7% achieved the minimum amount of home training (i.e., 300 minutes) over the full four weeks and 57.1% achieved the preferred training threshold (i.e., 600 minutes). With respect to weekly totals, the minimum training criteria was achieved in 78.6% of all weeks. There was considerable variation in total home training time (range 186.3 – 1443.0 minutes) as well as type of training EPIC Wheels participants engaged. Specifically, total time engaging in tablet-based training range from 146.3 to 1382.0 minutes, and time reported as skill training activity without the tablet (i.e., manually inputted during the daily prompting question on the tablet) ranged from 0.0 to 980.0 minutes.

Table 4.4 EPIC Wheels home training guidelines and participant results (n = 7)

Parameter	Instruction to participant	Minimum	Mean ± SD (Range)
Frequency: Total days of training Days/week training	20-28 days 5-7 days/week	20 days 5 days	16.4 ± 5.8 (10 - 26) 4.1 ± 1.9 (2.5 - 6.5)
Intensity:† Training duration	15-30 minutes	15 minutes	47.8 ± 16.9 min/training day (16.9 – 72.2)
Dosage: Minutes of training/week Total minutes training	75 – 150 300 - 600	75 minutes 300 minutes	206.3 ± 133.4 (46.6 – 360.8) 825.1 ± 206.3 (186.3 – 1443.0)

† Intensity of treatment was defined as the duration of training time in a single day

Table 4.5 EPIC Wheels home program training data for EPIC Wheels participant

Values in **bold font** did not meet the weekly minimum goal of 75 minutes or total training period goal of 300 minutes

ID	Week 1		Week 2		Week 3		Week 4		Total		
	Tablet[a]	All[b]	Tablet	All	Tablet	All	Tablet	All	Tablet	Other[c]	Grand[d]
V02	141.0	152.0	85.0	85.0	630.0	665.0	526.0	541.0	1382.0	61.0	1443.0
V03	214.5	265.0	60.5	**60.5**	50.8	90.8	86.0	171.0	411.8	175.0	586.8
V06	126.3	126.3	1.1	**1.1**	13.3	**53.3**	5.6	**5.6**	146.3	40.0	**186.3**
V07	133.9	148.9	69.9	**69.9**	124.5	154.5	8.0	108.0	336.3	145.0	481.3
W04	46.7	182.0	54.0	319.0	64.5	300.0	57.4	402.0	222.6	980.0	1202.6
W05	218.9	279.0	318.7	374.0	232.6	263.0	148.2	248.0	918.4	245.0	1163.4
W06	228.2	228.2	399.4	399.4	84.2	84.2	0.0	**0.0**	711.8	0.0	711.8
Mean ± SD	158.5 ± 65.9	197.3 ± 60.4	141.2 ± 152.8	187.9 ± 169.4	171.4 ± 214.0	230.1 ± 213.2	118.7 ± 187.4	210.8 ± 202.3	589.9 ± 443.1	235.1 ± 339.2	825.0 ± 453.6

[a] Minutes spent on tablet-related training (i.e., watching demo videos, training games & timed training activities)
[b] Total minutes of tablet-related training + self-reported non-tablet training time
[c] Total minutes of self-reported non-tablet training time
[d] Grand total of tablet and non-tablet training time

4.3.3 Resource Indicators

Data collection session duration information was only available for 10 participants, with a mean of 150.8 ± 48.8 minutes for DC1 and 124.9 ± 46.4 minutes for DC2. For DC1, 3 participants (30%) completed testing in ≤ 2 hours and for DC2 only one participant (10%) was finished in ≤ 1.5 hours. The HUI administration time was available for seven study participants, with an overall mean of 9.1 ± 4.1 minutes. A paired *t*-test comparing pre- and post-intervention HUI scores for EPIC Wheels participants indicated a statistically significant difference ($t = 2.07$, df = 6, $p = 0.08$). Data for in-person training time at T1 was available for 13 study participants, with 100% of sessions conducted in less than 2 hours ($m = 90.2 \pm 22.5$ minutes; range 45-115 minutes); EPIC Wheels participants (n=7) had a mean training time of 102.1 ± 15.1 minutes (range 74 to 115 minutes). For T2 (n=9) mean training time was 63.0 ± 6.1 minutes overall and 62.0 ± 5.1 minutes for EPIC Wheels participants (n=6).

4.3.4 Management Indicators

The mean processing time between study enrolment and initiation of the intervention was 11.7 ± 7.5 (range 4-28) days (Winnipeg site: 14.8 ± 9.5 days; Vancouver site: 9.6 ± 5.4 days). Only three participants had an enrolment to start delay of greater than two weeks, related to scheduling issues of participant availability. There was one incident of tablet malfunction (6.7% of participants) that required replacement for an EPIC Wheels participant (due to tablet software issues), resulting in the participant not having tablet access for several days; the participant was still able to achieve the minimum training threshold. Several participants required some assistance from the study coordinator to resolve voicemail or Wi-Fi connectivity issues;

however, none of these situations resulted in participants losing tablet access. No tablets were lost or damaged over the course of the study.

Trainer post-treatment protocol evaluation forms were available for 13 participants and indicated no major protocol deviations. A total of five minor protocol deviations were reported: one participant required a minor wheelchair adjustment prior to initiating training; the timing for follow-up phone calls was modified for one participant; two participants required an additional in-person visit, one for assistance with tablet log-in practice and the other for additional care provider spotter training; and one participant had an abbreviated first training session due to a conflicting appointment. Several additions to the protocol were identified: ensuring the Wi-Fi device was activated prior to tablet demonstration; including data logger installation in the task checklist; and providing options for participants who could not tolerate the tablet holder on their lap. All post-treatment evaluations indicated the protocol was clear and 84.6% confirmed the time allocated for administration was reasonable.

4.3.5 Treatment Indicators

There were no injuries or adverse incidents from study-related activities during any data collection sessions, training sessions, or home training. For treatment dosage in the EPIC Wheels group, there was a statistically non-significant weak correlation between the primary clinical outcome measure (WST-C) change score and total training time (Pearson $R = 0.19$, $p = 0.72$) and tablet-specific training time (Pearson $R = 0.22$, $p = 0.67$); no statistically significant correlation was found between any of the clinical outcome measures and total or tablet-specific training time. Additional *t*-test comparison of the clinical outcome measure mean change scores between participants who met the preferred training guideline of 600 minutes (n=4) and those who did not (n=3) found a statistically significant difference for the WhOM (Indoor); mean change scores were higher among participants who achieved the preferred training guidelines for the WST-C, WST-S, WheelCon, WhOM (Outdoor) and LSA (see Table 4.6) but did not reach a level of statistical significance.

Table 4.6 Comparison of change scores for EPIC Wheels participants who met the preferred training guideline of 600 minutes (n=4) and those who did not (n=3)

Outcome[a]	Preferred Mean (SD)	< Preferred Mean ± SD	Mean Difference (95%CI)	*t*	*p*
WST-C (%)	4.7 (9.4)	-5.5 (12.9)	10.2 (-11.3; 31.6)	1.22	0.28
WST-S (%)	3.1 (4.4)	0.0 (0.0)	3.1 (-3.6; 9.9)	1.20	0.29
WheelCon	15.3 (11.1)	10.1 (6.5)	5.2 (-13.5; 23.9	0.72	0.50
WhOM Indoor	2.4 (0.5)	1.3 (0.9)	1.1 (-0.3; 2.5)	2.08	**0.09***
WhOM Outdoor	2.7 (1.4)	1.8 (0.8)	0.9 (-1.4; 3.2)	1.06	0.38
LSA	10.1 (11.7)	1.3 (7.3)	8.8 (-11.1; 28.7)	1.14	0.31
WWT‡	-0.8 (12.0)	-2.5 (8.7)	1.7 (-19.6; 23.0)	0.21	0.69
HUI	0.099 (0.117)	0.293 (0.331)	-0.194 (-0.643; 0.253)	-1.12	0.32

‡ Lower scores are better
[a] WST-C = Wheelchair Skills Test Capacity; WST-S = Wheelchair Skills Test Safety; WheelCon = Wheelchair Use Confidence Scale; WhOM = Wheelchair Outcome Measure; LSA = Life-Space Assessment; WWT = Wheeling While Talking test; HUI = Health Utilities Index

All participants in the EPIC Wheels group who finished the study completed the post-treatment questionnaire and the results are summarized in Table 4.7. A total of 96.8% of question responses were in agreement, with over 82% being “strongly agree”.

Table 4.7 EPIC Wheels group post-treatment questionnaire results (n = 7)

Item	Strongly Disagree	Disagree	Agree	Strongly Agree
Receiving wheelchair skills training is valuable or important for me				7
The method of training I received was reasonable and appropriate for me		1		6
The kinds of wheelchair skills taught were reasonable and appropriate for me		1	2	4
The trainer working with me was reasonable and appropriate for me				7
The expectations for participating in training and practice sessions were manageable and practical			4	3
The essential components of the training program were provided as described at the study outset			1	6
I was able to perform or improve skills taught in the training program			1	6
I did not experience an injury or undue physical or mental stress				7
The training program was successful in improving my wheelchair skills			1	6
Response total		3.2%	14.3%	82.5%

4.4 Discussion

With respect to process issues, the recruitment rate and number of participants fell well below the targets outlined in feasibility indicators, despite several revisions to the inclusion criteria such as lowering the minimum age from 55 to 50 and increasing the maximum period of MWC use from 1 year to 2 years to removing the condition altogether.

A variety of recruitment strategies were implemented including advertisement in a wide variety of venues (e.g. hospital/ rehabilitations centres, health clinics, wheelchair vendors, senior centres, libraries, rehabilitation expos); multiple presentations and engagement with occupational and physical therapists who prescribe wheelchairs; local community newspaper articles and a television interview; telephone contact and invitation with individuals over 50 who had received a MWC through the Society for Manitobans with a Disability (i.e., the principal source for MWC acquisition in Manitoba); and hiring an occupational therapist for dedicated recruitment activities at each site. Monthly teleconference meetings were held with study staff at both sites to provide updates, discuss implementation issues, and brainstorm recruitment strategies.

One reason for the recruitment challenges may be related to the research study context, which required taking initiative to contact the research coordinator, whom they were unfamiliar with. The literature identifies *passive* and *opt-in* recruitment strategies (i.e., where the onus of contact rests with the participant) have substantially lower success than active and opt-in strategies, where individuals are contacted directly and provide a response or request no further contact (Page & Persch, 2013; Sygna, Johansen, & Ruland, 2015).

Another potential issue may have been the possibility of being allocated to a control group rather than the EPIC Wheels group. Howard et al (2009) report that clinicians assisting with recruitment may also have reservations about referring clients who might then be allocated to the control arm of a study. The possibility of allocation to either arm was explicitly conveyed in the consent form; in future, alternative approaches such as avoiding the term “control group” and describing two training program alternatives or using a wait-list approach might be more effective. The inclusion criteria also required bilateral upper extremity propulsion, which would preclude a number of MWC user groups such as those who exclusively foot propel and those with hemiplegia (e.g. post-stroke). This criterion was required due to the content of the training material (i.e., bilateral mobility strategies) as providing this content to non-bilateral MWC propellers might limit the effectiveness and potentially compromise vicarious reinforcement strategies (i.e., the trainee not being able to relate to the demonstrator). It was anticipated that, after demonstrating feasibility, additional content would be developed for the EPIC Wheels program targeting a variety of populations and devices (e.g. hemiplegia, lower limb amputation, male/female, power wheelchairs, scooters); future study should incorporate a variety of content streams within the EPIC Wheels delivery platform to expand the potential recruitment audience.

The number of individuals expressing interest via clinician referral was relatively small, despite considerable effort in marketing the study to practicing therapists. This response is consistent with some other studies in the literature, where authors cite health providers' lack of time in their clinical work, forgetting to bring the study to their clients' attention, concerns about client burden and not prioritizing study recruitment as challenges (Miller, Bakas, Buelow, & Habermann, 2013; Sygna, Johansen, & Ruland, 2015; Hubbard, et al., 2015). Tyson et al (2015) used hospital therapists to assist with recruitment and found those who were "gate keepers" (i.e., "pre-screened" clients, rather than providing all eligible clients with the option of participation) had lower recruitment rates; this finding appears to be particularly prevalent when recruiting older adults (McMurdo, et al., 2011). Hubbard et al (2015) highlight the importance of practicing clinicians in recruitment for rehabilitation trials and negative impact that a lack of "buy-in" can have. They further propose that clinicians' poor outcome expectations of recruitment, consistent with social cognitive theory, influence their effort and adherence to recruitment strategies. It might also be possible that clinicians' outcome expectations for clients to benefit from wheelchair skills training influences decisions about passing along study information. We do not know whether any of these factors were relevant for the therapists engaged to assist with recruitment in the EPIC Wheels study. However, given the fact that therapists contacted for this study had identified being involved with older adult MWC users on a regular basis, a better understanding of the factors that impact clinician referral is desirable.

Approximately one third of eligible individuals declined to participate in the study, exceeding the target parameter of <10%. A variety of reasons were given for not participating, but were primarily related to the distance, cost, or lack of an escort to travel to the four data collection and training sessions. Since all individuals who agreed to participate ultimately provided consent, the rate of refusal was acceptable. Future study should consider the economic costs of travel for data collection and training session and ensure sufficient resources are available to enable trainees to attend without undue hardship, or provide alternative venues that are accessible and convenient (Blanton, et al., 2006). The retention rate of 87.5% surpassed the feasibility criteria set. It was anticipated that control group participants would be more inclined to be lost to attrition; however, the only withdrawal was from the EPIC Wheels group and due to a health condition that prevented continuation with the program. One participant in the control group expressed frustration with their allocation and declined the second training session, but did attend for post-treatment data collection. It appears that, once enrolled, participants were engaged in the study and aside from extenuating circumstances (i.e., health issues) were motivated to complete the study.

The challenges with recruitment experienced in the feasibility study raise significant concerns with respect to a subsequent clinical trial being sufficiently powered to detect a treatment effect. Suggestions in the preceding paragraphs, such as expanding the program content, could assist in broadening the pool of potential participants. Increasing the number of study sites might impact the total number of participants, but the speed of recruitment remains an issue. The avenues by which the study was advertised were diverse, but relied heavily on the MWC users initiating contact. As noted in chapter two, older adults often feel overwhelmed during the period of transition to MWC use and are often dealing with a multitude of competing demands (e.g., hospital discharge planning, purchasing adaptive equipment, accessibility issues in the home, other rehabilitation therapies, etc.). In the current study we established positive connections with the clinical community (i.e., occupational and physical therapists) by providing education sessions, recruitment material, and follow-up inquiries; however, despite general affirmation for the training program, relatively few participants were recruited directly through clinician referral. In order to optimize this important recruitment source, it may be helpful to secure an advocate or "champion" within the health care system, or create a formal collaboration with regional health authorities rather than simply a supportive partner. Tyson et al (2015) advocate for such an approach, suggesting on-site champions can create a culture that identifies recruitment as a role for everyone and maintain enthusiasm over the course of the study. This approach could introduce additional recruitment resources and contextualize the training program as an option that is offered to all eligible MWC users who come in contact with these health systems. Revision and enhancement to the recruitment strategy is critical if a follow-up study is to achieve an acceptable recruitment rate and volume required to adequately evaluate a treatment effect.

Adherence to treatment was reasonably strong for both study groups with respect to attending training sessions, exceeding the target of 85%. Among the EPIC Wheels participants for whom data was available (i.e., study completers), the rate of adherence to the minimum training time standard (300 minutes) was above the 85% target, with 57% exceeding the preferred 600 minutes of training. The patterns of training were more variable between participants, in terms of the number of days per week practicing and the duration of training on those days. Participants were typically not able to practice five days every week; however, the duration of daily training was reasonable with all sessions, lasting at least 15 minutes and none exceeding 75 minutes. Given that most participants were invested in the training process (i.e., most meeting the minimum threshold of training time and many achieving the preferred threshold), it may be worthwhile reducing the minimum number of training days per week slightly. It should be noted that the program software calculates usage based on the start and stop time for each video-based component. Consequently, usage data would likely underestimate the total time participants spent interacting with the EPIC Wheels program, since additional time would be required to navigate between video components. Participants may have actually had longer "sessions" of training than the data files reflect, and may have been engaged in processing training information or performing wheelchair maneuvers during periods of time between video component activation. While participants were able to manually input additional time spent training without the tablet, they would not have included these intermittent tablet-based periods in such estimates.

The study trainers were largely able to conduct all training sessions in the prescribed time frame. The 2 hours allotted for T1 appears to have been appropriate and the mean training time for T2 was within a few minutes of the one-hour target; some additional flexibility with the T2 time allocation might be worthwhile integrating in a subsequent study. Data collection turned out to be more time-consuming that anticipated, with the majority of both pre- and post-intervention sessions exceeding the expected timeframe. While some participants required more frequent rest breaks between measures, the majority of time was spent in data collection. In particular, three specific measures accounted for over 80 minutes of time: the WST (37.4 ± 15.6 minutes), the WheelCon (22.8 ± 8.0 minutes), and the WhOM (21.1 ± 16.5 minutes). Several strategies might be employed in future to expedite the data collection process and reduce both the tester and participant burden. First, the WheelCon 3.0 is now available in a revised 21-item short-form version, which shows promise as a reliable alternative to the 65-item original test (Sakakibara, Miller, & Rushton, 2015). Second, future participants might be provided with preparatory questions or information in advance of the data collection sessions. For example, the WhOM is administered as a semi-structured questionnaire and respondents identify up to ten relevant activities they perform using a wheelchair, which can be time-intensive. A third option would be to provide participants with some of the measures to complete in advance and then review them for accuracy and completeness at data collection. Finally, the WST is also available in the WST-Q (questionnaire) version (Dalhousie University, 2012), evaluating both capacity (i.e., what can you do) and performance (i.e., what do you do), which is highly correlated with the objective WST-C version used in this study and considerably quicker to administer (~ 10 minutes).

Administration time for the HUI was within the expected parameters. There was a statistically significant difference in EPIC Wheels participant HUI scores pre- and post-treatment, indicating the intervention may have a measurable impact. Given the encouraging results and minimal administration burden, the HUI can be considered as an outcome to include in subsequent trials to measure health-related quality of life and potentially evaluate cost-effectiveness.

Regarding management issues, the tablet and related equipment proved to be quite robust with no loss or damage reported and minimal downtime during the training intervention. Transitioning participants into their training program following enrolment was relatively quick, but the average delay was slightly above the targeted value of <10 days. After enrolment, the study statistician was contacted by email to initiate the randomization procedure and respond with the group allocation; this typically required 1-3 days to process. Booking the initial training session could only be initiated once this was complete and required coordination of schedules between the trainee and trainer, as well as the training space. Given these variables, the processing time was not unreasonable, but future studies might benefit from a more expeditious procedure for group allocation and prepared 'availability' schedules to offer participants. The trainers found the time allowed to be sufficient and the intervention protocol clear, with only a few minor deviations required. These minor adjustments to process were logical and prudent decisions made, which speaks to the need for the study trainers to have sufficient experience and clinical reasoning skills. The modifications made to the treatment protocol were relatively minor, suggesting that the current protocol could be employed in a subsequent trial. Based on the experiences of this feasibility trial, it would be prudent to append a "Frequently Asked Questions" section to the protocol including guidance on potential circumstances where minor deviations might be warranted.

With respect to treatment, the feasibility study was conducted without major injury or adverse events occurring during data collection, in-person training, or home training activities. Several situations arose where participants did experience health issues (i.e., W02 & V06); these were not incurred due to study-related activities but clearly could impact participation and performance in training and data collection. This is particularly relevant given the target population of older adults whose mobility is compromised due to a health condition, as they are especially vulnerable to concomitant injuries and development of co-morbidities. Future study with the EPIC Wheels program should incorporate strategies to deal with such situations should they arise (e.g. guidelines for suspending or extending training/data collection based upon emergent health events).

There is some preliminary indication regarding a dose-specific treatment effect for EPIC Wheels. The entire video-based material in the program is approximately 250 minutes in length, of which 150 minutes is instructional content. All but one participant met the minimum training requirement of 300 minutes; however, only four achieved the preferred training goal of 600 minutes over the study period. Comparison based on the preferred training time threshold (i.e., 600 minutes) yielded higher change scores for all measures except the WWT and HUI, with the WhOM (Indoor) being statistically significant (i.e., higher). Whether training time was exclusively tablet-based or in combination with non-tablet practice did not appear to influence outcomes. This would suggest that participants may have some flexibility to choose whether to repeat tablet activities and games or continue practicing the skills learned independently, but increasing their total practice beyond the minimum standard appears to yield better outcomes overall.

Finally, the perception of program benefit for EPIC Wheels participants was strong. All but one participant agreed or strongly agreed with every statement on the post-treatment evaluation form, and the agreement rate of nearly 97% was well above the target feasibility parameter. All EPIC Wheels participants felt that wheelchair skill training was important and six of the seven strongly agreed that the method of training was appropriate and that the program had succeeded in improving their skill level. Only one participant responded with non-agreement; because they were a very experienced user, they disagreed that the method of training and types of skills taught were appropriate for them, but still agreed the program had improved their skills. In summary, EPIC Wheels participants perceived the program to be relevant, appropriate and beneficial.

4.5 Limitations

The indicators used to measure feasibility were established prior to undertaking the study and were based on recommendations from multiple sources within the research literature. However, no standardized format or tool is currently validated for use in medical rehabilitation and consequently the feasibility evaluation is based upon the selection of recommended indicators and assigned target criteria for success. The recruitment challenges and resulting small sample size provided less data upon which to evaluate the feasibility criteria, and limit generalizability of the results, as the study sample may not be representative of the larger population of older adult MWC users. A larger sample might have uncovered additional issues in the data collection and intervention protocols, safety risks, and equipment issues. Only three of the 15 participants were female, despite the fact that, in Canada, women comprise over 60% of adult wheelchair users and 70% of wheelchair users 65 and over (Smith, Giesbrecht, Mortenson, & Miller, 2016).

The reason for the disproportionate number of females recruited is unknown, but may reflect lower self-efficacy (Sakakibara, Miller, Eng, Backman, & Routhier, 2013) or increased prevalence of living alone and experiencing social isolation (Hall & Havens, 1999). The generalizability of the findings for female MWC users should be exercised cautiously. The collection of tablet usage and adherence data for the control group participants would have been useful and could potentially have also been compared to the adherence indicator, as was the case with the EPIC Wheels group. Several outcomes had some missing data where the study Tester or Trainer information was not documented. Greater diligence and oversight strategies should be employed in future studies to ensure a comprehensive and complete data set for all procedures.

4.6 Conclusion

Enhanced recruitment strategies are critical before moving forwards with a future study. Several strategies might be employed to achieve this goal. Enhancing the program content to address different propulsion styles (i.e., hemiplegia, exclusively foot propulsion) and targeting individuals in rural communities (potentially as an exclusively "virtual" study arm) would broaden the potential pool. Securing a champion within the health care authority as a co-investigator or collaborator would likely improve advertisement and recruitment by the clinical community. The use of peers (e.g. successful EPIC Wheels graduates) for recruitment, including audiovisual "testimonials", could harness the power of vicarious experience to further assist recruitment.

Future trials of the EPIC Wheels program may benefit from some adaptation to the program length. While adherence was generally strong and participants were willing to invest time and effort to move through the program content and training expectations, the demands of life made it challenging to practice with the recommended frequency. It would be worthwhile evaluating whether an additional 2 weeks of home training would allow participants to access the material at a more desirable pace (i.e., frequency) while still maintaining or exceeding the current intensity and dose.

In summary, the vast majority of feasibility indicators were met or exceeded in this study. The components of intervention administration, treatment adherence, safety, participant retention, and treatment dosage effect all suggest the study design is viable. Tester and participant burden during data collection could potentially be reduced through the use of alternate versions of some clinical measures without substantive loss of information. Recruitment rate and numbers present the greatest challenge to the feasibility of implementing a larger subsequent clinical trial.

5. Evaluation of clinical outcomes in the EPIC Wheels feasibility randomized controlled trial

5.1 Introduction

The previous chapter reported on the feasibility of conducting a randomized controlled trial with an mHealth wheelchair skills training program. The primary intent of the study was to measure the feasibility indicators and evaluate viability of the proposed study design for a larger clinical RCT. The findings from the previous chapter indicted that the study administration and intervention components were, for the most part, sufficiently robust to support future study. The data collection processes were also viable, but the administration time and burden might be reduced through the use of alternative versions of outcome measures that are shorter, but without substantive loss of information. The most concerning aspect of feasibility was the challenge of recruitment, which was discussed in detail in chapter 4.

One feasibility component explored in the previous chapter was participants' perceived benefit of the EPIC Wheels intervention. The post-treatment questionnaire indicated that participants found the training program reasonable to undertake and was successful in improving their wheelchair mobility skills. In addition to these perceived benefits, it is also important to collect quantitative data related to clinical outcomes of the EPIC Wheels program. Measurement of a treatment response and estimation of the effect size would be important to justify any subsequent RCT, to identify if the selected measures are appropriate and to accurately calculate sample size. While recognizing that such a feasibility study is limited in its power to detect a treatment effect, we hypothesized that there would be a statistically significant difference between groups for the primary clinical outcome of wheelchair skill capacity and that the EPIC Wheels group would demonstrate a meaningful improvement in score. We also hypothesized that there would be a statistically significant difference between groups on the secondary outcome measures.

Consistent with a phased approach to rehabilitation research, it is critical and prudent to establish what the potential benefit of an intervention is and what the active ingredients might be prior to moving to a large-scale RCT (Whyte, Gordon, & Rothi, A phased developmental approach to neurorehabilitation research: the science of knowledge building, 2009). Consequently, this chapter reports on the clinical outcomes of this study. The specific objectives are to:

1. Evaluate the effect of EPIC Wheels on the primary clinical outcome of wheelchair skill capacity and obtain an estimate of the treatment effect size;
2. Evaluate the effect of EPIC Wheels on the secondary clinical outcomes of wheelchair skill safety, wheelchair use confidence, satisfaction with activity performance, mobility, divided-attention, and health-related quality of life.

5.2 Methods

5.2.1 Study design

The study was a two-site randomized controlled trial (evaluator-blinded) with a factorial design, comparing two groups (EPIC Wheels and a cognitive-training control intervention) pre- and post-treatment, with “extra wheeling” as an additional intervention factor. The details of the study design, group allocation, study administration and participant recruitment are described in detail in chapter 4 (see Figure 4.1 for the study design).

5.2.2 Sample size

While the study was designed as a feasibility trial, we also conducted a sample size calculation to detect a statistically significant difference between groups on the primary clinical outcome (WST-C) and provide a reasonable estimate of a treatment effect, as this outcome is expected to be used in subsequent EPIC Wheels studies. With a 2 x 2 factorial design, sample size can be calculated using each main factor (i.e., EPIC Wheels vs. Control and Extra Wheeling vs. No Extra Wheeling) independently, and then selecting the larger of the two estimates (Montgomery, Peters, & Little, 2003). Arian et al (2010) report that small feasibility studies are unlikely to produce results that are statistically significant at the level of $p < 0.05$. Research in the field of wheelchair skills training is still maturing with few published studies using actual users, and given the novel home program approach an $\propto$ of 0.10 was selected to ensure a potentially beneficial treatment effect did not go undetected (Type II error). Given the absence of data regarding the impact of extra wheeling, we opted to use a comparable effect size (Cohen's d = 0.98) in the second factor calculation. To minimize the risk of identifying such an effect merely by chance (Type I error), the study is powered at 90%. Based on a sample size calculation for ANCOVA, each of the four groups would require 8 subjects for a total of 32 participants. In previous Canadian trials related to wheelchair skills training, a 9-18% dropout rate has been reported; conservatively adjusting for a 25% dropout rate (32/0.75), a total study N of 44 was planned (n = 11 for each group). A detailed description of sample size calculation is provided in Appendix C.

5.2.3 Data collection

Clinical outcome measures were administered by a study Tester at baseline and at study end, as soon as possible following the 1-month intervention. Copies of the outcome measures, where possible, are provided in Appendix G.

5.2.3.1 Primary clinical outcome

The primary clinical outcome was wheelchair skill capacity, measured using the Wheelchair Skills Test 4.2 (WST) (Dalhousie University, 2012). The WST is a structured assessment with 32 discrete mobility skills required to perform social roles in the community. Each skill is scored as a 2 (pass), 1 (pass with difficulty), or 0 (fail), producing a total Capacity (WST-C) score (0-100%) with a higher score reflecting more skills passed. The WST is sufficiently sensitive to detect proximal effects of training; can be completed in 30-60 minutes; and does not demonstrate floor or ceiling effects (Kirby, et al., 2004). Two systematic reviews of available wheelchair skill outcome measures confirm the WST has the strongest psychometric properties and has been used most extensively in clinical trials (Kilkens, Post, Dallmeijer, Seelen, & van der Woude, 2003; Kirby, Swuste, Dupuis, MacLeod, & Monroe, 2002). The WST has demonstrated reliability for test-retest (ICC = 0.90), intra-rater (ICC = 0.96), and inter-rater (ICC = 0.97) administration (Kirby, et al., 2004). Construct validity has been supported by statistically significant relationships with predictive variables of age, sex, MWC experience, diagnosis, and use of a lightweight wheelchair, which together accounted for 35% of variability in WST score using multiple regression (adjusted $R^2 = 0.35$) (Ozturk & Ucsular, 2011). Concurrent validity has been established through positive correlation with two criterion measures: therapists' global assessment of user ability ($R_S = 0.39 - 0.40$) and the Functional Independence Measure

(Admission score R_S = 0.38; Discharge score R_S = 0.31) (Kirby, et al., 2004; Kirby, Swuste, Dupuis, MacLeod, & Monroe, 2002).

Previously published studies have used younger or mixed age populations and data specific to older adults were not available. We obtained permission to use a data subset (adults > 50 years) from a recently published study (Routhier, Kirby, Demers, Depa, & Thompson, 2012) providing WST-C change scores following training, and calculated the power of our study to capture a comparable change (m = 9.3%; s = 9.5%). A difference of 9.3% corresponds to acquisition of 3 additional skills on the WST-C; previous studies report subjects' perceptions of a clinically important difference with such improvements (Karmarkar, Collins, Kelleher, Ding, Oyster, & Cooper, 2010; Smith & Kirby, 2011) and this informed the sample size calculation. Research literature reporting on MWC use among older adults specifically implicates carpet, inclines, curbs, gravel and poor sidewalk conditions as barriers to independent mobility (Laliberte-Rudman, Hebert, & Reid, 2006). Acquisition of even one of these important skills could provide a clinically important difference to wheelchair users, their care provider, and those providing training. A Minimal Clinically Important Difference (MCID) should reasonably exceed measurement error or noise, typically identified as the Minimal Detectable Change (MDC) (Beaton, Boers, & Wells, 2002). No formal MCID has been established for the WST; however, using data from a Canadian trial (Smith & Kirby, 2011), a Reliability Change Index calculation indicates 3.0% is the MDC required and is a reasonable proxy for MCID (Beaton, Boers, & Wells, 2002) (see Appendix C for details).

5.2.3.2 Secondary clinical outcomes

Secondary clinical outcomes reflect more distal impacts of the intervention. Given the dearth of evidence in the literature, there is substantial value in understanding the relationship between skill training and safety, confidence, community participation, mobility and quality of life. Six secondary measures contributed to discerning the clinical impact of the EPIC Wheels intervention.

1. WST 4.2 Skill Safety. The WST also provides a total 32 item Safety (WST-S) score (0-100%) reflecting the number of skills addressed in a safe manner (higher score indicates greater safety), regardless of whether the skill is passed or not. This is of considerable importance since training also involves learning to recognize risks and limitations.

2. Wheelchair Use Confidence Scale for Manual Wheelchair Users **(WheelCon-M 3.0).** Self-efficacy has been identified as a key component in the performance of wheelchair mobility skills (Sakakibara, Miller, Souza, Nikolova, & Best, 2013) and preliminary research has suggested that standardized training can increase wheelchair confidence among older adults (Rushton, Miller, Kirby, Eng, & Yip, 2011). Low wheelchair mobility and self-management self-efficacy is a prevalent condition, particularly among older adults. A recent study of 123 MWC users over 50 found a strong correlation ($r = 0.70$) between low wheelchair mobility self-efficacy and low wheelchair skill capacity, and even among those with high skill capacity 25% reported low self-efficacy (Sakakibara & Miller, 2015). The WheelCon is a self-report questionnaire composed of 65 statements related to confidence using a wheelchair in activities and environments, each rated on a scale from 0 (“not confident”) to 100 (“completely confident”), producing a total mean score of 0 – 100 (Rushton, Miller, Kirby, Eng, & Yip, 2011). A 2010 study evaluated test-retest reliability (ICC = 0.84) and significant correlation with comparison measures supporting its validity (Rushton, Miller, Mortenson, & Garden, 2010).

***3. Wheelchair Outcome Measure* (WhOM).** The rehabilitation literature strongly suggests the use of measures of user-identified activities of relevance and perceived satisfaction with performance (Hoenig, Giacobbi, & Levy, 2007; Mallinson & Fischer, 2007; Mortenson, Miller, & Auger, 2008). Using an interview format, the WhOM asks MWC users to identify relevant activities and rate them on both Importance and Satisfaction, using an 11-point scale (0-10) with higher scores indicating greater importance/satisfaction. There are two separate subsections, each composed of up to five activities: Indoor (for activities in and around the home) and Outdoor (for activities outside the home and in the community). Two scores can be calculated for each section: a mean Satisfaction score (MeanSat) ranging from 0 to10, and a mean Importance x Satisfaction score (MeanImpt x Sat) ranging from 0 to 100. The WhOM demonstrates reliability and validity in use among older adults (Test-retest ICC = 0.77–1.00; correlation with Quebec User Evaluation of Satisfaction with assistive Technology $r_s = 0.36 - 0.45$) (Auger, Demers, Gelinas, Routhier, Mortenson, & Miller, 2010). A study of wheelchair users with spinal cord injury reported a $MDD_{95\%}$ of 1.61 for MeanSat and 16.27 for MeanImpt x Sat (Miller, Garden, & Mortenson, 2011). The MeanSat scores are reported in this study.

***4. Life-Space Assessment* (LSA).** The LSA is a 20-item questionnaire that tracks the wheelchair user travel on a proximal-to-distal continuum of five environments from the home to outside of town (Auger, Demers, Gelinas, Miller, Jutai, & Noreau, 2010), and capturing mobility habits over a 4-week period including frequency of travel and level of assistance required. Total score ranges from 0-120 and is weighted for frequency and level of assistance, with higher scores reflecting further distance from home, greater frequency of travel, and less assistance required. Evaluation of the LSA among power wheelchair users found excellent test-retest reliability (ICC = 0.87) (Auger, et al., 2009).

***5. Wheeling While Talking test* (WWT).** Wheelchair mobility is a complex skill and prone to risk for tips, falls and potential injury, particularly with older adult users where motor and cognitive function may decline with age. The WWT is a new divided-attention assessment for wheelchair users. Scoring reflects the additional number of seconds required to complete a slalom course during the dual-task versus motor task-only condition, with a larger time differential indicating poorer performance. Initial evaluation with residents in a long-term care facility demonstrated reliability for test-retest (ICC = 0.92), intra-rater (ICC = 1.00) and inter-rater (ICC = 1.00) administration (Giesbrecht & Miller, 2013). Collecting WWT data will allow investigation of changes in dual-task performance and the potential impact of cognitive processing demands which are associated with wheelchair safety and risk for tips and falls.

***6. Health Utility Index Mark 3* (HUI).** Health utility measurement is useful in performing cost-utility and cost-effectiveness analyses of new rehabilitation interventions. National guidelines for healthcare economic analyses strongly advocate the use of a validated measure of health-related quality of life (HRQL), which can be converted to quality-adjusted life years (QALY) gained, to fully inform funding decisions (Torrance, Furlong, & Feeny, 2002). The HUI is a brief questionnaire that asks about health status, deriving both single- and multiple-attribute utilities to ascertain QALY (Jones, Feeny, & Eng, 2005), meeting the criteria for a valid HRQL utility score (Drummond, 2001). Each single-attribute utility is scored between 0.00 and 1.00 and the multiple-attribute utility scale is scored from -0.36 to 1.00, with higher scores reflected better health and quality of life. Several studies have reported a change score of 0.03 can be considered representative of a minimally important difference (Luo, Johnson, & Coons, 2010; Horsman, Furlong, Feeny, & Torrance, 2003; Grootendorst, Feeny, & Furlong, 2000). Our study is not sufficiently powered to undertake a cost-utility analysis, but will determine the feasibility of collecting cost-utility data and estimate what changes in HRQL might be anticipated.

5.2.4 Statistical analyses

Given the study focus on feasibility and limiting the risk of a type II error, significance testing was conducted using an $\propto$ of 0.10 with no adjustment made for multiple testing. Analyses were conducted on a per-protocol basis (i.e., participants who completed the study) and then on an intention to treat basis for comparison (i.e., using multiple imputation); all participants were enrolled and remained in the arm to which they were allocated (Armijo-Olivo, Warren, & Magee, 2009).

The first study objective was *to evaluate the effect of EPIC Wheels on the primary clinical outcome of wheelchair skill capacity and obtain an estimate of the treatment effect size*. To address this objective, post-treatment WST-C scores were compared between the EPIC Wheels and control groups using analysis of covariance (ANCOVA), controlling for baseline score as a covariate (Tabachnick & Fidell, 2007). Borm et al. (2007) demonstrate that correlation between pre- and post-intervention scores (ρ) influences analysis power; when $\rho > 0.5$, change score is more powerful than direct post-intervention comparison. However, when ρ lies between 0.2 and 0.8, ANCOVA (controlling for baseline score) further reduces the required sample size by 10-40% over change score. Given that preliminary data suggest ρ ~ 0.5 (Routhier, Kirby, Demers, Depa, & Thompson, 2012), ANCOVA should provide the most powerful analysis, in addition to reducing error variance and allowing modification when statistical assumptions are not met (Dimitrov & Rumrill, 2003). Diagnostic assessments were conducted for model assumptions and significance testing (p) and estimated marginal means (EMM) with 95% confidence intervals were estimated. Effect size was calculated as a ratio of the effect and total sums of squares (η_p^2), as well as Hedge's g with a 95% confidence interval for end-point, EMM and change scores. Hedge's g can accommodate for unequal sample sizes and corrects for variance differences between groups as well as a positive bias with small sample sizes inherent in Cohen's d (Lakens, 2013). Hedge's g values of 0.2, 0.5 and 0.8 and η_p^2 values of 0.01, 0.06 and 0.14 were used to differentiate small, medium and large effect sizes, respectively (Cohen, 1988).

One argument for potential improvement in wheelchair skills using the EPIC Wheels program is the inducement of subjects to use their wheelchair more, rather than the specific content of the training program. The factorial design, with Extra Wheeling as a second factor, was used to address this question. The interaction between Treatment group and Extra Wheeling group was examined using a two-way ANCOVA controlling for baseline WST-C score to delineate whether additional wheeling had a synergistic or antagonistic effect on training program.

The second study objective was *to evaluate the effect of EPIC Wheels on the secondary clinical outcomes*. ANCOVA was used to compare post-treatment scores between groups for wheelchair skill safety (WST-S), wheelchair confidence (WheelCon), satisfaction with performance of meaningful activities (MeanSat scores for WhOM Indoor and WhOM Outdoor), mobility (LSA), safety risk (WWT) and quality of life (HUI). In each case, baseline score was used as a covariate. Endpoint and change score analysis of variance (ANOVA) tests were also conducted to compare precision with ANCOVA for sensitivity analyses. Means and standard deviations are reported for pre, post and change scores for each measure.

5.3 Results

5.3.1 Participants

A total of 15 participants were enrolled in the study over 31 months (Vancouver n = 9; Winnipeg n = 6). A detailed summary of recruitment and participant demographics was provided in chapter 4. One participant (W02) from the EPIC Wheels treatment group withdrew due to health issues that arose shortly after enrolment; he did not engage in tablet training, attend the second in-person training session or attend the post-intervention data collection. This participant had been contacted regularly over a period of 18 months in an attempt to resume training, after which point the participant asked to be removed from the study. A second participant in the EPIC Wheels group (V06) sustained a shoulder injury during the study period (unrelated to wheelchair training activities). The participant re-aggravated the injury immediately prior to DC2 and had considerable difficulty or was unable to attempt a number of the skills on the WST; however, this participant was able to complete the remaining outcome measures comfortably. Consequently, the WST was readministered with this participant approximately eight weeks later, after the effects of the shoulder injury had resolved; the WST reassessment results are reflected in an adjusted WST-C score for the EPIC Wheels group.

5.3.2 Missing data

All participants remained in the group to which they were allocated. However, post-treatment data were missing for W02 because he withdrew from the study. One option available was to analyze the data on a per-protocol basis using a case deletion approach and analyze only complete data sets (Tabachnick & Fidell, 2007). A Missing Values Analysis returned a non-significant result (Little's MCAR test Chi squared statistic = 0.00) and, since the participant withdrew due to health issues that arose almost immediately after enrolment rather than factors related to the training program, these data could be assumed to be missing completely at random (MCAR) and a case deletion approach used (Armijo-Olivo, Warren, & Magee, 2009). One limitation of this approach is the loss of information, approximately 6.7% of the complete data set, and potential lowering of statistical power (Dong & Peng, 2013). However, the literature suggests that when missing data is less than 5-10%, non-systematic, and does not affect multiple participants (Patrician, 2002), the potential bias on statistical analysis is relatively inconsequential and analysis of complete cases may be appropriate (Dong & Peng, 2013; Groenwold, Moons, & Vandenbroucke, 2014; Barnes, Lindborg, & Seaman, 2006). A second approach would be to estimate the post-treatment outcome values using a multiple imputation approach (Rubin, 1977) and analyze on an intention to treat basis. While this is acceptable given the MCAR assumption defined previously, the substantial amount of data being imputed (i.e., all post-treatment responses for W02) and the limited volume of remaining data upon which to formulate a regression-based imputation would suggest the resultant values ought to be considered with caution. Some sources also question the appropriateness of imputing values for participants with uncollected outcomes (Armijo-Olivo, Warren, & Magee, 2009), so neither option is without issue (Altman, 2009). Consequently, given the limited amount of missing data restricted to a single participant the MCAR circumstances related to drop-out, the data analysis was initially conducted using a case deletion approach (n=14) and then the potential impact of imputed values for the missing data (n=15) was also reported for comparison (Altman, 2009; Tabachnick & Fidell, 2007). Prior to analysis, assumptions for ANCOVA statistical viability were confirmed (see Appendix P). Independence of the covariate and treatment effect was established through the study design (i.e., randomization) and confirmed via between-groups analysis of pre-test WSTC scores ($t = 0.64$; df = 12; $p = 0.53$) demonstrating no statistically significant difference.

5.3.3. Summary of scores

A summary of group mean pre- and post-test scores, as well as mean change scores, for the primary and secondary outcome measures, is provided in Table 5.1 (n=14). Table 5.2 provides a summary of the estimated marginal mean (EMM) scores for each group (i.e., means adjusted for baseline score) and effect sizes including η_p^2 (for ANCOVA analysis) as well as Hedge's *g* for EMM, end-point and change scores. To simplify presentation, WST-C and WST-S scores were converted from percentage to decimal format.

5.3.4 Primary outcome: WST Capacity

Comparison between the treatment and control group using ANCOVA revealed no significant difference in skill capacity score post-intervention when adjusting for baseline score ($F = 0.35$; $p = 0.57$; $\eta^2 = .03$). The estimated marginal mean post-intervention WST-C scores were 65.0% (SE = 3.9; 95% CI 56.5, 73.5) for the EPIC Wheels group and 68.2% (SE = 3.9; 95% CI 59.7, 76.7) for the control group, for a mean difference of 3.3% (SE = 5.5; 95% CI -8.9, 15.4).

Table 5.1 Summary of pre- and post-test scores for EPIC Wheels (n=7) and Control group (n=7)

Outcome Measure[a]	EPIC Wheels			Control Group		
	Pre-test Mean ± SD	Post-test Mean ± SD	Change score Mean ± SD	Pre-test Mean ± SD	Post-test Mean ± SD	Change score Mean ± SD
WST-C	0.672 ± 0.170	0.676 ± 0.174	0.003 ± 0.068	0.615 ± 0.167	0.656 ± 0.180	0.041 ± 0.080
WST-C Adj†	0.672 ± 0.170	0.707 ± 0.174	0.035 ± 0.068			
WST-S	0.978 ± 0.047	0.996 ± 0.012	0.018 ± 0.035	0.960 ± 0.043	0.951 ± 0.067	-0.009 ± 0.035
WheelCon	66.8 ± 11.6	79.8 ± 13.4	13.0 ± 9.1	71.6 ± 14.6	73.1 ± 13.5	1.5 ± 5.0
WhOM-IN	4.9 ± 1.2	6.7 ± 1.9	1.8 ± 0.9	5.0 ± 3.1	6.3 ± 3.1	1.2 ± 1.6
WhOM-OUT	4.6 ± 1.1	6.9 ± 1.6	2.3 ± 1.2	5.1 ± 3.2	5.2 ± 2.9	0.1 ± 1.7
LSA	42.4 ± 20.1	48.8 ± 18.3	6.4 ± 10.4	44.6 ± 11.2	43.4 ± 28.1	-1.2 ± 20.6
WWT‡	5.5 ± 5.6	4.0 ± 6.5	-1.5 ± 9.9	6.3 ± 4.8	8.4 ± 6.2	2.1 ± 1.9
HUI	0.14 ± 0.23	0.32 ± 0.20	0.18 ± 0.23	0.31 ± 0.23	0.35 ± 0.37	0.04 ± 0.15

[a] WST-C = Wheelchair Skills Test Capacity; WST-S = Wheelchair Skills Test Safety; WheelCon = Wheelchair Use Confidence Scale; WhOM = Wheelchair Outcome Measure; LSA = Life-Space Assessment; WWT = Wheeling While Talking test; HUI = Health Utilities Index

† DC2 reassessment score used for participant V06 because of upper body injury sustained immediately prior to DC2

‡ Lower scores are better

Table 5.2 Effect sizes for estimated marginal mean, end-point and change scores for EPIC Wheels (n=7) and Control group (n=7)

Outcome Measure[a]	EPIC EMM	Control EMM	η_p^2 *	Hedge's *g* (95% CI)		
				EMM	End point	Change score
WST-C	0.650	0.682	0.03	-0.29 (-0.35; -0.24)	0.11 (0.01; 0.20)	-0.48 (-0.52, -0.44)
WST-C adjusted†	0.680	0.684	0.01	-0.04 (-0.09; 0.02)	0.27 (0.18; 0.36)	-0.08 (-0.12; -0.04)
WST-S	0.989	0.958	0.19	0.85 (0.84; 0.87)	0.88 (0.85; 0.90)	0.72 (0.70, 0.74)
WheelCon	81.2	72.2	0.28	1.07 (-3.07; 5.21)	0.47 (-6.58; 7.51)	1.47 (-2.38; 5.31)
WhOM (Indoor)	6.8	6.2	0.05	0.42 (-0.29; 1.12)	0.17 (-1.18; 1.52)	0.37 (-0.55, 1.29)
WhOM (Outdoor)	7.1	5.0	0.40	1.35 (0.59; 2.11)	0.72 (-0.45; 1.88)	1.40 (0.63, 2.17)
LSA	48.6	41.3	0.06	0.43 (-7.88; 8.74)	0.21 (-12.21; 12.63)	0.44 (-8.11, 8.98)
WWT‡	3.8	7.4	0.09	0.53 (-2.80; 3.86)	0.57 (-4.14; 3.09)	0.65 (-2.68, 3.98)
HUI	0.38	0.27	0.08	0.47 (0.36; 0.58)	0.07 (-0.04; 0.18)	0.68 (0.57, 0.78)

[a] WST-C = Wheelchair Skills Test Capacity; WST-S = Wheelchair Skills Test Safety; WheelCon = Wheelchair Use Confidence Scale; WhOM = Wheelchair Outcome Measure; LSA = Life-Space Assessment; WWT = Wheeling While Talking test; HUI = Health Utilities Index

* Higher value is better

† DC2 reassessment score used for participant V06 because of upper body injury sustained immediately prior to DC2

‡ Lower scores are better

Similarly, comparison between Extra Wheeling and No Extra Wheeling groups revealed no statistically significant difference and nominal effect size (F = 0.04; p = 0.84; η^2 = 0.01), with estimated marginal mean post-intervention WST-C scores of 67.1% (SE = 3.4; 95% CI 59.6, 74.7) and 65.7% (SE = 4.6; 95% CI 55.6, 74.7), respectively for a mean difference of 1.4% (SE = 5.7; 95% CI -11.2, 14.1). All assumptions for ANCOVA with the Extra Wheeling data were confirmed.

When the interaction between intervention and Extra Wheeling group was examined using a two-way ANCOVA controlling for baseline WST-C score, no statistically significant effect was observed (F = 0.17; p = 0.69; η^2 = 0.02). Neither of the two factors (Group or Extra Wheeling) presented a statistically significant main effect (Group: F = 0.17; p = 0.69; η^2 = 0.02; Wheeling: F = 0.08; p = 0.79; η^2 = 0.01). A detailed summary of these analyses output is provided in Appendix Q.

5.3.4.1 Imputed data analysis

A multiple imputation (MI) approach was used to replace the missing post-treatment data from participant W02. Since the missing data appears in a monotone fashion (i.e., for a single participant, all subsequent is missing), a Markov Chain Monte Carlo method with full specification was employed, using SPSS 23. This application uses a linear regression-based process to generate plausible but randomly obtained values to replace the missing ones (van Ginkel & Kroonenberg, 2014). All pre- and post-treatment outcome measure scores were included as predictor variables. While 3-5 iterations are often considered sufficient (Tabachnick & Fidell, 2007), ten iterations were obtained to ensure a robust result. The MI procedure produced ten sets of data as well as pooled parameter estimates and variances. After splitting the data file by iteration, subsequent analyses were conducted using the ten data sets.

The MI parameter estimate of the mean WST-C score for the EPIC Wheels group was 65.9% (SD = 19.3) and the estimated marginal means were 63.4% (SE = 5.5, 95% CI 52.4; 74.4) for EPIC Wheels group and 68.5% (SE = 4.7; 95% CI 59.4; 77.6) for the control group with a mean difference of 5.1% (SE = 7.3). Using the pooled estimates, ANCOVA analysis revealed no statistically significant difference between treatment groups, with small effect size ($F = 0.48$, $p = 0.49$, $\eta^2 = .05$). The estimated marginal means were 67.4% (SE = 6.7; 95%CI 49.8; 76.9) for Extra Wheeling and 63.4% (SE = 6.7; 95%CI 49.8; 76.9) for No Extra Wheeling, with a mean difference of 4.0% (SE = 7.9). ANCOVA analysis revealed no statistically significant difference between Wheeling groups with a small effect size ($F = 0.26$, $p = 0.61$, $\eta^2 = .05$). Finally, the two-way ANCOVA evaluating the interaction effect between treatment group and Extra Wheeling group found no statistically significant effect and small effect size ($F = 0.00$; $p = 0.99$; $\eta^2 = 0.04$). Neither of the two factors (Treatment Group or Extra Wheeling) presented a statistically significant main effect (Group: $F = 0.38$; $p = 0.54$; Wheeling: $F = 0.11$; $p = 0.74$). Table 5.3 presents a comparative summary of findings for the case deletion and multiple imputation analyses.

Table 5.3 Comparative summary of analyses for case deletion and MI analyses for WST-C scores

Method	Case Deletion					Multiple Imputation				
Group	Mean[a] (SD)	EMM[b] (SE)	Mean Diff[c] (SE)	ANCOVA	2-way ANCOVA	Mean[a] (SD)	EMM[b] (SE)	Mean Diff[c] (SE)	ANCOVA	2-way ANCOVA
EPIC	67.6 % (18.1)	65.0 % (3.9)	3.3 % (5.5)	$F = 0.35$ $p = 0.57$	$F = 0.17$ $p = 0.69$	65.9 % (19.3)	63.4 % (5.5)	5.1 % (7.3)	F = 0.48 $p = 0.49$	$F = 0.00$ $p = 0.99$
Control	65.6 % (18.0)	68.2 % (3.9)				65.6 % (18.0)	68.5 % (4.7)			
Wheeling YES	67.5 % (18.7)	67.1 % (3.4)	1.4 % (5.7)	$F = 0.04$ $p = 0.84$		67.5 % (18.7)	67.4% (6.7)	4.0 % (7.9)	F = 0.26 $p = 0.61$	
Wheeling NO	65.0 % (16.7)	65.7 % (4.6)				63.2 % (18.3)	63.4% (6.7)			

[a] Mean post-treatment WST-C score

[b] Estimated Marginal Mean for post-treatment WST-C score

[c] Mean difference between groups for EMM

5.3.5. Secondary outcomes

Analyses using ANCOVA (controlling for baseline score) were conducted for each secondary outcome and reported in Table 5.4. Group differences were statistically significant for the WheelCon and WhOM (Outdoor) measures and approaching statistical significance for the WST (Safety) measure.

Table 5.4 ANCOVA results for secondary outcome measures

Outcome Measure[a]	*F*	*P*	η_p^2	EMM ± SE (95% CI)	
				EPIC Group	Control Group
WST-S	2.61	0.14	0.19	0.989 ± 0.013 (0.959; 101.8)	0.958 ± 0.013 (0.928; 0.987)
WheelCon	**4.35**	**0.06***	**0.28**	**81.2 ± 3.0 (74.5; 87.9)**	**72.2 ± 3.0 (65.5; 78.9)**
WhOM Indoor	0.61	0.45	0.05	6.8 ± 0.5 (5.6; 7.9)	6.2 ± 0.5 (5.1; 7.3)
WhOM Outdoor	**7.31**	**0.02***	**0.40**	**7.1 ± 0.5 (5.9; 8.3)**	**5.0 ± 0.5 (3.8; 6.2)**
LSA	0.75	0.41	0.06	48.6 ± 6.0 (35.4; 61.8)	41.3 ± 6.0 (28.0; 54.5)
WWT‡	1.12	0.31	0.09	3.8 ± 2.4 (-1.5; 9.1)	7.4 ± 2.4 (2.1; 12.7)
HUI	0.94	0.35	0.08	0.373 ± 0.078 (0.208; 0.549)	0.270 ± 0.078 (0.099; 0.441)

[a] WST-C = Wheelchair Skills Test Capacity; WST-S = Wheelchair Skills Test Safety; WheelCon = Wheelchair Use Confidence Scale; WhOM = Wheelchair Outcome Measure; LSA = Life-Space Assessment; WWT = Wheeling While Talking test; HUI = Health Utilities Index
* Statistically significant result
‡ Lower scores are better

5.3.6 Sensitivity analyses

ANCOVA analyses were re-run using MI for each secondary measure with the following results: WST-S (F 1,12 = 0.68; p = 0.41); WheelCon (F 1,12 = 3.27; p = 0.07); WhOM Indoor (F 1,12 = 0.39; p = 0.53); WhOM Outdoor (F 1,12 = 6.51; p = 0.01); LSA (F 1,12 = 0.84; p = 0.36); WWT (F 1,12 = 1.01; p = 0.31); and HUI (F 1,12 = 0.85; p = 0.36). Additional analyses were conducted using ANOVA to compare treatment groups using end point scores as well as change scores. WST-C scores were also evaluated after adjusting for the V06 participant reassessment. A summary of the results for end-point and change scores is presented in Table 5.5. For both the case deletion and MI methods, statistically significant differences were observed in change score for the WheelCon and WhOM (Outdoor) measures. There was a high correlation between pre- and post-treatment WST-C scores (Pearson R = 0.84, p = 0.00 for original data; R = 0.91, p = 0.00 for V06 adjusted) and no statistically significant correlation between baseline and change score for the WST-C (Pearson R = -0.20, p = 0.50 for original V06; R = -0.211, p = 0.71 for V06 reassessment). These findings support analyses using ANCOVA controlling for baseline (versus direct end point comparison) and change score comparison (Borm, Fransen, & Lemmens, 2007).

Table 5.5 ANOVA analyses of end-point and change scores

Method	Case Deletion (n=14)				Multiple Imputation (n=15)			
Measure[a]	End-point Score		Change Score		End-point Score		Change Score	
	F (df)	*p*	*F* (df)	*p*	*F* (df)	*p*	*F* (df)	*p*
WST-C	0.04 (1,12)	0.84	0.53 (1,12)	0.48	0.01 (1,13)	0.98	0.65 (1,13)	0.42
WST-C adjusted†	0.28 (1,12)	0.61	0.01 (1,12)	0.98	0.08 (1,13)	0.78	0.15 (1,12)	0.70
WST-S	3.00 (1,12)	0.11	2.02 (1,12)	0.18	1.32 (1,13)	0.25	0.51 (1,13)	0.48
WheelCon	0.79 (1,12)	0.39	**5.12 (1,12)**	**0.04***	0.72 (1,13)	0.40	**3.76 (1,13)**	**0.05***
WhOM Indoor	0.11 (1,12)	0.75	0.95 (1,12)	0.35	0.38 (1,13)	0.57	0.72 (1,13)	0.44
WhOM Outdoor	1.85 (1,12)	0.20	**7.80 (1,12)**	**0.02***	1.20 (1,13)	0.30	**7.52 (1,13)**	**0.02***
LSA	0.41 (1,12)	0.54	0.82 (1,12)	0.38	0.36 (1,13)	0.55	0.91 (1,13)	0.34
WWT	0.94 (1,12)	0.35	1.15 (1,12)	0.30	0.91 (1,13)	0.34	1.16 (1,13)	0.28
HUI	0.01 (1,12)	0.98	1.45 (1,12)	0.25	0.01 (1,13)	0.96	1.31 (1,13)	0.25

[a] WST-C = Wheelchair Skills Test Capacity; WST-S = Wheelchair Skills Test Safety; WheelCon = Wheelchair Use Confidence Scale; WhOM = Wheelchair Outcome Measure; LSA = Life-Space Assessment; WWT = Wheeling While Talking test; HUI = Health Utilities Index

† DC2 reassessment score used for participant V06 because of upper body injury sustained immediately prior to DC2

* Statistically significant result; df = degrees of freedom

5.4 Discussion

The first objective, with respect to clinical outcome measures, was to determine the impact of the EPIC Wheels program on wheelchair skill capacity. Analyses did not identify a statistically significant different between the EPIC Wheels and control groups, and the effect size was minimal, explaining 3% or less of variance in scores; MI and sensitivity analyses did not suggest any statistical difference. When adjustment was made for the V06 participant reassessment, the relative improvement in both intervention groups was comparable and small, although slightly greater than the proposed minimal detectable change of 3%; over three-quarters of the participants demonstrating a change of less than 5% in skill capacity. Other case mix variables (evaluated through bivariate association - results not presented) such as age, grip strength and length of MWC use, as well as dose-related factors such as total training or tablet-specific training time, did not uncover any statistically significant associations with change in skill capacity score. Two EPIC Wheels group participants were unable to recruit a spotter for home training activities; however, their WST-C change scores were not ostensibly different from others in this cohort.

Wheelchair skill capacity was selected as the primary measure of intervention effectiveness based on the results of other training studies and the proximal relationship to a skills-based intervention. It was somewhat surprising there was not a larger increase in capacity score and that a difference between groups was not apparent and our hypothesis of a statistically significant group difference and a clinically important improvement in the EPIC Wheels group was not supported. Previous studies related to in-person wheelchair skills training have looked primarily at improvement in skill capacity and reported a larger change in capacity score (MacPhee, Kirby, Coolen, Smith, MacLeod, & Dupuis, 2004; Best, Kirby, Smith, & MacLeod, 2005; Ozturk & Ucsular, 2011). It might be anticipated that this intensive in-person training (e.g. 3-9 hours of 1:1 contact) would elicit a more direct impact on skill capacity, particularly given the relationship between the intervention (i.e., WSTP) and the outcome measure (i.e., WST). One explanation for the limited change in the EPIC Wheels study may be that participants experienced qualitative improvements to their existing skill set, rather than acquiring additional skills. For example, at DC1 a participant might have been able to propel their wheelchair 100 meters independently (i.e., scored "2" on WST skill #14), but after receiving training on efficient propulsion techniques, they might experience less fatigue and upper extremity discomfort and be able to engage in activities such as shopping or laundry, which they were unable to prior to training. The WST 4.2 does provide some gradation in score, with each skill being rated as a 0, 1 or 2; however, this scale may not be sensitive enough to capture such qualitative improvements. One criticism of the WST is that it measures what individuals *can* do (capacity) rather than what they *actually* do (performance) (Inkpen, Parker, & Kirby, 2012). It may be that participants experienced improvements in their wheelchair use in real world conditions, rather than their capacity to demonstrate discrete skills in the structured and potentially unfamiliar context of the lab-based WST. Similarly, a participant might have been capable of propelling their wheelchair up a ramp (i.e., in a controlled testing situation) but would never actually attempt this maneuver in the community because of the perceived difficulty or risk, whereas after training they might feel sufficiently proficient and confident to do so.

Another possible contributing factor may have been a lack of stability in the WST-C measure. One might anticipate that baseline measurement would accurately describe existent skill capacity and post-treatment measurement would capture improvement in performance. Among all participants, there were 47 instances of improvement across 25 of the 32 skills assessed (i.e., an increase of 1 or 2 points). However, there were also 20 instances across 14 separate skills where a decrease of 1 or 2 points was observed, suggesting that skill capacity on these items *diminished* over the course of the study and obviated, to some extent, the improvements incurred. On the one hand, it may be that wheelchair performance does fluctuate considerably among older adults, depending upon the time, context and state of health. Alternately, if one assumes that skills acquired are maintained over the short term (i.e., 4-6 weeks), lack of measurement consistency and precision may have been a contributing factor. Test-retest reliability of the WST-C 4.1 has been reported to be very high (ICC = 0.901; 95% CI 0.768; 0.961) but psychometric evaluation was conducted with younger individuals (42.1 ± 16.2 years) with considerably greater experience using a wheelchair (9.7 ± 9.6 years) (Lindquist, Loudon, Magis, Rispin, Kirby, & Manns, 2010).

A third explanation for the lack of significant change in capacity is the contiguous nature of data collection and training. Post-intervention data collection typically occurred within a week of concluding training. Sakakibara et al (2013) found that a condensed training program with novice MWC users had a more immediate and substantive impact on self-efficacy rather than on skill capacity and, consistent with the tenets of Social Cognitive Theory, increased confidence could influence motivation and subsequent practice leading to further capacity gains over time (Bandura, 1997). Participants in the EPIC Wheels group might have demonstrated larger gains had there been a longer period to consolidate skills between training and data collection. This may have implications for future study design. Given the 4-week period of training and the observation that some participants didn't access the entire home program content or didn't get to some material until the final weeks of the home program, a longer latency period between training and data collection may prove to be a more accurate measure of change.

The effect of the second experimental factor, Extra Wheeling, was also not evident in a difference in skill capacity. This factor was incorporated to protect against a potentially confounding situation wherein the impact of increased wheelchair use demands while completing the EPIC Wheels training program might contribute to skill improvement, rather than the specific program content and method of delivery. The lack of a statistically significant difference between Extra Wheeling groups and the lack of a significant interaction effect suggests that simply increasing wheelchair use does not improve skills, nor does it increase or decrease the potency of the EPIC Wheels training program. This is consistent with principles of motor learning theory that suggest that considerable practice and repetition is required to learn a motor skill but such practice needs to be skill-specific and focused (Muratori, Lamberg, Quinn, & Duff, 2013).

The intent of a wheelchair training program is to improve safe and effective use in order to prevent accidents and injury; increase independence, community participation and activity engagement; and decrease care provider burden and risk. The second objective of this study was to evaluate the EPIC Wheels training effect on measures that reflect these goals. It was originally anticipated that these outcomes would be more difficult to realize than skill capacity; however, the reverse was true. All of the secondary measures in this study reported higher or better mean post-treatment scores (both raw and estimated marginal means) for the EPIC Wheels group, although not all were statistically significant. The WheelCon and WhOM (Outdoor) measures did demonstrate statistically significant higher mean scores and these differences were confirmed by the sensitivity analyses using MI and change score ANOVA. Cohen (1988) has proposed that Hedge's *g* values of 0.2, 0.5 and 0.8 and η_p^2 values of 0.01, 0.06 and 0.14 can indicate small, medium and large effect sizes, respectively. Both measures surpassed a Hedge's *g* of 1.0 and η_p^2 of 0.28, suggesting a substantive impact. In studies with small sample sizes, clinically important differences can be uncovered even when statistical significance is not achieved (Johnson, McMorris, Raynor, & Monsen, 2013). The WST Safety had a medium to large effect size with 19% of variance explained by group allocation and the remaining measures (WhOM Indoor, LSA, WWT and HUI) had small to medium effect sizes (Hedge's *g* of 0.42 to 0.68), although the explained variance was substantially smaller. A further examination of the findings will be undertaken in the following section.

These secondary measures provide some evidence that the EPIC Wheels group saw a clinically important improvement in their wheelchair use and impact on community participation. The most apparent impact appeared to be on confidence with wheelchair use, as indicated by the WheelCon results. The mean improvement of 9.0 exceeds the threshold (SEM = 5.9) for meaningful change beyond measurement error for groups (Rushton, Miller, Kirby, & Eng, 2013), but is less than the improvement of 13.7 reported in a study of older adults with no MWC experience (Sakakibara, Miller, Eng, Backman, & Routhier, 2013). The EPIC Wheels program explicitly incorporated strategies to address self-efficacy, as identified in previous chapters. Low wheelchair confidence is fairly common among older adults; a recent study reported a prevalence rate of 39% (95%CI 29.0; 49.0) among community-dwelling MWC users over 50 years of age scoring in the "low confidence" range (i.e., below their defined threshold of 80%) on the

WheelCon (Sakakibara & Miller, 2015). In the EPIC Wheels study, the overall rate of participants scoring in the low range was double this rate at 78.6%. The percentage EPIC Wheels participants in the low confidence range dropped from 85.7% to 42.9% after treatment, while the rate among control group participants rose from 71.4% to 85.7%. Mean baseline WheelCon scores for both men (71.6, SD =11.8) and women (57.3, SD = 8.1) were lower than those reported in another study with comparable inclusion criteria (86.8, SD = 10.7 and 72.1 SD = 23.2, respectively) (Sakakibara, Miller, Eng, Backman, & Routhier, 2013). In the EPIC Wheels study, two female participants had the lowest WheelCon scores, both at baseline and post-intervention, consistent with literature that suggests older adult women tend to have less confidence with wheelchair use (Sakakibara, Miller, & Rushton, 2015).

Higher confidence increases the likelihood that an individual will see goals as attainable and persevere in the face of potential barriers (Bandura, 1997). Sakakibara et al (2013) found that skills training enhanced wheelchair-specific self-efficacy among a group of older adults with no wheelchair experience. Furthermore, enhancing wheelchair-specific self-efficacy improves life-space mobility (Sakakibara, Miller, & Rushton, 2015) as well as perceptions of social participation (Sakakibara, Miller, Routhier, Backman, & Eng, 2014; Sakakibara B. , Miller, Eng, Backman, & Routhier, 2013) among older adult wheelchair users. The current study results are consistent with these findings, in that EPIC Wheels skills training was associated with a statistically significant increase in self-efficacy (i.e., WheelCon scores) as well satisfaction with participation in important life roles (i.e., WhOM). Self-efficacy has a demonstrated direct impact on participation frequency, as well as an indirect effect via improvements in mobility and perceptions of participation (Sakakibara, Miller, Routhier, Backman, & Eng, 2014). These findings support the underlying theoretical relationship suggested by Sakakibara et al, although the specific path or direction of influence between these variables is speculative at this point. It is conceivable that, consistent with Social Cognitive Theory (Bandura, 1997), the EPIC Wheels training would initially impact wheelchair-specific confidence more strongly than ability (i.e., WST-C score) and, as participants expand their willingness to use the wheelchair in increasingly challenging environments, additional skill capacity is realized.

The WhOM measure, addressing Outdoor activities, achieved statistical significance as well. The mean change score for EPIC Wheels participants was 1.86 for Indoor and 2.33 for Outdoor activities, both of which exceed the $MDD_{95\%}$ threshold of 1.61, indicating a clinically important change (Miller, Garden, & Mortenson, 2011). The WhOM measures indicate increased satisfaction with performing wheelchair-related participation outcomes self-identified as being relevant to participants. Rather than prescribing activities as some participation measures do, the WhOM asks participants to select activities that reflect important components of participation for them in real life situations, both within the home and in the community. Wheelchair users identify that environmental obstacles present barriers to engagement in community-based activities, such as inclines, curbs and irregular surfaces (Giesbrecht, Miller, & Woodgate, 2015). It may be that through improvement in the quality of skill performance and confidence with wheelchair use, older adult MWC users might be better able to negotiate such obstacles and increase their engagement in meaningful activities.

Enhancing wheelchair-specific self-efficacy has also been associated with improvements in life-space mobility (Sakakibara, Miller, Eng, Backman, & Routheir, 2014). EPIC Wheels participants did obtain a mean LSA change score of 6.4 (SD = 10.4); however, this is less than the 10-point difference indicative of a clinically meaningful change (Kammerlind, Fristedt, Bravell, & Fransson, 2014; Baker, Bodner, & Allman, 2003) and the effect size was small. The LSA measure asks participant to reflect on their mobility habits over the previous month and, given that the EPIC Wheels program is 4 weeks in duration, participants may not have had sufficient opportunity or time to adapt their mobility patterns before attending the post-treatment data collection session. It may also be that participants experienced an improvement in the quality or number of activities engaged in within a particular life space, rather than the frequency of travel or extended geographical distance. Weather and seasonal effects during training periods, such as rain and snow, may have limited participants' travel patterns.

The study findings also provide evidence that the EPIC Wheels intervention promotes increased safety and reduced risk of injury due to inappropriate or unsafe wheelchair use. The WST Safety outcome had a medium to large effect size, with 19% of variation in score explained by treatment group. In addition, the WWT measure also demonstrated a medium to large effect size, with a η_p^2 value of 0.09. It appears that participants in the EPIC Wheels group had improvements in safe operation of their wheelchair and were less impacted by divided-attention demands (Giesbrecht & Miller, 2013). Such improvements could be beneficial in decreasing wheelchair accidents, tips/falls and collisions with objects or people, which are common among wheelchair users and particularly older adults (Kirby, Ackroyd-Stolarz, Brown, Kirkland, & MacLeod, 1994; Gavin-Dreschnack, et al., 2005). These effects could also impact wheelchair skill performance, as older adult MWC users may be more willing to attempt skills and engage in activities if they are (legitimately) less fearful of adverse events occurring. Safer wheelchair operation may also lessen the demand for care providers to provide constant supervision and assistance as well as decrease their anxiety if they are more confident in the MWC user's capacity to make wise decisions and operate their wheelchair safely. Decreasing care provider burden, both physically and emotionally, would be a substantial benefit as chapter two of this dissertation identified the pervasive and overwhelming responsibility care providers assume with the transition to wheeled mobility.

The various benefits realized by the EPIC Wheels participants may have had an impact on their perceived quality of life. When considering change score, there was a small to medium effect size among EPIC Wheels participants on the HUI measure. The mean change score of 0.18 exceeds the threshold of 0.03 for a Minimally Important Difference (Luo, Johnson, & Coons, 2010). It seems reasonable that older adults who are more confident and satisfied in using their MWC to engage in relevant activities both inside and outside their home, and who may also operate their wheelchair more safely and broadly within their life-spaces, are also likely to experience a better health-related quality of life (Hosseini, Oyster, Kirby, Harrington, & Boninger, 2012).

5.5 Limitations

There are several study limitations that should be noted. Significant challenges with recruitment resulted in a sample size smaller than the study originally intended. Consequently, the power to detect statistically significant differences was compromised. While all of the secondary measures favoured the EPIC Wheels group and most had at least a medium effect size, four had non-significant results. The primary outcome of wheelchair skill capacity appeared to be equivocal between groups, but a larger sample might elucidate a difference, as well as secondary measures with small to medium effect sizes reported. As noted earlier, the contiguous positioning of data collection following training may not have provided a sufficient period for consolidation of learning. Similarly, some of the secondary measures asked participants to consider score their performance based on a preceding period of time (e.g. LSA: "over the last four weeks") which would have including the training period, rather than evaluation of a period of time post-intervention. A longer latency period might have produced different post-treatment scores. Ideally, an RCT would incorporate some post-intervention data collection to measure retention. Given the purpose of the study (i.e., to establish feasibility of the study and intervention components), caution regarding ambitious analyses of the outcome effects, and the need to first establish some indication of benefit (Tickle-Degnen, 2013; Thabane, Ma, & Chu, 2010), we elected to postpone integration of retention follow-up to a subsequent large scale RCT. However, the lack of retention data collection meant that we could not determine whether participants retained any improvement in score or demonstrated continued improvement.

The use of a more liberal *p* value of 0.10 was used intentionally to promote identification of group differences in a small sample feasibility study; however, such a decision always presents a higher risk of a type I error, such as identifying statistically significant differences in the WheelCon and WhOM measures that are unwarranted. In addition, the lack of adjustment for multiple testing would also increase the risk of identifying a group difference as statistically significant when it might be due to chance. However, the secondary measures were exploratory in nature, without a priori end-point expectations, and the large effect sizes reported for these measures would suggest that the differences noted were unlikely to be obtained by chance.

The loss of one participant out of 15 represents a relatively low dropout rate, but still presented challenges for statistical analysis. The use of MI to replace the missing values for this participant offered some increase in power due to the larger sample size, but also leads to greater variance due to the multiple imputed values employed in the analyses. Calculating both case-deletion and MI results, as well as additional sensitivity analyses, provided a more thorough evaluation and comparison of results. In addition to allocation on the basis of Treatment group and Extra Wheeling group, participants were also randomized on the basis of study site. Given the sample size, it was not practical to integrate strata into the statistical analyses; in future study with larger recruitment, stratification based on site should be included.

The use of voluntary participants may have contributed to an overly optimistic evaluation of the intervention. It is possible that individuals responding to study advertisements were more motivated and resourceful than the broader population of older adult MWC users. Several measures included are self-report outcomes and social desirability may have influenced participant responses; however, these factors might be expected to influence both the treatment and control groups equally. Inclusion criteria are intended to create a more homogenous sample and control for confounding variables. The changes made to the inclusion criteria over the course of the study increased heterogeneity and could have impacted the findings (Lösch & Neuhäuser, 2008). For example, introducing younger participants could have increased the likelihood of demonstrating a change in wheelchair skill capacity and self-confidence, as increasing age is negatively associated with these outcomes. Alternately, extending the acceptable length of wheelchair use might have reduced to chance of realizing improvement in performance as patterns of use become more entrenched. In addition, the generalizability of the results to the older adult population and novice wheelchair users becomes more difficult given the criterion changes noted above.

5.6 Conclusion

The results of this feasibility study indicate a small improvement in wheelchair skill capacity for both groups, slightly larger than the minimally detectable change value, with no significant between-group difference. The EPIC Wheels participants had higher scores on all the secondary outcome measures with effect sizes ranging from small to large, with significant differences in wheelchair-specific self-efficacy and satisfaction with participation in outdoor activities scores. Because the primary purpose of the study was to determine feasibility, rather than treatment effect, as well as the small sample size, considerable caution should be exercised in the interpretation of the clinical outcomes. The findings do present some promising evidence that the EPIC Wheels intervention can provide clinically important benefits for older adult manual wheelchair users. The effect size estimate for wheelchair skill capacity was muted, which might present some concern for its use as the primary outcome in future studies. The benefits noted in some participants and the results from the phase 2 pilot study suggest that this may still be a useful indicator, but consideration should be given to using the WhOM or WheelCon as a primary measure. The training program appeared to have a positive impact on safe wheelchair operation as both the WST-S and WWT demonstrated medium to large effects sizes, although the group differences did not reach statistical significance.

6. Qualitative analysis of EPIC Wheels participant experience

6.1 Introduction

The previous chapter provided a summary of clinical outcome measures comparing the EPIC Wheels and control group interventions. The findings suggest that participants in both groups demonstrated small improvements in objective performance of wheelchair skills capacity, with no statistically significant difference between treatment groups. Medium to large effect sizes were found in the EPIC Wheels group for outcomes related to wheelchair-related safety, confidence and participation. Furthermore, the WheelCon, WhOM Outdoor and HUI change scores for EPIC Wheels participants were sufficiently large to indicate a clinically important difference. Collectively, the findings from chapter 5 provide some indication that the outcome measures selected for inclusion were appropriate, appeared to have a clinically beneficial impact, and provided effect size estimates appropriate for evaluation and sample size calculation in future study. Chapter 4 identified feasibility among most of the assessed indicators for process, resources, management and treatment, including strong affirmation for the relevance, expectations and benefit of the EPIC Wheels program in the post-treatment questionnaire results. Reasonably strong retention and program adherence rates reported in the chapter 4 also suggest that participants were invested in the training program. To obtain a more in-depth evaluation of EPIC Wheels' feasibility, we conducted follow-up interviews with participants to discuss their specific experience with the program and the impact it had.

The use of qualitative methods in conjunction with RCT studies in rehabilitation has been highly recommended to support construct validity of the quantitative outcome measures, identify additional contextual variables that mediate intervention active ingredients, and uncover unexpected findings (Campbell, et al., 2007; Rauscher & Greenfield, 2009). In addition to measuring the impact of an intervention on clinically related outcome measures, it is also important to obtain direct information from intervention recipients with regard to their experience. While the quantitative clinical measures reported in chapter 5 provide valuable group information, a qualitative approach can be used to elicit individual responses and experiences; this data can further inform the quantitative findings and identify commonalities and differences among group participants.

Exploring the benefits of skill training among EPIC Wheels participants would provide valuable information regarding what components of the intervention were perceived to be beneficial. This information can help elucidate what might be active ingredients of the intervention, which in turn provides additional information about feasibility. Components that are perceived to be critical should be retained, while those elements that participants see as equivocal or detrimental might be excluded or remediated before further study is conducted. In addition, participant interviews would enable exploration of apparent discrepancies between the primary and secondary clinical outcomes, which would also inform the study design and measures used in future studies. Given the integral role of care providers in facilitating mobility and community participation for older adult MWC users, and their role in undertaking the EPIC Wheels training program for many of the participants, their involvement in the follow-up interviews was important. By conducting separate interviews with the participant and their care provider, we could obtain additional perspective on the participant's experience with, and impact of, the EPIC Wheels program. This triangulation of data could confirm perceived clinical benefits and potentially highlight different perspectives or recollections of engagement with the intervention.

Consequently, a qualitative approach was used to obtain insight into and perceptions of participants' and their care providers' experiences with the EPIC Wheels program. This feedback can inform the evaluation of program feasibility and clinical impact. This chapter reports on the findings of the follow-up interviews with EPIC Wheels participants and their care providers. The specific objectives are to explore:

1. Participant experience with the delivery of the EPIC Wheels program;
2. Participant perceptions of the tablet-based training program; and
3. Impacts of the program on participants' participation experience.

6.2 Methods

6.2.1 Study design

A qualitative approach, involving individual semi-structured interviews, was used. Qualitative methods are well suited to gaining an understanding of participants' experiences (Creswell, 2003). Individual semi-structured interviews provided the opportunity to explore the unique experience of each participant without the threat of pressure to conform (Stokes & Bergin, 2006) and to explore the quantitative findings from chapters 4 and 5 in greater depth (Doody & Noonan, 2013). When participants and their care provider gave consent for the feasibility RCT study, they were offered the option to also provide consent and indicate their willingness to be contacted for a follow-up interview; all study participants agreed to contact and consent. Between March and July 2015, each participant who had completed the EPIC Wheels program and their care provider, if applicable, was invited to participate in a 60-90 minute follow-up interview. All EPIC Wheels participants were invited to provide maximum variation and diverse perspectives representative of the range of subjects (Kroll, Neri, & Miller, 2005; Ohman, 2005).

6.2.2 Data collection

A semi-structured interview guide was developed, consistent with principles of guide design (Ohman, 2005; Leech, 2002) (see Appendix R). The content of the interview guide was informed by the feasibility indicators reported on in chapter 4 (e.g. session attendance, training expectations), clinical outcomes reported on in chapter 5 (e.g. skills acquired, changes in confidence) and questions related to program impact on daily life (e.g. community use, activities engaged in). The interview guide outlined a series of open-ended questions, each with a subset of follow-up probes, to ensure comprehensive coverage of the areas of interest. The interview guide was pilot tested with graduate students in occupational therapy and then reviewed by an expert in qualitative research (Dr. Roberta Woodgate); several minor revisions were made to the final design and the wording of the guide was modified slightly for the interviews with care providers. Two research assistants at each site received training and orientation before conducting the interviews. One research assistant facilitated the interview while the second research assistant took field notes, operated the recording equipment, and provided additional verbal prompts during the interview when appropriate. Participants were given the option of conducting the interview in their home or a community location of convenience; two MWC users and their care providers chose the university campus while the remaining participant were interviewed in their homes. MWC users and their care provider, if applicable, were interviewed separately and independently to encourage honest and forthcoming responses. Interviews were 60 to 90 minutes in duration and were audio-recorded; one of the research assistants transcribed the recordings verbatim at a later time. The second research assistant verified transcription accuracy against the audio recordings and replaced personal identifiers with the participant ID number. To accommodate the interim data analysis timeline and facilitate consolidation of data collection and analyses, all interviews were conducted between April and July of 2015. EPIC Wheels participants had completed their training between May of 2014 and July of 2015; consequently, the interval between training and interview varied between participants.

6.2.3 Data Analysis

I conducted data analyses using a Directed Content Analysis approach, where key concepts from existing evidence and study hypotheses form the initial coding categories (Hsieh & Shannon, 2005). Directed Content Analysis is a more structured qualitative approach, and was conducive to answering feasibility questions related to the user experience and contributing factors. This approach attempts to validate or extend understanding of the theoretical framework that underlies the intervention. The EPIC Wheels program was explicitly designed to incorporate principles from social-cognitive (i.e., self-efficacy) (Bandura, 1997), Andragogical (Knowles, 1980), and technology adoption (UTAUT) (Venkatesh, Thong, & Xu, 2012) theories. These theoretical principles were thought to enhance learning as well as engagement and adherence with the training program. In addition to informing the interview guide questions, these theoretical perspectives provided a lens through which the data was viewed and interpreted (Creswell, Hanson, Clark Plano, & Morales, 2007) (see Table 6.1).

Table 6.1 Guiding theoretical frameworks

Social Cognitive Theory 4 Sources of self-efficacy	Andragogy 6 Adult learning principles	UTAUT* 6 Determinants of AT use
Mastery experience Verbal persuasion Vicarious reinforcement Reinterpretation of physiological and affective state	Internally motivated and prefer self-directed learning Goal-oriented Bring life experience and knowledge to the learning process Learning relevant to social roles Practical learning strategies Respect during the learning process	Performance expectancy Effort expectancy Social influence Facilitating conditions Intrinsic/hedonistic motivation Price value Habit

* UTAUT = Unified Theory of Acceptance and Use of Technology; AT – Assistive Technology

Transcripts were reviewed multiple times to immerse myself in the data, and the content was then parsed into discrete elements (i.e., open coding). Codes were subsequently consolidated into larger components structured around feasibility issues, incorporating theoretical perspectives when relevant, and using a constant comparative approach (Lincoln & Guba, 1985). Unifying categories were ultimately developed to organize and summarize the broad components and their underlying content. The qualitative findings were used to enhance and interpret the clinical outcomes, such as key intervention ingredients, theoretical constructs incorporated into the design, and relevant outcomes that might not be captured in the quantitative results.

6.2.4 Trustworthiness

Trustworthiness refers to evaluation of rigour and validity in qualitative research. Lincoln and Guba (1985) propose that trustworthiness is related to issues of credibility, transferability, dependability and confirmability. With respect to credibility, comprehensive involvement of all available EPIC Wheels participants speaks to a common experience (Sandelowski, 1986). To encourage honest and forthright responses, interviews with the MWC users and their care providers were conducted separately. The interview guide was informed by the quantitative measures collected (i.e., feasibility and clinical outcomes) and theoretical foundations from the intervention design; questions were constructed with a neutral orientation and follow-up probes encouraged both positive and negative perspectives to elicit potentially contradictory evidence. The comprehensive description of participant information provides a sense of transferability of the findings (Cope, 2014). Maintaining field notes and an audit trail of the analysis process contributed to dependability of the data. Confirmability was supported through inclusion of direct participant quotes (Cope, 2014) and the use of several triangulation strategies including debriefing and collaborative theme analyses with Dr. Woodgate; member checking (i.e., confirming content via a summary document with 4 participants); and integration of the quantitative and qualitative findings (Ohman, 2005). Participants did not indicate concerns or disagreement with the summary document they received.

6.2.5 Participants

During the period of qualitative data collection, six EPIC Wheels participants had completed their training; one was still finishing training and therefore not yet available. One of the six completers had since passed away; the remaining five MWC users all agreed to participate in the interviews. Among these five MWC users, three had care providers, all of whom also agreed to participate. Consequently, all 8 individuals who were available participated in the interview process. In each case where a care provider was involved, it was the participant's wife; she provided at least some assistance with wheelchair-related mobility and supervision during home training. A summary of the eight participants is provided in table 6.2; additional participant information was reported previously in chapter 4 and Appendix N. The wheelchair user and their care provider (where applicable) are included in the same row and identified using a pseudonym. The time interval between training completion and interview participation ranged from 3 to 72 weeks. Change scores for the primary and secondary clinical outcome measures and home program training time for the wheelchair users are provided for reference.

6.3 Findings

After the qualitative analysis was complete, feedback from the EPIC Wheels participants fell into three broad categories: experience with the training process; content and delivery of the tablet program; and impact of the EPIC Wheels intervention. Each category subsumed several related components, which are summarized in Figure 6.1. The results from and discussion of the data analysis will be reported collectively in the remainder of this Findings section.

Figure 6.1 Categories and associated components of qualitative analysis

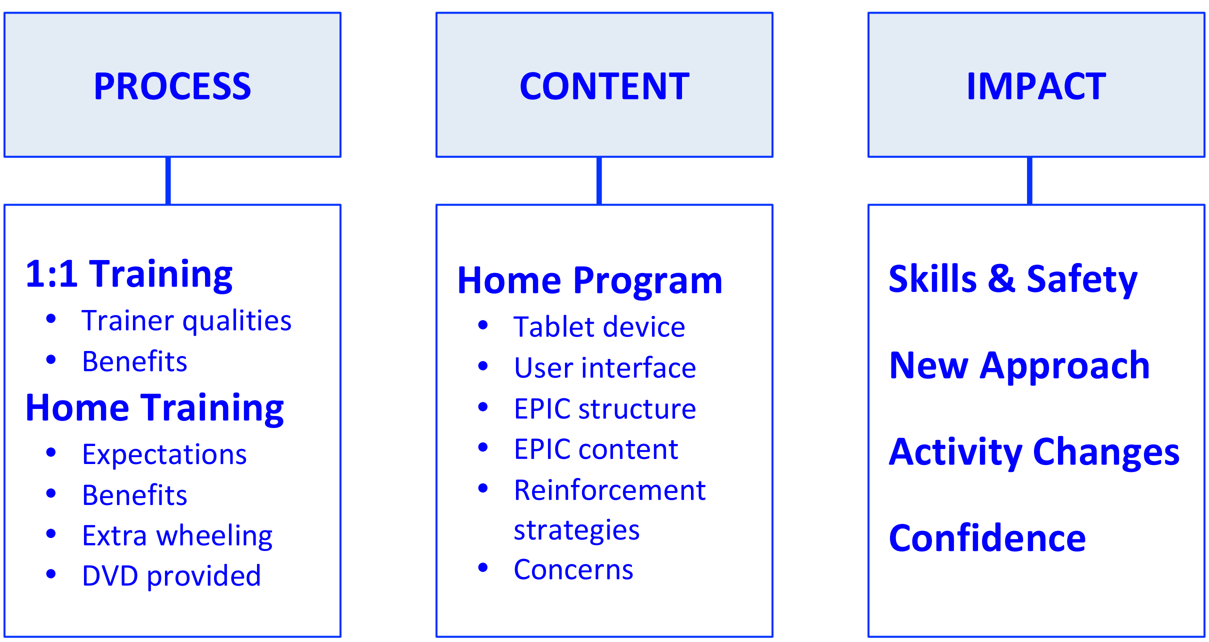


Table 6.2 Interview participants with summary information

Pseudonym	Role[a]	Interval before interview	Clinical outcome pre-post change score[b]								Training time[c]		Extra Wheeling (min)[c]
			WST-C	WST-S	WCon	WhOM Indoor	WhOM Outdoor	LSA	WWT†	HUI	Tablet[d]	Total[e]	
Albert Beatrice	WCU CP	46 weeks	0.0%	+3.1%	+8.5	+1.6	+1.8	+25	-11.6	+0.04	223	**1203**	**1180**
Charlie Diane	WCU CP	39 weeks	+18.8%	+9.4%	+17.1	+3.0	+2.8	-1	-5.4	+0.03	918	**1163**	325
Ernie Francine	WCU CP	72 weeks	+0.8%	0.0%	+12.2	+2.3	+2.0	-6	+2.0	-0.04	412	587	NA
George	WCU	8 weeks	+1.6%	0.0%	+15.2	+1.0	+2.5	+8.5	-12.6	+0.62	146	*186*	350
Henry	WCU	3 weeks	+3.1%	0.0%	+2.8	+0.5	+1.0	+1.5	+3.0	+0.30	336	481	350

† lower is better

[a] WCU = wheelchair user; CP = care provider (spouse)

[b] WST-C = Wheelchair Skills Test Capacity; WST-S = Wheelchair Skills Test Safety; WheelCon = Wheelchair Use Confidence Scale; WhOM = Wheelchair Outcome Measure; LSA = Life-Space Assessment; WWT = Wheeling While Talking test; HUI = Health Utilities Index

[c] Number of minutes spent in home training/extra wheeling. *Italics/shaded* = did not meet the minimum threshold of 300 min; **Bold** = met the preferred threshold of 600 min; NA = not allocated to the Extra Wheeling group

[d] Minutes spent on tablet-related training (i.e., watching demo videos, training games & timed training activities)

[e] Total of tablet and non-tablet training time

Feasibility of the EPIC Wheels program is dependent upon viable implementation, user acceptability and beneficial outcomes of the intervention. The study participants interviewed provided a positive evaluation of the training program, affirming the process of delivery, the relevance of content and the structure of the training material. Furthermore, they articulated that the program had a substantive impact on their wheelchair use in daily life.

6.3.1 Experience with the training process

6.3.1.1 1:1 Training

Participants highlighted the value of integrating in-person (1:1) and home training components. The trainer was perceived as a vital component of the training experience. Several common attributes were identified as having a positive contribution. The trainer's ability to establish and maintain a supportive and collaborative working relationship was highlighted. This included personal characteristics such as "caring, pleasant and cordial", but also related to goal-directed attributes such as "honest, direct and frank." The nature of the working relationship was framed as equitable, where participants felt free to ask any question without judgment and perceived their trainer as being genuine. These attributes provided motivation, as Henry put it: "*I'm doing this because I have a real interest in it, but I also thought that I can't let [the trainer] down … it becomes important, I think, to have that human relationship."* These findings suggest that the trainers were effective as agents of *verbal persuasion*, contributing to participants' development of self-efficacy and perseverance in training (Bandura, 1997).

The trainer brought credibility and expertise, which was apparent in their ability to teach skills and provide specific feedback. The trainer demonstrating correct skill performance side-by-side with the participant in a wheelchair was highlighted as a particularly useful teaching tool:

> *"[the trainer] was able to take a chair and show us and I thought that was really good that she had no problems, you now, being in a chair herself"* [Francine]
>
> *"good trainers have to be able to communicate what they want you to learn and demonstrate it … she was the only one who sat in a wheelchair with me"* [Albert]

Several participants noted that the trainer provided specific and targeted feedback on their performance, which facilitated correction in skill refinement. Beatrice highlighted how the trainer had provided clarity and purpose to her role as care provider: "*when I got to meet with the trainer, then I understood better what the whole purpose was … what [Albert's] objectives were… what he should be accomplishing."*

Participants felt their trainer coordinated and tailored the program for their unique needs, desires and current capacity. Three MWC users talked about how the trainer addressed skills that were specifically relevant to them and two indicated they did not feel compelled to work on skills they felt were not applicable to their life and daily activities. The pace of training and transition from one skill to the next was described as appropriate and not rushed, and two participants commented on feeling like the trainer specifically modified the pace for them. Charlie and Francine both referred to the trainer's recommendation for setting a schedule for home training with dedicated practice time during the week.

The amount and frequency of trainer contact was perceived to be sufficient; participants agreed that involvement of the trainer was critical but had somewhat variant perspectives of how much direct contact with the trainer was required. George stated that the tablet home program could replace *some* of the 1:1 contact while Ernie indicated the program would be effective without 1:1 sessions; however, the remaining three wheelchair users and all of the care providers felt in-person training was essential because of the individualized feedback required:

> *"she recommended something slightly different, not by much, but nevertheless it made a big difference"* [George]
>
> *"they could show you different things that you just can't show in the video"* [Albert]

The weekly follow-up phone calls by the trainer were met with mixed reviews, ranging from being useful to maintain motivation, to indifference, to a perception of mildly condescending: *"Well it does not hurt to have a little pat on the head and be a good boy and do what you are supposed to do kind of thing"* [George]. Francine felt follow-up calls were more important early in the process and less essential later on.

Another essential trainer role was technical support, such as facilitating use of the tablet home program. Charlie felt the first in-person session was important to ensure trainees knew how to use and navigate the home program, particularly if they were unfamiliar with the computer tablet device. A key role identified by 3 trainees was the ability of the trainer to resolve technical issues with the tablet, whether these were minor (i.e., assistance with log-in) or more substantial (i.e., getting the voicemail feature to function consistently).

All but one of the participants felt that the training location, time commitment and associated costs were not problematic, as Charlie stated "*it would be a lot more inconvenient to have to always go at a certain time [for multiple appointments with a trainer]"* than training at home. Henry indicated the cost associated with travel was prohibitive and "*if it wasn't for the cab that I could take [$50 travel reimbursement] … I probably would have backed out*." This highlights the importance of addressing the financial and travel demands of participants when considering the feasibility of future studies.

6.3.1.2 Home training

All of the trainees indicated the expectations for weekly home training were reasonable and achievable; this was also apparent in the post-treatment questionnaire results and only one participant did not meet the minimum training expectations. Francine suggested that 30 minutes per day was a good target, while 60 minutes would likely feel excessive; the training data reported in chapter 4 provides support for this pattern with a mean of approximately 48 minutes on each training day and a maximum of 72 minutes. Diane wondered whether the total number of minutes might have been somewhat high and was concerned that Charlie had not achieved that threshold; however, his total training time was over 1100 minutes. None of the participants felt that finding time for home practice was a barrier; Ernie and Charlie used a specific schedule as recommended by their trainer while Albert used a varied schedule. The recommended target of training 5 days per week was perceived as difficult to achieve at times, in large part because of the various other activities and commitments of daily life trainees had to work around: "*I would do, you know, 2 hours a day and then not the next … move it all around … I didn't necessarily do it every day at home"* [Albert]. This view was supported by the objective data reporting a mean of just over 4 training days per week, with the lower range dropping to 2.5 days per week. For future trials of the EPIC Wheels program, it might be beneficial to offer a period of home training longer than one month. This would allow participants more latitude in the frequency of training, which was more difficult to achieve than the dosage and intensity.

Most participants indicated that their motivation to adhere to the expectations was high due to the relevance of the content, the quality of the program, and the demonstrable improvement they experienced. George indicated health issues that arose over the course of the four weeks negatively impacted training adherence; he found this disappointing and would have liked to resume a more intense home training regime. Henry indicated adherence waned due to 'boredom' because he was already functioning at a very high skill level: "*I actually wanted to sit down and do this stuff and practice … but … after week one it became a bit boring … it was kind of 'been there, done that'*. " However, when asked about the program being boring or tedious, none of the other wheelchair users or care provider indicated this was the case: "*I found it engaging*" [Charlie].

The flexibility of home training was highlighted as most appealing, allowing participants to set their own pace, sequence the order in which skills were addressed, modify training activities and control their schedule: *"the biggest advantage that I see of this program is that it was fitted around my time, when I wanted it*" [Charlie]. The trainees noted that home training was relatively easy to undertake and that the home venue was very appropriate because it reflected a true environment of MWC use. This perspective is consistent with adult learning principles that recommend a relevant and practical focus that addresses current social roles (Knowles, 1980).

Most obstacles or environmental conditions for training could be accessed easily, although finding a ramp to practice with was more difficult. For efficiency, Charlie would try to combine skills that were performed outdoors and practice them in the same session.

The four participants who were allocated to Extra Wheeling group were asked about the benefit of this additional expectation to the EPIC Wheels program. Albert and Henry felt the extra wheeling made no difference in the program's benefit, George felt it was important but would have engaged in additional wheeling regardless, while Charlie felt it made the program more effective. Beatrice summarizes it this way*: "learning the skills, it's not just sitting in the chair and wheeling it around … there's a lot more to it … more capabilities."*

Like the control group, all EPIC Wheels group participants received a copy of the training program DVD at the conclusion of the study. Participants were asked about their use of the DVD and its value. Four participants volunteered that they had not viewed the DVD at all, but two of these felt it might prove useful for review at some point. The remaining participant indicated limited viewing of the DVD, while their care provider reported they had not watched it at all.

6.3.2 Experience with the home program content

The home training approach was perceived as a good fit: "*this is, I think, the best of both worlds in that you're not taking a lot of time [to attend in-person appointments] and you've got a trainer that you have contact or communication with*" [Charlie]. Participants felt that the computer tablet was a good vehicle to deliver the training content because it provided a large visual display and was relatively easy to operate. Trainees also noted that the tablet had good sound quality and volume; none of them had used the headphones that were provided with the training kit. They also indicated that the lap-mounted tablet holder was very convenient for in-chair instruction, as George stated "*it does not get much better than having the 'trainer' sitting right there [on your lap]"*. Despite the secure tablet mounting and no incidents of damage, Ernie chose not to use the holder fearing the tablet might fall.

Overall, there was consensus among trainees that the tablet software was generally simple to use, self-explanatory and easily navigated. Four of the wheelchair users identified an initial 'learning curve', particularly if they lacked familiarity with a tablet device, but this was quickly overcome with practice, and the tutorial during the first 1:1 training session was beneficial in expediting this process. Ernie, whose health condition impacted fine motor control, reported difficulty with the sensitivity of the touch screen and had Francine perform much of the program navigation.

The voicemail feature was perceived as a useful tool for communication with the trainer, particularly for emergent issues, because of the relatively quick response time. George and Beatrice (Albert's wife) identified a preference for telephone contact with the trainer, perceiving this to be more expeditious. Three participants initially experienced some disruption with the voice messaging application, and had to resort to the contingency plan of calling their trainer on the telephone. The technical issues were initially addressed by the trainer or referred on to the site coordinator, if necessary. This raises two feasibility issues. First, establishing reliable Internet connectivity (at least on a periodic basis) is essential for trainee-trainer communication and data transfer. Second, adequate and appropriate technical support is necessary to address inevitable issues. Trainers were typically capable of dealing with basic tablet set-up and navigation, but relied on the site coordinator to resolve more complex problems. A structured system of multi-level support should be established where technical issues can be quickly and easily escalated from the trainer to a dedicated support person for more expeditious resolution. In addition, an alternative method of contact, such as an emergency telephone number, should continue to be provided in case the voice messaging application is compromised, potentially as a direct link to technical support rather than the trainer.

Study participants had varying levels of familiarity with the tablet technology, but ultimately all were receptive to using it for wheelchair skills training. Their desire to improve wheelchair use and accompanying belief that the EPIC Wheels program was contributing to that outcome correspond with the construct of *performance expectancy*, the strongest driver of technology adoption in the UTAUT model (Venkatesh, Morris, Davis, & Davis, 2003; Venkatesh, Thong, & Xu, 2012). The affirmation and perceived sincerity of the trainer described earlier, as well as the support and involvement of the care providers who were involved in the home training, point to *social influences* emergent in the program delivery. *Effort expectancy*, such as the challenges of learning to navigate a tablet itself and deal with voice messaging malfunctions, present a risk to technology uptake early on but participants noted that, once addressed, the software and device operation was relatively simple. More critical was the presence of *facilitating conditions*, specifically the support offered by the trainer and study staff to address and mitigate these technical issues with expediency and respect (Liu, Cruz, Rincon, Buttar, Ranson, & Goertzen, 2014). The additional influence of facilitating conditions with increasing age and decreasing familiarity with technology further reinforces their importance and impact with the target population in this study (Wang & Shih, 2009). Comments from five participants on the value of scheduled training times, whether suggested by the trainer or by their own volition, suggest this might contribute to establishing *habit* as facilitating factor to longer-term uptake.

The home program structure was described as clear and organized, with logical sequencing. All wheelchair users made reference to the progression of increasing complexity, which contributed to the effectiveness of the program: *"the progression from easy to hard was good"* [Henry]. Participants appreciated the format of instruction, followed by practice activities, and then further instruction. In particular, the visual demonstration of skills was valuable, including incorrect performance to avoid: *"learning all these things through the [video] rather than having to experience them myself"* [Ernie]. Trainees made particular note of how they could relate to the individuals demonstrating techniques in the videos: "*the program shows people doing the things that they are trying to teach you … you can see these old dudes doing something … and I keep saying 'if he can do it, I can'* " [Henry]. Participants articulated that the program went beyond simply teaching a series of noncontiguous techniques or "splinter skills"; participants appreciated the rationale and practical application that introduced each section of content. Furthermore, they described the program as teaching a problem-solving approach to wheelchair use, rather than a prescriptive set of procedures to learn.

The content of the home training program was described as comprehensive, with an appropriate level of detail and few gaps or omissions. Francine felt that the basic skills had more detail than desired, but that this might meet the needs of a more novice trainee. Charlie offered that the program length was sufficient but should not be shorter than the current four weeks. The demand or level of difficulty was described as appropriate, providing a good challenge and "*never too* *easy*” [Albert]. All participants agreed that the number of training activities, which are used to practice the various skills and skill components, was appropriate. Participants described the program content as interesting; Albert states “*I found it engaging”* and George was “*not bored*”, although their motivation was driven by the relevance and applicability of the content more than the “fun” derived through various training activities:

> *“That was kind of fun stuff and all the rest of it. But we always found the useful information that really made the difference”* [Ernie]
>
> *“The reason I followed [the training activities] and did them completely is that I kept seeing that I was improving my being able to use the wheelchair better.”* [Charlie]

The improvements demonstrated in the WheelCon results reported in chapter 5 provide some evidence that the EPIC Wheels program was successful in integrating self-efficacy strategies from social cognitive theory. In the post-treatment interviews, participants were cognizant of a progression in difficulty and complexity of skills as the program advanced, and felt there was a good balance between being challenged and achieving success. The graded structure appears to have achieved the desired effect of facilitating successful performance and providing *mastery experience* for participants. This is the most influential factor for improving self-efficacy (Bandura, 1997). The effectual motivation of the trainers, reported earlier, suggests they were successful agents of *verbal persuasion*. Participants made particular note of how they could relate to the older adult MWC users in the demonstration and training videos, feeling like the skills were achievable and realistic. This experience of *vicarious reinforcement* is the second most influential factor for addressing self-efficacy (Bandura, 1997). Interestingly, Albert commented that none of the demonstrators had a lower limb amputation, which made it less relevant for him; future versions of the EPIC Wheels program should consider using a wider variety of individuals and health conditions or potentially offer customized versions of the program. For example, self-efficacy affects men and women differently (Sakakibara, Miller, Eng, Backman, & Routhier, 2013), and participants might benefit from a modified version with exclusively male or female demonstrators.

A limited number of training games were included in the home program, and these were met with mixed reviews. Two participants felt the games were useful and fun to play, and often did them together with their care provider. Charlie felt there were some good games and others were more childish; Francine agreed they were not all age-appropriate: "*some of them have … cartoon characters … it was a bit juvenile*". Belchior et al (2012) identify several important elements of video game use for training among older adults. Flow is a desirable psychological state that provides a sense of mastery and satisfaction, and emerges when there is concordance between one's ability and the demands of the activity (Csikszentmihalyi, 1990). The experience of flow in game play among older adults can be facilitated by providing user control, concrete and consistent feedback on performance, and facilitating an immersive experience (Belchior, Marsiske, Yam, & Mann, 2012). Due to limited resources available for program development, the training games were quite simplistic, and were likely perceived as inferior to animation that participants might have been accustomed to in popular media. The divergent participant perspectives on training games should inform future studies with the EPIC Wheels program. Games and activities currently provide a substantial portion of the "practice" component of the home program, and engaging activities that encourage increased motor skill repetition are likely to elicit better outcomes. Adult learning theory and recent research related to older adult acceptance and enjoyment of video games would suggest that games perceived to be childish, unacceptable or non-challenging could result in trainees skipping these components or have a negative impact on program adherence (Souders, Boot, Charness, & Moxley, 2016; Osmanovic & Pecchioni, 2016). Brown and Venkatesh (2005) found that hedonic motivation (i.e., enjoyment) has a strong influence on technology uptake. A limitation of the existing games is the lack of interactivity; the video-based presentation means that wheelchair-specific performance has no impact on the game outcome. This detracts from the immersiveness and flow experience of the game (Marston, Kroll, Fink, & Gschwind, 2016), provides no knowledge of results to the user (Winstein, 1991), and limits the customizability and grading of participant response. One way to address this issue would be the use of sensors for game control. This type of integration might be achieved using sensor technology currently available in computer tablets (e.g. accelerometer, GPS) or via low-cost external sensors that could be mounted to the user (e.g. sensored gloves or wrist/arm devices) and/or the wheelchair directly. User performance data captured using such sensor technology could also be compared with ideal performance via algorithms to provide specific feedback on corrective changes. Future research should explore how inexpensive commercial sensing devices might be easily integrated to provide gaming input and how commercial or custom games could be used to facilitate specific wheelchair skill practice.

Feedback on the use of reinforcement strategies, such as visual feedback on training activity and earning stars and awards for completing training components, was largely positive. The checkmarks (indicating a video component had been viewed) were well-received by participants, serving multiple functions such as a visual record of which components they had completed, assistance with navigating where to resume training, providing feedback on progress, and a simple but effective form of motivation. Several trainees enjoyed obtaining stars and awards, perceiving this as getting 'credit' for their investment in the program; "*it made it fun … I would kind of look forward to doing it*" [Charlie]. George, however, did not like the stars or awards, nor did he enjoy the training games. It is possible that these issues impacted George's adherence, as he completed only 146 minutes of tablet training over four weeks and did not move beyond the basic propulsion section (i.e., roughly 25% of the program content); however, he did demonstrate improvements in all but one of the clinical outcome measures. The display of minutes practiced and the weekly progress bar were described by all participants as providing useful feedback and a source of motivation; Henry indicated a desire for additional training activity feedback.

Trainees identified several adaptations related to content that they felt would improve the tablet home program. Henry suggested increasing content related to the relevance of the skills demonstrated while George wanted weekly and total program progress data included on the home screen. Three respondents suggested emphasizing independence with, and inclusion of, more advanced skills; Ernie specifically wanted inclusion of a section on independent wheelie performance and expanded content on winter and wet weather strategies. Henry requested content on strategies for carrying objects, although there was already a substantial section related to this topic. Francine and Albert suggested increasing content related to care provider strategies and specifically transferring the MWC user in and out of the wheelchair. Albert also felt there should be more demonstrations by an individual with a lower limb amputation, as this would be more relevant to his circumstances.

The interviewed participants articulated specific examples of program attributes that contributed to their appreciation for the learning approach and their engagement in the program. From a feasibility perspective, there is evidence to suggest that the six Andragogical principles identified in chapter 1 were integrated as intended and had the desired effect. First, adult learners are *internally motivated and prefer self-directed learning*. Participants indicated that, while they found the EPIC Wheels program interesting and enjoyable, their desire to improve wheelchair mobility skills was the primary reason for engagement and their motivation to adhere to the target training goals. This position is supported by the quantitative data regarding adherence to training expectations. The positive opinions expressed regarding the flexibility of home training, whether it is the training schedule or the sequence and selection of content, support the notion of self-directed learning. Older adults *bring life experience* and pursue content that is *goal-oriented* and *relevant to existing social roles*. The EPIC Wheels trainees identified that individualized content and goal setting was very important for their involvement and success with the training program. Furthermore, the opportunity to relegate non-relevant skills was seen as further reinforcing this principle. Adult learners prefer *practical learning strategies*. Participants highlighted the use of side-by-side trainer demonstrations and targeted performance feedback as an example of a practical and effective strategy for learning during the 1:1 sessions. In addition, trainees noted the value of the home-based component as being reflective of real-life wheelchair use, with authentic obstacles and environments for practice. Finally, older adults desire *respect during the learning process*. The EPIC Wheels trainees noted how their trainer would adapt the content and pace of training to suit their individual needs, while maintaining a collaborative approach that was not demeaning or judgmental. Future work could address elements of the program that have the potential to conflict with adult learning preferences, such as the issues identified with training games. Specifically, investigation around older adults' perspectives of games as a training intervention and gaming preferences could contribute to more effective use of this approach.

6.3.3 Impact of the EPIC Wheels intervention

A key component in feasibility evaluation is some determination of the clinical benefit and perceived value of the intervention for participants. The EPIC Wheels participants articulated that the training program had some substantive impact. Both MWC users and care providers indicated that the training program had resulted in more proficient and safer wheelchair use. This improvement facilitated engagement in more activities, not only within the home setting but also in the community. For some, this meant venturing further from home, accessing environments with traditional rather than adapted transit, and doing so with less or no assistance from their care provider. These observations are consistent with the significant changes observed in the quantitative measures of satisfaction with performance of activities (i.e., WhOM Outdoor) as well as the trend towards improved mobility suggested by the LSA results presented in chapter 5. Participants noted these benefits were derived in part because the wheelchair users felt more confident and capable operating their wheelchair and dealing with environmental obstacles that had previously been barriers. Care provider also reported being more confident in the skills of the MWC user, decreasing both the physical demands of assistance and the cognitive/affective stress of worrying about or having to supervise the user. These perceptions are consistent with the significant changes noted in the WheelCon measure and the positive trends noted in the WST Safety outcomes reported in chapter 5.

6.3.3.1 Improved skills and safety

Participants talked about learning new skills, and specifically ones they had previously considered unattainable: *"things I never thought I'd be able to do in a wheelchair … I never would have tried"* [Albert]. Improvement in basic propulsion was a very common response. Four participants referred to more efficient propulsion, which translated into increased endurance and less fatigue; this was in part attributed to learning how to incorporate coasting, rather than constant (and unnecessary) pushing on the drive wheels. A second frequent response was increased capacity to manage inclines. Participants referred to both ascending and descending slopes, making reference to ramps, hills and curb cuts as typical examples of real-life applications. Some identified more complex scenarios, such as steep inclines and wet conditions, as being manageable following their training. Several spoke specifically about the 'slalom' approach (i.e., wheeling diagonally in a crisscross manner on the slope) as particularly valuable.

Other areas of improvement noted were traversing rough or soft terrain (such as grass); managing thresholds, obstacles and transitions; negotiating doorways, tight spaces and corners; and reaching down to pick up objects. Two particular skill components that enabled most of these tasks were briefly "popping" the casters off the ground and learning to shift body weight in different directions to load and unload the drive wheels.

In addition to gaining skill capacity, participants also reported increased safety. George indicated he was able and willing to attempt these new skills because "*I don't think I am as worried now about falling*". Learning to manage the "tippiness" of the chair (e.g. via weight shifting) and education related to fall prevention resulted in trainees feeling safer in the wheelchair and reduced their fear of tips/falls. Some participants reported other peripheral benefits from engaging in the EPIC Wheels program. Two wheelchair users, as well as their care provider, reported increased upper body strength and overall health, while another identified improvement in coordination and timing.

Among the care providers, several benefits were noted. For Francine, learning when to assist and when to "*just back off, and let [Ernie] do it*" was valuable, as well as her ability to provide assistance when required. She also felt a greater sense of 'teamwork' and collaboration with respect to mobility and engagement in daily activities, as well as a decrease in the frustration Ernie experienced. Beatrice, when asked about a reduction in the amount of assistance she needed to provide responded "*definitely!*".

6.3.3.2 Learning a new approach

While study participants reported learning specific skills, a common observation was that they had learned how to handle or approach situations where they encountered barriers to mobility. Beatrice described how Albert was now able to problem-solve situations following the EPIC Wheels training: "*now [finding a solution] just comes automatically … and it's just 'handle-ability' and getting out of different situations*." Beatrice felt that Albert was better able to assess situations and determine how to proceed, in terms of selecting the most appropriate technique and evaluating whether he could safety proceed. As a result, Albert felt more confident in coping with unexpected situations, which inevitably arise. George, who was an experienced user, confirmed this notion of having increased his awareness in assessing situations following training: "*the mental aspect of the whole thing, it just astounds me*." Participants noted it was not just skills they learned, but also alternative approaches to dealing with barriers. Furthermore, trainees related how they were able to generalize skills learned in one context into other situations: "*so there you got a little bit of knowledge, that you are able to parallel into daily situations*" [Ernie]. The practicality of the techniques taught aided in being able to transfer skills into various situations. Participants also observed that the training improved their ability to ascertain when assistance was required and how to request or obtain appropriate assistance from others.

6.3.3.3 Changes in activity level

Most participants reported a substantial change in their level of participation in activities of daily living; as reported in the previous chapter, three of the five MWC users had increased LSA scores. Diane remarked "*I'm so happy that [Charlie] engages more now ... with having the chair*." Ernie and Francine both felt he was getting out into the community more often and feeling more engaged. Ernie noted that the number of activities he was involved in had not necessarily changed, but the frequency and ease of participation had increased substantially and his level of frustration had diminished. Albert reported his overall use of the MWC had risen and he was venturing outside the home much more often. He also noted that activities were now much easier and required little or no assistance from Beatrice. These responses were relatively consistent with the LSA results, where Ernie had a slight decrease in score while Albert showed a dramatic increase in mobility score. Albert noted that he had increased his involvement in outdoor domestic tasks such as shopping and shoveling as well as leisure activities such as gardening and fishing. Learning to independently navigate inclines meant that *"[he's] not just restricted to being on a flat surface*" [Beatrice]. Both Ernie and Albert were able to use the bus independently as a result of their training, with Ernie transitioning from HandiTransit to the regular public transit system and being able to use the ferry system on his own. Charlie (and Diane) indicated he was now able to independently perform a variety of domestic activities within their apartment complex, such as taking out the garbage, doing the laundry (located down the hall) and fetching mail. This achievement was notable as it contributed to Charlie's self-esteem and perceptions of reciprocity: "*he's happy that he can do the washing*" [Diane]. Diane also remarked that, prior to the EPIC Wheels training, "*we thought we wouldn't be travelling anymore and, of course, now we are.*" Most participants reported traveling further and more frequently outside of the home because they had learned to propel in a more efficient fashion. Henry was the only participant that felt his level of activity had not changed, because it was high prior to enrolling in the study. However, he indicated the program had helped him with managing inclines and managing soft surfaces, which in turn improved his participation in outdoor activities.

6.3.3.4 Changes to confidence

There was unanimity among participants that the training program had a substantial impact on confidence with wheelchair use; a point substantiated by the large effect size improvement in WheelCon score reported in chapter 5. There was a recognition that the program enabled learning of skills that participants had previously thought were unachievable: "*it gave me a lot more confidence [to] do a lot of stuff I did not think you could*" [George]. Albert stated his confidence *"increased by 100% … there were things I learned to do I never thought I would be able to do; nobody shows you how when you buy your wheelchair.*" Beyond having confidence in the individual skills, the training engendered a sense of mastery in dealing with challenging situations as Ernie put it: "*I felt that that I can surmount almost anything as long as I consider it carefully and think my way through*." Francine observed that *"[Ernie] sort of got a little bit more sense of himself … it's your sense of self, by practicing it and doing that, it gave him more self-confidence."* Even Henry, who identified himself as a proficient MWC user, observed that the training program provided both confirmation of, and increased confidence with, mobility skills: *"I feel my confidence improved over certain types of terrain - rough terrain - certainly, I'm more confident now that I can do it, versus before … and the rest is simply confirmation that I was going okay."* One strategy that participants felt contributed to increased confidence and overcoming presuppositions about what they were capable of in their MWC was demonstration. Francine said *"I think showing other people doing it and then doing it yourself is really good … seeing other people in a video doing it makes him want to do it more."* George affirmed this notion, particularly in seeing individuals of a comparable age demonstrating skills in the tablet videos.

Another element that contributed to confidence was an increased sense of safety; this perception is also corroborated by the large effect size improvement reported for the WST-S and WWT measures reported in chapter 5. When asked about the impact of the EPIC Wheels program, George responded, "*[the] safety issue is the biggest, I think … I don't have to be so concerned about [tipping] backwards and … I don't think I am as worried now about falling."* Of note, George had the largest change (improvement) in WWT score (i.e., a measure of dual-task demand). Care providers also reported a greater sense of confidence in their partner's safe operation of the MWC, which then reduced their own anxiety:

"*I have total confidence that he knows what he can and shouldn't do, so I don't worry everyday cause I'm not there."* [Beatrice]

"I feel real confident about ... his skills and his ability to use the wheelchair." [Diane]

"He became more confident, and then I wasn't peeking around the corner to make sure that [things were] alright ... I did not have to worry about him taking off the corners in people's houses any more." [Francine]

6.4 Limitations

The low recruitment level also impacted the number of EPIC Wheels participants available for follow-up interviews; in addition, the study drop-out (who requested no further contact) and the passing of one previous participant further limited the available pool. However, all available EPIC Wheels participants and care providers agreed to be interviewed, providing a reasonably strong and representative sample of the EPIC Wheels completers. The self-initiated recruitment strategy is likely to have resulted in participants who were motivated and perceived wheelchair skills training as a positive enterprise, which may have predisposed them to a more positive evaluation of the program. Two research assistants at each site conducted the follow-up interviews; in each case, one of the interviewers was also the site coordinator. The study trainers and principal investigators were not present during the interviews; however, participants may have been reluctant to share negative perceptions because they were familiar with the site coordinator and a social desirability bias may have impacted their responses. The interview guide was deliberately configured with neutral questions (e.g. "what was it like …", "tell me about …") and the interviewers solicited both positive and negative experiences. The use of different research assistants could have influenced the delivery and flow of the interview at the two sites; a consistent interview guide, comparable format, and orientation for the research assistants were used to address this concern. While member checking occurred with four individuals, involving all participants in this process would have enhanced credibility.

Despite the risks of social desirability bias, the participants did articulate criticisms of the program, which would suggest the pressure for positive evaluation was not overwhelming. The time between study completion and follow-up interview varied between participants and this might have influenced responses. Participants with a shorter latency period may have had less opportunity to see the impact of training on their engagement in relevant activities of life; for those with a long latency period, recollection of their training experiences may have been affected or lost over time. There were a relatively small number of women recruited for the study and the only female who had completed the EPIC Wheels training at the time of the follow-up interviews had passed away. Consequently, the findings in this chapter are exclusively from a male perspective and it is conceivable that the experience might have been different for females. For example, wheelchair-specific self-efficacy appears to differ between men and women (Sakakibara, Miller, & Rushton, 2015) and the manner in which women perceive the EPIC Wheels program to address confidence with wheelchair use would be of interest.

6.5 Conclusions

Participants provided strong qualitative support for the program design, content and method of delivery, and identified substantial clinical benefits of the training program in terms of increased proficiency and safe operation of their MWC, culminating in greater independence using their wheelchair for more activities in and outside of the home. Care providers confirmed these benefits and expressed appreciation that their spouse was more confident and active in their MWC; in some cases, they reported less concern about safety and needing to provide supervision or assistance with wheelchair-related activities.

The interview participants identified value in both the in-person and home training aspects of the EPIC Wheels program, and noted the important role of the trainer in both of these components. This would suggest that implementation of the EPIC Wheels intervention would be most effective with the continued involvement of the trainer role, although there might be flexibility in the extent of contact and involvement. The key elements for the trainer appear to be the initial introduction to the home program, creating a customized training plan, feedback on individual skill performance and support with tablet technology issues, primarily related to Wi-Fi connectivity. The potential application of the EPIC Wheels program *without* these in-person trainer visits (e.g. individuals living in rural/remote locations without access to a rehabilitation professional) requires further investigation, and whether these critical elements can be effectively delivered in alternative or virtual ways.

7. Discussion, synthesis and future directions

7.1 Introduction

The MWC is commonly used to address mobility limitations among older adults in Canada. In fact, there are well over 100,000 community-dwelling individuals 65 years of age and older using a MWC (Smith & Miller, Demographics of older community dwelling Canadian wheelchair users, 2014). Despite many older adults acquiring a MWC, few received training in effective use (Karmarkar, et al., 2011; Smith & Kirby, 2011), which may limit independent mobility (Shields, 2004) and restrict community participation (Statistics Canada, 2008). As a result, care providers are often required to provide assistance (Hoenig, Tayor, & Sloan, 2003), risking injury and burnout (Laliberte-Rudman, Hebert, & Reid, 2006). Therapists who prescribe MWCs to older adults frequently lack the time and expertise to provide training beyond basic propulsion and transferring in and out of the wheelchair. mHealth is an emerging area of rehabilitation intervention with the potential to address these service gaps while still protecting therapist demands. The purpose of this dissertation was to develop and evaluate a wheelchair skills training program that could be delivered primarily as a clinician-monitored home program, using mHealth technology. In this chapter, I will provide discussion and synthesis of the key findings and insights that evolved in this dissertation and potential implications; address some of the critical elements, strengths and weaknesses; and propose some future directions for study and research related to the EPIC Wheels program.

7.2 Understanding the transition to MWC use

To facilitate the development and optimal delivery of a wheelchair skills training program among older adults, it was important to understand their first-hand experience of wheelchair use and acclimation. The first section of my dissertation addressed the issue of older adults transitioning to MWC use. There is little known about the experience of making this transition. While some literature explores the impact of wheelchair acquisition (Chaves, Boninger, Cooper, Fitzgerald, Gray, & Cooper, 2004; Meyers, Anderson, Miller, Shipp, & Hoenig, 2002), the type of device obtained or the process of assessment and procurement (Hoenig, et al., 2005; Mortenson & Miller, 2008), the lived experience and the challenges of becoming proficient with its use are poorly understood. Given the limited evidence available, a qualitative approach was well suited to this investigation. Focus groups with experienced MWC users offered an opportunity to capture retrospective reflections on what this transition was like and what factors were influential. Collectively, the group members were able to build on common experiences as well as identify individual differences. Participants highlighted a lack of support and knowledge about what they needed to adapt to wheelchair mobility, and little direction about how these needs might be met. Many were frustrated by inefficient propulsion and environmental obstacles, and were unaware that specific techniques and strategies could ease or eliminate these mobility barriers. Only a few had received wheelchair skills training, while most had to learn "on the fly" and through informal means. The importance of role models and "relatable" peers was identified. This idea aligns very closely with the concept of vicarious experience in Social Cognitive Theory, which is a principal facilitator of self-efficacy (Bandura, 1997). The multi-dimensionality of contributing factors was another central concept articulated by the participants. These included environmental factors such as the MWC device, its configuration and physical accessibility in the context of use, and social stigma. In conjunction, there are personal factors including physical attributes like strength and dexterity as well as affective attributes like acceptance of wheelchair use, confidence, and self-image. These issues all need to be considered when addressing wheelchair mobility with older adults.

Implications: Health care funders need to recognize that resources are required to support older adults in their transition to MWC use and to encourage community participation. These resources need to address multiple factors beyond selection and configuration of the MWC and environmental accessibility such as skill training, addressing confidence and safety concerns, and encouraging use in a community setting. Canadian health care systems should recognize and incorporate training into the wheelchair procurement process. Integrated training services should be provided to older adults who are prescribed a wheelchair or, at the very least, made available on a fee-for-service basis. Given the varying level of need and amount of training provided, there may be value in offering the EPIC Wheels program in modules, such as basic, intermediate and advanced skills. Declines in MWC use and proficiency that occur due to *aging as a wheelchair user*, highlighted in chapter 2, suggest that a "refresher" skills program might be useful in addressing changing needs. Such an approach could accommodate for different levels of capacity and training among older adult MWC users.

Clinicians also need to be aware of the need for comprehensive training, particularly among older adults. Clinicians who prescribe wheelchairs should ensure they have adequate preparation in order to provide comprehensive skills training, whether this is provided through their professional entry-to-practice degree training or through continuing competency and educational opportunities. The chapter 2 findings and the challenges of recruitment using a participant-initiated approach in the RCT study may suggest that older adult MWC users are not aware of the need for, availability of, or potential benefit from, wheelchair skills training; as the adage goes, “you don’t know what you don’t know”. Efforts to provide education and knowledge translation of evidence demonstrating the benefits of participating in a training program such as EPIC Wheels should be directed towards older adult MWC. The use of peers, either directly or via ‘testimonials’, could leverage the benefits of vicarious reinforcement in this regard.

The dualistic nature of social support was a salient point revealed in the chapter 2 study. Participants noted that in some regards support from friends and family was an asset during the transition to MWC use, but that exercising independence from that support and venturing into the community was also imperative. These points were useful in moving into the development phase of the EPIC Wheels program as they reinforced several tenets of SCT embedded into the program, such as verbal persuasion and vicarious experience. For example, appropriate encouragement from individuals important to the MWC user could enhance confidence and facilitate greater independence. The use of comparable demonstrators for video instruction in the mHealth program promoted the notion that independent performance and proficiency with these skills was attainable.

Implications: Wheelchair training programs, including EPIC Wheels, should appropriately integrate family/care providers. This should include education and information such as best strategies to safely supervise and provide beneficial feedback on practice; appropriate verbal encouragement; benefits of venturing outside the home; how and when to provide appropriate assistance; and encouraging user participation even when assistance is provided.

7.3 Incorporating stakeholders in the intervention development

Chapter three reported on the studies related to development and pilot testing of the EPIC Wheels program. The findings from chapter 2 provided valuable direction for content creation and the delivery strategies implemented. The literature strongly encourages involving potential future users during intervention development (Craig, Dieppe, Macintyre, Nazareth, & Petticrew, 2008), and the PAD approach I used proved to be effectual in this regard. While a MWC user might be the primary end-user of a training program, the findings in chapter 2 highlight the important role that a care provider plays and the relevance of including them appropriately in the training process. In addition, a training intervention such as EPIC Wheels, would be most effective when implemented under the guidance of a therapist or wheelchair expert. The inclusion of all three stakeholder groups provided not only diversity of feedback, but also confirmation of decisions through triangulation of responses from these different perspectives. The PAD process was enhanced by the iterative nature of multiple entry points throughout the two-year development period with multiple prototypes, a pilot testing study, and review of the clinical prototype prior to undertaking the feasibility RCT. This comprehensive feedback loop provided affirmation that the program content was sufficient and appropriate. Furthermore, stakeholder input contributed to, and was confirmatory of, many theoretical principles incorporated into EPIC Wheels. For example, stakeholders advocated for training activities of graded difficulty (mastery experience), peer demonstrators (vicarious experience), trainer follow-up and monitoring (verbal persuasion), and fun and engaging training games (reinterpretation of physiological/emotional state), which align with facilitators of self-efficacy in SCT. This feedback provided additional strategies for implementation and also affirmed that the intended self-efficacy constructs were apparent.

7.4 Multiple methods of inquiry

I used both qualitative and quantitative methods in the various studies that contributed to this dissertation. Focus groups provided a venue to gather perceptions and critiques of the emergent prototype program; this qualitative method is particularly useful during the development stage of rehabilitation interventions (Sullivan-Bolyai, Bova, & Harper, 2005). A quantitative pilot study measured objective feasibility indicators as well as clinical outcomes. Finally, a post-intervention questionnaire and qualitative follow-up interviews captured participant perceptions, enriching our understanding of the quantitative findings and enabling a effective mixing of the two methodologies (Creswell, 2003).

In chapter 4, I reported on the feasibility of the RCT implementation. A strength of this study was the comprehensive, structured matrix incorporating a wide variety of feasibility indicators as a framework for evaluation (Arain, Campbell, Cooper, & Lancaster, 2010; Van Teijlingen & Hundley, 2002). The administration protocols were effectual, although some adaptation to the data collection procedures to reduce administration burden is desirable. The feasibility study importantly brought to light issues related to adequate rate and volume of recruitment, which should be addressed before further studies are conducted.

Implications: Future study of the EPIC Wheels program should incorporate an invested partner in the health care system as collaborator and champion to enhance recruitment through the clinical community. Other strategies, such as incorporating an additional study arm for rural locations that utilizes teleconference for the 1:1 visits, could be employed. The reimbursement of costs related to attending the 1:1 sessions needs to be built into any future study.

The EPIC Wheels participants were invested in the training process, as demonstrated by the relatively strong rates of adherence to training expectations, although some participants found it more challenging to meet the training frequency demands and make their way through the entire program in four weeks. EPIC Wheels participants demonstrated and reported beneficial outcomes; those who met the preferred training intensity of 600 minutes appeared to have better results.

Implications: The minimum treatment dosage of 300 minutes appears to be sufficient for a treatment effect; encouraging additional training may prove to be even more beneficial. The training program could be adapted to be longer, to allow for less intensity (and pressure to get through the material) over the 4 weeks for participants with multiple commitments; scheduling fewer days per week and focusing on sufficient intensity and total training time appear to be critical ingredients. The relationship between the precise make-up of training (i.e., tablet-based games/activities versus self-practice) and impact is not yet clear and requires further study.

Chapter five reported on the evaluation of clinical measurement outcomes in a feasibility RCT study. The use of an RCT design with a control group matched for clinician contact and tablet usage was beneficial for this study. The addition of a second intervention factor, extra wheeling, further enhanced the rigor of controlling for alternative and confounding variables. These study design attributes contributed to the power of the analyses to uncover potential differences between groups. The RCT design presented some limitations as well. The allocation of participants to a control intervention halved the number of individuals who could receive the EPIC Wheels program, restricting the amount of data and qualitative feedback available. Chapter six provided qualitative inquiry into the experience of both the EPIC Wheels study participants and their care providers. In these follow-up interviews, participants related how they perceived improvement in proficiency and safety with wheelchair mobility and became more confident to try new skills and engage in activities inside and outside the home with greater independence. These insights were helpful in reconciling statistically non-significant quantitative findings in the primary clinical outcome of skill capacity and the more promising findings in the secondary clinical outcomes.

7.5 Contribution of theoretical frameworks

The integration of several theoretical frameworks to guide the intervention design and evaluation was an asset in this dissertation. First, the concept of self-efficacy, from SCT, was a key element in designing an approach to wheelchair skills training. This relationship has already received attention and support in the literature to provide a rationale for inclusion (Rushton, Miller, Kirby, Eng, & Yip, 2011; Sakakibara, Miller, Eng, Backman, & Routhier, 2013); however, the qualitative study components in both the development (i.e., focus groups) and evaluation (i.e., follow-up interviews) components provide independent and collateral evidence for use and the statistically significant results obtained in the quantitative findings (i.e., WheelCon) further endorse the relationship. The benefits to participation and mobility from improved self-efficacy, even when objective change in skill capacity was not apparent, speaks to the importance of having integrated this strategy into the EPIC Wheels program. While all four facilitators of self-efficacy were addressed in some degree, a limitation of the study was the finite supports provided for reinterpretation of physiological and affective symptoms. This is the least influential factor, but additional strategies specifically addressing this concept could be pursued. A second theoretical framework in the dissertation was incorporation of adult learning strategies (i.e., Andragogy). Because the EPIC Wheels intervention specifically targeted teaching older adults motor skills and the critical importance of adopting this learning resource in a home-program context, these strategies were intentionally implemented in the program design. Comparable to the concept of self-efficacy described above, the post-study interviews were used to explore participants' perceptions of program delivery, as well as content, and provide confirmation that these Andragogical strategies had been successful in achieving the desired outcome. For example, the program had originally been conceived with a linear structure (i.e., moving sequentially from one skill to the next with access dependent upon completing the previous element). Based on stakeholder feedback and the principle of self-directed learning, the only prescriptive component of the program was the initial 6-part safety section. Qualitative feedback after study completion indicated overwhelming affirmation for the flexibility to move freely throughout program content. The strong retention and training adherence rates among EPIC Wheels participants suggest good uptake of the learning approach employed.

Implications: Participant control and management of the home program (e.g. pace, sequence, skills addressed, timing) is important and likely to contribute to program engagement and adherence.

A third theoretical framework was the use of the UTAUT model for assistive technology uptake. Given the nature of the program delivery platform (i.e., a video-based software program on a computer tablet) and the likelihood that many older adults might not be familiar or comfortable with this technology, the UTAUT provided direction during the formulation of the EPIC Wheels intervention (e.g. dedicating a portion of the first 1:1 session to tablet/program training; integrating the voicemail support; including a printed user guide). In addition to the study participants, the success of EPIC Wheels was also dependent upon the study trainers also embracing a technology-based approach to rehabilitation (i.e., teaching the participant how to use the program and monitoring their data/progress on-line). Feedback from the participants via the follow-up interviews about training at home with the tablet, and trainers' documentation on the intervention protocol checklist and post-treatment questionnaire, provided insight into how the UTAUT constructs influenced perceptions and acceptance of the mHealth program.

7.6 Benefits and active ingredients

The third phase of this dissertation evaluated the impact of the EPIC Wheels program in comparison with a cognitive-training control group. When adjusted scores were considered, both groups achieved a small improvement (~ 4%) in skill capacity score, representing an improvement in roughly 1 skill on the WST, and no statistically significant between-group difference. However, among the secondary measures there was a statistically significant difference and substantial effect size for self-efficacy (p = 0.06; η_p^2 = 0.28) and satisfaction with performance of activities outdoors (p = 0.06; η_p^2 = 0.28). In addition, outcomes related to safe wheelchair operation, such as skill safety and divided-attention, were also indicative of a positive effect. The EPIC Wheels intervention shows considerable promise in terms of addressing the principal intent for it creation, namely to improve community participation and enable better and safer wheelchair use. Some consideration should be given as to whether skill capacity is sensitive or relevant enough to be used as the primary outcome, or whether multiple primary outcomes are more appropriate in subsequent trials (Craig, Dieppe, Macintyre, Nazareth, & Petticrew, 2008). The clinical benefits of the program were elucidated in the findings reported in chapters five and six. The qualitative interviews provided considerable insight into some of the potential active ingredients inherent in the EPIC Wheels program. The engagement of factors that enhance self-efficacy, as described previously, were reiterated through the experience of both WMC users and care providers. Contextualizing training in a problem-solving approach, rather than a set of discrete splinter skills, was another effectual element articulated in the follow-up interviews; this was also identified as important by focus group participants in during the initial intervention development stages and provides some confirmation that it was successfully incorporated. The training activities and games were reported as strong contributors to skill development. While the benefits and successes experienced through engaging in these training elements was the strongest motivator for participants (i.e., performance expectancy), when they were also enjoyable and engaging it proved to be additionally motivating for practice (i.e., hedonic motivation).

7.7 Strengths and limitations

One strength of this dissertation was the use of a phased approach to complex intervention development and evaluation (Campbell, et al., 2007; Craig, Dieppe, Macintyre, Nazareth, & Petticrew, 2008). Given the limited evidence available around older adults' MWC use, an initial qualitative exploration of the experience transitioning from ambulatory to wheeled mobility provided a stronger theoretical foundation for intervention development (Craig, Dieppe, Macintyre, Nazareth, & Petticrew, 2008). Incorporating targeted stakeholder groups during the development and pilot testing phase allowed for a comprehensive development and provided confirmation for the conceptual and theoretical approach employed, namely the use of SCT and Andragogical strategies. Conducting a feasibility RCT allowed for preliminary evaluation of the treatment effect and comprehensive assessment of feasibility before undertaking a large-scale evaluation. This systematic approach allowed me to refine the EPIC Wheels program en route, with the intent to make the intervention both clinically effective and pragmatically implemented.

Another strength of this dissertation was the use of multiple and mixed methods of inquiry. As already noted, multiple research strategies are recommended to develop and evaluate complex rehabilitation interventions (Craig, Dieppe, Macintyre, Nazareth, & Petticrew, 2008). The use of PAD, focus groups, individual interviews, a pre-post pilot study and an RCT feasibility study provided a broad source of data. The qualitative elements enabled confirmation of the quantitative findings, a more in-depth understanding of the reasons why the program was well received and effective, and potential explanation for the non-significant statistical results for the primary outcome despite the clinical benefits realized. The capacity to integrate and mix these data types, rather than simply collecting quantitative and qualitative data, adds to the rigor and validity of the findings (Creswell, 2003).

A limitation to the PAD approach was the point at which the MWC users and care providers were initially introduced. These stakeholders could have been consulted at a more preliminary stage (i.e., before the conceptualization of a home-based training program using a mobile device method of delivery) and potentially identified an alternative approach to improving wheelchair use. Given the overwhelming nature of this transition period (as elucidated in chapter 2), and the potential issue of new users "not knowing what they didn't know", we chose to use individuals further removed from initial use who we felt could consider these issues retrospectively.
A challenge in recruitment for the RCT was the most salient limitation in this study. The small sample size resulted in reduced power to ascertain statistically significant differences between the study groups. While statistically significant differences were found for two of the secondary measures, the medium to large effect sizes in the remaining measures suggest that a larger sample might have achieved statistical significance in these outcomes as well. Despite considerable and widespread efforts of advertisement and invitation, response from interested parties and referral by clinical partners was limited. This recruitment issue could present challenges for a larger follow-up RCT. Addressing a larger pool of MWC users (e.g. age range, diagnoses, propulsion strategies) could ameliorate this limitation, but might require additional content that would be user group specific (e.g. hemiplegic propulsion strategies). Among those who declined to participate, distance and cost were the only reasons provided by multiple individuals; this further speaks to the challenges of providing rehabilitation services through a centralized service model, particularly with older adults who have mobility issues. The EPIC

Wheels platform has the potential to be delivered with less in-person contact, which would further diminish the travel time and cost involved; however, the benefits EPIC Wheels participants identified with their trainer providing orientation to the tablet/program and personalized feedback on performance would need to be addressed in some way. One alternative might be to leverage the video capability inherent in the tablet device, and provide 1:1 sessions (either asynchronously or in real-time) as a substitute for in-person training.

Using two study sites in the RCT was both a strength and limitation. The cities were diverse in many respects, which improves the generalizability of the results. However, they target an urban audience that was relatively homogenous geographically and might not reflect the impact on people living in rural/remote locations or a more diverse cultural context.

7.8 Future directions

Given the results of the feasibility RCT, subsequent evaluation of the EPIC Wheels program is warranted. As previously mentioned, the success of a subsequent trial would be dependent upon a comprehensive recruitment approach implementing the strategies identified earlier to obtain a larger sample. A larger scale study would enable a more robust statistical analysis with sufficient power to evaluate with an alpha set at 0.05, adjusting for multiple comparisons and stratification by study site. This would allow for greater precision of point estimates and variance (i.e., tighter confidence intervals) and adjust for confounding variables such as sex, age, health condition, cognition, grip strength, and propulsion method. Consideration should be given to using multiple primary outcome measures and potentially ones that more directly measure impact on participation and clinical impact, such as the WhOM. A larger study might consider a broader target audience, with additional content that could be customized to the participant (e.g. age, sex and diagnosis of demonstrator model; hemiplegic propulsion strategies). Additional measurement of cost-effectiveness and a more direct measure of care provider burden would provide important information that could be used to advocate for uptake by funders.

The use of training activities and games was well received and motivating to trainees. Development of more immersive and engaging games would have potential to further enhance program adherence and benefit. Exploring the use of sensor technology, either user or wheelchair mounted, could offer a more realistic experience and would provide knowledge of results to the participant, enhancing motor learning. We are currently evaluating several tablet-based interactive wheelchair games, using inexpensive wheel-mounted Bluetooth sensors, for effectiveness and acceptability among older adults, and future iterations could be incorporated into the EPIC Wheels program. The existing tablet capacity for video recording and transmission could be leveraged to provide asynchronous or real-time exchange between trainee and trainer. This might enable the program to be delivered entirely from a distance for individuals living in rural or remote locations without the capacity to access rehabilitation services and centres of delivery.

EPIC Wheels is novel in that it is the first published mHealth training program that addresses motor skill learning in a clinician-monitored format. The tablet-based platform could be modified to delivery training for other mobility devices such as a power wheelchair or scooter and, ultimately, a variety of other rehabilitation interventions.

REFERENCES

Aarhus, R., Gronvall, E., Larsen, S., & Wollsen, S. (2011). Turning training into play: Embodied gaming, seniors, physical training and motivation. *Gerontechnology , 10*, 110-120.

Agostini, M., Moja, L., Banzi, R., Pistotti, V., Tonin, P., Venneri, A., et al. (2015, Feb 22). Telerehabilitation and recovery of motor function: a systematic review and meta-analysis. *Journal of Telemedicine and Telecare* .

Allen, R., & Wiles, J. (2014). Receiving support when older: what makes it OK? *Gerontologist , 54* (4), 670-682.

Alon, G., Sunnerhagen, K., Geurts, A., & Ohry, A. (2003). A home-based, self-administered stimulation program to improve selected hand functions of chronic stroke. *NeuroRehabilitation , 18*, 215-225.

Altman, D. (1985). Comparability of randomised groups. *Statistician , 34*, 125-136.

Altman, D. (2009). Missing outcomes in randomized trials: addressing the dilemma. *Open Medicine , 3* (2), e51-53.

Americans With Disabilities Act. (1990). *Pub. L. No. 101-336 § 37.165b, 104 Stat. 328 Title II Regulations.*

Anderson, K., Woodbury, M., Phillips, K., & Gauthier, L. (2015). Virtual reality video games to promote movement recovery in stroke rehabilitation: a guide for clinicians. *Archives of Physical Medicine and Rehabilitation , 96*, 973-976.

Arain, M., Campbell, M., Cooper, C., & Lancaster, G. (2010). What is a pilot or feasibility study? A review of current practice and editorial policy. *BMC Medical Research Methodology , 10*, 67.

Arledge, S., Armstron, W., Babinec, M., Dicianno, B., Digiovine, C., Dyson-Hudson, T., et al. (2011). *RESNA wheelchair service provision guide.* Arlington, VA: RESNA.

Armijo-Olivo, S., Warren, S., & Magee, D. (2009). Intention to treat analysis, compliance, drop-outs and how to deal with missing data in clinical research: a review. *Physical Therapy Reviews , 14* (1), 36-49.

Ashari, A., Hamid, T., Hussain, M., & Hill, K. (2015, Sep 24). Effectiveness of individualized home-based exercise on turning and balance performance among adults older than 50 yrs: a randomized controlled trial. *American Journal of Physical Medicine and Rehabilitation* , Epub ahead of print.

Assistive Technology Act. (2004). PL 108-364, §3, 118 stat 1707.

Auger, C., Demers, L., Gelinas, I., Miller, W., Jutai, J., & Noreau, L. (2010). Life-space mobility of middle-aged and older adults at various stages of usage of power mobility devicees. *Archives of Physical Medicine and Rehabilitation , 91*, 765-773.

Auger, C., Demers, L., Gelinas, I., Routhier, F., Mortenson, W., & Miller, W. (2010). Reliability and validity of the telephone administration of the wheelchair outcome measure (WhOM) for middle-aged and older users of power mobility devices. *Journal of Rehabilitation Medicine , 42*, 574-581.

Bainbridge, E., Bevans, S., Keeley, B., & Oriel, K. (2011). The effects of the Nintendo Wii Fit on community-dwelling older adults with peceived balance deficits: A pilot study. *Physical and Occupational Therapy in Geriatrics , 29*, 126-135.

Baker, P., Bodner, E., & Allman, R. (2003). Measuring life-space mobility in community-dwelling older adults. *Journal of the American Geriatric Society , 51* (11), 1610-1614.

Bandura, A. (1997). *Self-efficacy: the exercise of control.* New York: W. H. Freeman and Company.

Bandura, A. (1986). *Social foundations of thought and action: a social cognitive theory.* Englewood Cliffs, NJ: Prentice Hall.

Barker, D., Reid, D., & Cott, C. (2004). Acceptance and meanings of wheelchair use in senior stroke survivors. *American Journal of Occupational Therapy , 58* (2), 221-230.

Barlow, I., Liu, L., & Sekulic, A. (2009). Wheelchair seating assessment adn intervention: a comparison between telerehabilitation and face-to-face service. *International Journal of Telerehabilitation , 1* (1), 17-28.

Barnes, S., Lindborg, S., & Seaman, J. (2006). Multiple imputation techniques in small smple clinical trials. *Statistics in Medicine , 25*, 233-245.

Bates, P., Spencer, J., Young, M., & Rintala, D. (1993). Assistive technology and the newly disabled adult: Adaptation to wheelchair use. *American Journal of Occupational Therapy , 47* (11), 1014-1021.

Beaton, D., Boers, M., & Wells, G. (2002). Many faces of the minimal clinically important difference (MCID): a literature review and directions for future research. *Current Opinions in Rheumatology , 14*, 109-114.

Belchior, P., Marsiske, M. S., Yam, A., & Mann, W. (2012). Older adults' engagement with a video game training program. *Activities, Adaptation and Aging , 36* (4), 269-279.

Best, K., Kirby, R., Smith, C., & MacLeod, D. (2005). Wheelchair skills trainig for community-based manual wheelchair users: A randomized controlled trial. *Archives of Physical Medicine and Rehabilitation , 86*, 2316-2323.

Best, K., Miller, W., & Routhier, F. (2015). A description of manual wheelchair skills training curriculum in entry-to-practice occupational and physical therpay programs in Canada. *Disability and Rehabilitation: Assistive Technology , 10* (5), 401-406.

Best, K., Routhier, F., & Miller, W. (2015). A description of manual wheelchair skills training: current practices in Canadian rehabilitation centers. *Disability and Rehabilitation: Assistive Technology , 10* (5), 393-400.

Beswick, A., Rees, K., Griebsch, I., Taylor, F., Burke, M., West, R., et al. (2004). Provision, uptake and cost of cardiac rehabilitation programmes: improving services to under-represented groups. *Health Technology Assessment , 8* (4), 1-166.

Blanton, S., Morris, D., Prettyman, M., mCulloch, K., Redmond, S., Light, K., et al. (2006). Lessons learned in participant recruitment and retention: the EXCITE trial. *Physical Therapy Journal , 86* (1520-1533).

Bohannon, R. (2008). Hand-grip dynamometry predicts future outcomes in aging adults. *Journal of Geriatric Physical Therapy , 31*, 3-10.

Bonaparte, J., Kirby, R., & Macleod, D. (2004). Learning to perform wheelchair wheelies: comparison of 2 training strategies. *Archives of Physical Medicine and Rehabilitation , 85*, 785-793.

Borisoff, J. (2012). British Columbia Institute of Technology. *Rehabilitation Engineering Design department* . Vancouver, BC.

Borm, G., Fransen, J., & Lemmens, W. (2007). A simple sample size formula for anlaysis of covariance in randomized clinical trials. *Journal of Clinical Epidemiology , 60*, 1234-1238.

Bowen, D., Kreuter, M., Spring, B., Cofta-Woerpel, L., Linnan, L., Weiner, D., et al. (2009). How we design feasibility studies. *American Journal of Preventative Medicine , 36* (5), 452-457.

Brennan, S. (2012). *Victimization of older Canadians.* Ottawa: Statistics Canada.

Brown, S., & Venkatesh, V. (2005). Model of adoption of technology in the household: a baseline model test and extension incorporating household life cycle. *MIS Quarterly , 29* (4), 399-426.

Callahan, J., Kiker, D., & Cross, T. (2003). Does method matter? A meta-analysis of the effects of training method on older learner training performance. *Journal of Management , 29* (5), 663-680.

Campbell, A., Robertson, M., Gardner, M., Norton, R., Tilyard, M., & Buchner, D. (1997). Randomised controlled trial of a general practice programme of home based exercise to prevent falls in elderly women. *British Medical Journal , 315*, 1065-1069.

Campbell, N., Murray, E., Darbyshire, J., Emery, J., Farmer, A., Griffiths, F., et al. (2007). Designing and evaluating complex interventions to improve health care. *British Medical Journal , 334* (7591), 455-459.

Canada Mortgage and Housing Corporation. (2012). *Housing for older Canadians: the definitive guide to the over-55 market.* Ottawa: CMHC.

Canadian Agency for Drugs and Technologies in Health. (2006). *Guidelines for the economic evaluation of health technologies: Canada.* Ottawa.

Caprani, N., O'Connor, N., & Gurrin, C. (2012). Touch screens for the older user. In F. Auat Cheein, *Assistive Technologies* (pp. 95-118). InTechn Open Access Publisher.

Cason, J. (2015). Telehealth and occuaptional therapy: integral to the triple aim of health care reform. *American Journal of Occupational Therapy , 69* (2), 1-8.

Chang, C., Lin, K., Chen, W., Jane, S., Yeh, S., & Wang, T. (2015, Nov 19). Effects of a home-based resistance training program on recovery from total hip replacement surgery: feasibility and pilot testing. *Journal of Nursing Research* , Epub ahead of print.

Charness, N., Fox, M., & Mitchum, A. Lifespan cognition and information technology. In K. Fingerman, C. A. Berg, & J. Smith, *Handbook of lifespan psychology* (Vol. 2010). New York: Springer.

Charness, N., Fox, M., & Mitchum, A. (2010). Lifespan cognition and information technology. In K. Fingerman, C. A. Berg, & J. Smith, *Handbook of lifespan psychology.* New York: Springer.

Chaves, E., Boninger, M., Cooper, R., Fitzgerald, S., Gray, D., & Cooper, R. (2004). Assessing the influence of wheelchair technology on perception of participation in spinal cord injury. *Archives of Physical Medicine and Rehabilitation , 85*, 1854-1858.

Chen, K., & Chan, A. (2011). A review of technology acceptance by older adults. *Gerontechnology , 10*, 1-12.

Chen, T., Mann, W. C., Tomita, M., & Nochajski, S. (2000). Caregiver involvement in the use of assistive devices by frail older persons. *Occupational Therpay Journal of Research , 20*, 179-199.

Chiu, C., & Mann, D. (2004). The effect of training odler adults with stroke to use home-based assistive devices. *Occupational Therapy Journal of Research , 24*, 113-120.

Clark, R., & Kraemer, T. (2009). Clinical use of Nintendo Wii bowling simulation to decrease fall risk in an elderly resident of a nursing home: A case report. *Journal of Geriatric Physical Therapy , 32*, 174-180.

Clarke, P., & Colantonio, A. (2005). Wheelchair use among community-dwelling older adults: Prevalence and risk facgors in a national sample. *Canadian Journal on Aging , 24*, 191-198.

Cohen, J. (1988). *Stastical power analysis for he behavioral sciences* (2nd Edition ed.). Nillsdale, NJ: Lawrence Erlbaum Associates.

Cook, A., & Miller-Polgar, J. (2008). *Cook & Hussey's assistive technologies: principles and practice* (3rd Edition ed.). St. Louis: Mosby Elsevier.

Coolen, A., Kirby, R., Landry, J., MacPhee, A., Dupuis, D., Smith, C., et al. (2004). Wheelchair skills training program for clinicians: A randomized controlled trial with ocupational therapy students. *Archives of Physical Medicine and Rehabilitation , 85*, 1160-1167.

Cope, D. (2014). Methods and meanings: credibility and trustworthiness of qualitative research. *Oncology Nursing Forum , 41* (1), 89-91.

Craig, P., Dieppe, P., Macintyre, S., Nazareth, I., & Petticrew, M. (2008). Developing and evaluating complex interventions: the new Medical Research Council guidance. *British Medical Journal , 337*, a1655.

Cranswick, K., & Dosman, D. (2008). *Eldercare: What we know today.* Ottawa: Statistics Canada.

Cress, M., Buchner, D., Prohaska, T., Rimmmer, J., Brown, M., Macera, C., et al. (2005). Best practices for physical activity programs and behavior counseling in older adult populations. *Journal of Aging and Physical Activity , 13* (1), 61-74.

Creswell, J. (2003). *Research design: qualitative, quantitative and mixed methods approaches* (2nd Edition ed.). Thousand Oaks, CA: SAGE Publications.

Creswell, J., Hanson, W., Clark Plano, V., & Morales, A. (2007). Qualitative research designs: selection and implementation. *The Counseling Psychologist , 35* (2), 236-264.

Csikszentmihalyi, M. (1990). *Flow: the psychology of the optimal experience.* New York: Harper & Row.

Czaja, S., Charness, N., Fisk, A., Hertzog, C., Nair, S., Rogers, W., et al. (2005). Factors predicting the use of technology: findings from the Center for Research and Education on Aging and Technology Enhancement (CREATE). *Psychology and Aging , 21*, 333-352.

Dalhousie University. (2012). *Wheelchair Skills Program*. Retrieved December 4, 2014, from http://www.wheelchairskillsprogram.ca

Dalhousie University. (2012). *Wheelchair Specifications Form*. Retrieved August 1, 2013, from Wheelchair Skills Training Program: http://www.wheelchair skillsprogram.ca

Davis, L., & Chesbro, S. (2003). Integrating health promotion, patient education, and adult education principles with the older adult. *Journal of Allied Health , 32* (2), 106-109.

Delahaye, B., & Ehrich, L. (2008). Complex learning preferences and strategies of older adults. *Educational Gerontology , 34*, 649-662.

DeMets, D. (1998). Data and safety monitoring boards. In P. Armitage, & T. Colton, *Encyclopedia of Biostatistics* (pp. 1066-1071). Chichester: John Wiley & Sons.

Demiris, G., Oliver, D. P., Dickey, G., Skubic, M., & Rantz, M. (2008). Findings from a participatory evaluation of a smart home application for older adults. *Technology and Health Care , 16* (2), 111-118.

Desai, R., Jayavant, S., & Varshneya, H. (2013). To investigate the immediate and short term effects of wheelchair skill training program (WSTP) on participation in patients with spinal cord involvement. *Indian Journal of Occupational Therapy , 45* (2), 9-14.

Dimitrov, D., & Rumrill, P. (2003). Pre-test-posttest designs and measurement of change. *Work , 20*, 159-165.

Ding, D., Cooper, R. A., & Pearlman, J. (2007). Incorporating Participatory Action Design into research and education. *International Conference on Engineering Education Proceedings.* Coimbra, Portugal.

Dong, Y., & Peng, C. (2013). Principled missing data methods for researchers. *Springerplus , 2*, 222.

Doody, O., & Noonan, M. (2013). Preparing and conducting interviews to collect data. *Nurse Researcher , 20* (5), 28-32.

Drummond, M. (2001). Introducing economic and quallity of life measurements into clinical studies. *Annals of Medicine , 33*, 344-349.

Ellis, D., & Allaire, J. (1999). Modeling computer interest in older adults: the role of age, educaiton, computer knowledge and computer anxiety. *Human Factors , 41*, 345-355.

Emerson, R. (1976). Social exchange theory. *Annual Review of Sociology , 2* (1), 335-362.

Eriksson, J., A, E., & Johansson, G. (2000). Design and evaluation of a software prototype for participatory planning of environemental adaptations. *IEEE Trans Rehabilitation Engineering , 8* (1), 94-106.

Fanning, J., Awick, E., Wojcicki, T., Gothe, N., Roberts, S., Ehlers, D., et al. (2015, Nov 23). Effects of a DVD-delivered exercise intervention on maintenance of physical activity in older adults. *Journal of Physical Activity and Health* , Epub ahead of print.

Fanning, J., Mullen, S., & McAuley, E. (2012). Increasing physical activity with mobile devices: a meta-analysis. *Journal of Medical Internet Research , 14* (6), e161.

Fenter, P. (2002). Understanidng the role of practice in learning for geriatric individuals. *Topics in Geriatric Rehabilitation , 17*, 11-32.

Finlayson, M., & van Denend, T. (2003). Experiencing the loss of mobility: perspectives of older adults with MS. *Disaiblity and Rehabilitation , 25* (20), 1168-1180.

Flynn, S., Palma, P., & Bender, A. (2007). Feasibility of using the Sony PlayStation 2 gaming platform for an individual poststroke: A case report. *Nournal of Neurological Physical Therapy , 31*, 180-189.

Fradet, L., Lee, G., & Dounskaia, N. (2008). Originas of submovements in movements of elderly adults. *Journal of Neuroengineering and Rehabilitation , 5*, 28.

Friedman, L., Furberg, C., & DeMets, D. (2010). *Fundamentals of clinical trials* (4th Edition ed.). New York: Springer Science+Business Media.

Fuhrer, M., Jutai, J., Scherer, M., & DeRuyter, F. (2003). A framework for the coneptual modelling of assistive technology device outcomes. *Disability and Rehabilitation , 25*, 1243-1251.

Ganesh, S., Hayter, A., Kim, J., Sanford, J., Sprigle, S., & Hoenig, H. (2007). Wheelchair use by veterans newly prescribed a manual wheelchair. *Archives of Physical Medicine and Rehabilitation , 88*, 434-439.

Gao, Y., & Mandryk, R. (2011). GrabApple: the design of a casual exergame. *Proceedings of the 10th International Conference on Enterainment Computing* (pp. 35-46). Springer.

Garber, S. L., Bunzel, R., & Monga, T. N. (2002). Wheelchair utilization and satisfaction fallowing cerebral vascular accident. *Journal of Rehabilitation Research and Development , 39*, 521-534.

Gavin-Dreschnack, D., Nelson, A., Fitzgerald, S., Harrow, J., Sanchez-Anguiano, A., Ahmed, S., et al. (2005). Wheelchair-related falls: current evidence and directions for improved quality care. *Journal of Nursing Care Quality , 20* (2), 119-127.

Gerling, K., Mandryk, R., Miller, M., Kalyn, M., Birk, M., & Smeddinck, J. (2015). Designing wheelchiar-based movement games. *ACM Transactions on Accessible Computing , 6* (2), 1-15.

Giesbrecht, E., & Miller, W. (2013). Development of the Wheeling While Talking test. *Rehabilitation Engineeering and Assistive Technology Society of North America Conference Proceedings.* Bellevue, WA: RESNA.

Giesbrecht, E., Miller, W., & Smith, E. (2014). Levels of assistance and unmet needs of Canadian wheelchair users. *Investing in our futures: national conferenc eof the Canadian Research Data Centre NEtwork.* Winnipeg: Oct 29-31.

Giesbrecht, E., Miller, W., & Woodgate, R. (2015). Navigating uncharted territory: a qualitative study of the experience of transitioning to wheelchair use among older adults and their care providers. *BMC Geriatrics , 15*, 91.

Giesbrecht, E., Miller, W., Eng, J., Mitchell, I., Woodgate, R., & Goldsmith, G. (2013). Feasibility of the Enhancing Participation In the Community by improving Wheelchair Skills (EPIC Wheels) program: study protocol for a randomized controlled trial. *BMC Trials , 14*, 350.

Giesbrecht, E., Miller, W., Mitchell, I., & Woodgate, R. (2014). Development of a wheelchair skills home program for older adults using a Participatory Action Design approach. *BioMed Research International , 172434*, 1-13.

Giesbrecht, E., Ripat, J. C., & Quanbury, A. (2011). Experiences with using a pushrim-activated power-assisted wheelchair for commuity-based occupations: a quaitative exploration. *Canadian Journal of Occupational Therapy , 78*, 127-136.

Gill, T., Baker, D., Gottschalk, M., Peduzzi, P., Allore, H., & Byers, A. (2002). A program to prevent functional decline in physically frail, elderly persons who live at home. *New England Journal of Medicine , 347*, 1068-1074.

Gitlin, L. (1998). Individual variations in experience with assistive devices among older adults. In D. Gray, L. Quatrano, & M. Lieverman, *Designing and using assistive technology* (pp. 117-135). Baltimore: Paul H. Brookes.

Gitlin, L., & Levine, R. (1992). Prescribing adaptive devices to the elderly: Principles for treatment in the home. *International Journal of Technology and Aging , 5*, 107-120.

Groenwold, R., Moons, K., & Vandenbroucke, J. (2014). Randomzied trials with missing outcome data: how to analyze and what to report. *Canadian Medical Association Journal , 186* (15), 1153-1157.

Grootendorst, P., Feeny, D., & Furlong, W. (2000). Health Utilities Index Mark 3: evidence of construct validity for stroke and arthritis in a population health survey. *Medical Care , 38* (3), 290-299.

Hall, M., & Havens, B. (1999). *The effect of social isolation and loneliness on the health of older women.* Aging in Manitoba Study, Department of Community Health Sciences. Winnipeg: University of Manitoba.

Hanlon, R. (1996). Motor learning following unilateral stroke. *Archives of Physical Medicine and Rehabilitation , 77* (8), 811-815.

Hart, T., & Bagiella, E. (2012). Design and implementation of clinical trials in rehabilitation research. *Archives of Physical Medicine and Rehabilitation , 93* (8 Suppl 2), S117-126.

Hedberg-Kristensson, E., Ivanoff, D., & Iwarsson, S. (2007). Experiences among older persons using mobility devices. *Disability and Rehabilitation: Assistive Technology , 2*, 15-22.

Hinojosa, J., Kramer, P., Brasic Royeen, C., & Luebben, A. (2003). Core concepts of occupation. In P. Kramer, J. Hinojosa, & C. Brasic Royeen, *Perspective in human occupation: Participation in life* (pp. 1-17). Baltimore: Lippincott Williams & Wilkins.

Hoenig, H., Giacobbi, P., & Levy, C. (2007). Methodological challenges confronting researchers of wheeled mobility aids and other assistive technologies. *Disability and Rehabilitation: Assistive Technology , 2*, 159-168.

Hoenig, H., Landerman, L., Shipp, K., Pieper, C., Richardson, M., Pahel, N., et al. (2005). A clinical trial of a rehabilitation expert clincian versus usual care for providing manual wheelchairs. *Journal of the American Geriatrics Society , 53*, 1712-1720.

Hoenig, H., Sandford, J., Butterfield, T., Griffiths, P., Richardson, P., & Hargraves, K. (2006). Development of a teletechnology protocol for in-home rehabilitation. *Journal of Rehabilitation Research and Development , 43*, 287-298.

Hoenig, H., Tayor, D., & Sloan, F. (2003). Does assistive technology substitute for personal assistance among the disabled elderly? *American Journal of Public Health , 93*, 330-337.

Horn, J., & Cattell, R. (1967). Age differences in fluid and crystallized intelligence. *Acta Psychologica (Amst) , 26*, 107-129.

Horsman, J., Furlong, W., Feeny, D., & Torrance, G. (2003). The Health Utilities Index (HUI): concpts, measurement properties and applications. *Health and Quality of Life Outcomes , 1*, 54.

Hosseini, S., Oyster, M., Kirby, R., Harrington, A., & Boninger, M. (2012). Manual wheelchair skills capacity predicts quality of life and community integration in persons with spinal cord injury. *Archives of Physical Medicine and Rehabilitation , 93* (12), 2237-2243.

Howard, L., de Salis, I., Tomlin, Z., Thornicroft, G., & Donovan, J. (2009). Why is recruitment to trials difficult? An investigation into recruitment difficulties in an RCT of supported employment in patients with severe mental illness. *Contemporary Clinical Trials , 30*, 40-46.

Hsieh, H., & Shannon, S. (2005, 15 9). Three approaches to qualitative content analysis. *Qualitative Health Research* , 1277-1288.

Hubbard, G., Campbell, A., Daviees, Z., Munro, J., Ireland, A., Leslie, S., et al. (2015). Experiences of recruiting to a pilot trial of Cardiac Rehabilitation in patients with bowel cancer (CRIB) with an embedded process evaluation: lessons learned to improve recruitment. *Pilot and Feasibility Studies , 1*, 15.

Inkpen, P., Parker, K., & Kirby, R. (2012). Manual wheelchair skills capacity versus performance. *Archives of Physical Medicine and Rehabilitation , 93* (6), 1009-1013.

International Standards Organization. (2014, 12 15). *ISO/TS 13131:2014(en)*. Retrieved 5 15, 2015, from www.iso.org: https://www.iso.org/obp/ui/#iso:std:iso:ts:13131:ed-1:v1:en

Jay, G., & Willis, S. (1992). Influence of direct computer experience on onlder adults' attitude toward computers. *Journal of Gerontology: Psychological Sciences , 47*, P250-257.

Jette, A., Rooks, D., Lachman, M., lIn, T., Levenson, C., Heislein, D., et al. (1998). Home-based resistance training: Predictors of participation and adherence. *Gerontologist , 38*, 412-421.

Johnson, K., McMorris, B., Raynor, L., & Monsen, K. (2013). What big size you have! Using effect sizes to determine the impact of public health nursing interventions. *Applied Clinical Informatics , 4* (3), 434-444.

Johnston, M., & Case-Smith, J. (2009). Development and testing of interventions in occupational therapy: toward a new generation of research in occupational therapy. *Occupational Therapy Journal of Research , 29*, 4-13.

Jones, C., Feeny, D., & Eng, K. (2005). Test-retest reliability of health utilities index scores: evidence from hip fracture. *International Journal of Technology Assessment in Health Care , 21*, 393-398.

Jordan, J., Holden, M., Mason, E., & Foster, N. (2010). Intervenitons to improve adherence to exercise for chronic musculoskeletal pain in adults. *Cochrane Database Systematic Review* (1), CD005956.

Jung, Y., Li, K., Janissa, N., Gladys, W., & Lee, K. (2009). Games for a better life: effects of playing Wii games on the well-being of seniors in a long-term care facility. *Proceedings of IE '09* (p. Article 5). New York: ACM.

Kairy, D., Lehoux, P., Vincent, C., & Visintin, M. (2009). A systematic review of lcinical outcomes, clinical process, healthcare utilization and costs associated with telerehabilitation. *Disability and Rehabilitation , 31* (6), 427-447.

Kammerlind, A., Fristedt, S., Bravell, M., & Fransson, E. (2014). Test-retest reliability of the Swedish version of the LIfe-Space Assessment Questionnaire among community-dwelling older adults. *Clinical Rehabilitation , 28* (8), 817-823.

Karmarkar, A., Collins, D., Kelleher, A., Ding, D., Oyster, M., & Cooper, R. (2010). Manual wheelchair-related mobility characteristics of older adults in nursing homes. *Disability and Rehabilitation: Assistive Technology , 5*, 428-437.

Karmarkar, A., Collins, D., Wichman, T., Franklin, A., Fitzgerald, S., Dicianno, B., et al. (2009). Prosthesis and wheelchair use in veterans with lower-limb amputation. *Journal of Rehabilitation Research and Development , 46*, 567-576.

Karmarkar, A., Dicianno, B., Cooper, R., Collins, D., Matthews, J., Koontz, A., et al. (2011). Demographic profile of older adults using wheeled mobility devices. *Journal of Aging Research , 2011* (560358).

Kaye, H., Kang, T., & LaPlante, H. G. (2000). *Mobility device use in the United States.* Washington, DC: National Institute on Disability and Rehabilitation Research.

Kilkens, O., Dallmeijer, A., De Witte, L., van der Woude, L., & Post, M. (2004). The Wheelchair Circuit: construct validity and responsiveness of a test to assess manual wheelchair mobility in persons with spinal cord injury. *Archives of Physical Medicine and Rehabilitation , 85*, 424-431.

Kilkens, O., Post, M., Dallmeijer, A., Seelen, H., & van der Woude, L. (2003). Wheelchair skills tests: A systematic review. *Clinical Rehabilitation , 17*, 418-430.

Kirby, R., Ackroyd-Stolarz, S., Brown, M., Kirkland, S., & MacLeod, D. (1994). Wheelchair-related accidents caused by tips and falls among noninstitutionalized users of maually propelled wheelchairs in Nova Scotia. *American Journal of Physical Medicine and Rehabilitation , 73* (5), 319-330.

Kirby, R., Dupuis, D., MacPhee, A., Coolen, A., Smith, C., Best, K., et al. (2004). The wheelchair skills test: measurement properties. *Archives of Physical Medicine and Rehabilitation , 85* (5), 794-804.

Kirby, R., Mifflen, N., Thibault, D., Smith, C., Best, K., Thompson, K., et al. (2004). The manual wheelchair-handling skills of caregivers and the effect of training. *Archives of Physical Medicine and Rehabilitation , 85*, 2011-2019.

Kirby, R., Swuste, J., Dupuis, D., MacLeod, D., & Monroe, R. (2002). The Wheelchair Skills Test: A pilot study of a new outcome measure. *Archives of Physical Medicine and Rehabilitation , 83*, 10-18.

Kittel, A., DiMarco, A., & Stewart, H. (2002). Factors influencing the decision to abandon manual wheelchairs for three individuals with a spinal cord injury. *Disability and Rehabilitation , 24* (1), 106-114.

Kitzinger, J. (1995). Qualitative research: introducing focus groups. *British Medical Journal , 311* (7000), 299-302.

Knowles, M. (1980). *The modern practice of adult education: From Pedagogy to Andragogy.* New York: The Adult Education Company.

Kraskowsky, L., & Finalyson, M. (2001). Factors affecting older adults' use of adaptive equipment: Review of the literature. *American Journal of Occupational Therapy , 55* (3), 303-310.

Kroll, T., Neri, M., & Miller, K. (2005). Using mixed mthods in disability and rehabilitation research. *Rehabilitation Nursing , 30*, 106-113.

Krueger, R., & Casey, M. (2000). *Focus groups: a practical guide for applied research.* Thousand Oaks, CA: Sage Publications.

Kueider, A., Parisi, J., Gross, A., & Rebok, G. (2012). Computerized cognitive training with older adults: a systematic review. *PLoS ONE , 7* (7), e40588.

Kumar, S., Nilsen, W., Abernethy, A., Atienza, A., Patrick, K., Pavel, M., et al. (2013). Mobile health technology evaluation: the mHealth evidence workshop. *American Journal of Preventative Medicine , 45* (2), 228-236.

Lösch, C., & Neuhäuser, M. (2008). The statistical analysis of a clinical trial when a protocol amendment changed the inclusion criteria. *BMC Medical Research Methodology , 8*, 16.

Laguna, K., & Babcock, R. (2000). Computer testing of memory across the adult life span. *Experimental Aging Research , 26*, 229-243.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primar for t-tests and ANOVAs. *Frontiers in Psychology , 4* (863).

Laliberte-Rudman, D., Hebert, D., & Reid, D. (2006). Living in a restricted occupational world: The occupational experiences of stroke survivors who are wheelchair users and their caregivers. *Canadian Journal of Occupational Therapy , 73*, 141-52.

Lancaster, G. (2015). Pilot and feasibility studies come of age! *Pilot and Feasibility Studies,* 1(1), 1.

Laver, K., Schoene, D., Crotty, M., George, S., Lannin, N., & Sherrington, C. (2013). Telerehabilitation servcies for stroke. *Cochrane Database of Systematic Reviews* (12), 1-39.

Law, M. (2002). Participation in the occupations of everyday life. *American Journal of Occupational Therapy , 56* (6), 630-649.

Lawler, E., & Thye, S. (1999). Bringing emotions into social exchange theory. *Annual Review of Sociology , 25* (1), 217-244.

Layne, J., Sampson, S., Mallio, C., HJibberd, P., Griffith, J., Das, S., et al. (2008). Successful dissemination of a community-based strength training program for older adults by peer and professional leaders: the people exercising program. *Journal of the American Geriatric Society , 56*, 2323-2329.

Lee, S., & Zhai, S. (2009). The performance of touch screen soft buttons. *Proceedings of Human Factors in Computing Systems*, (pp. 309-318). Boston.

Leech, B. (2002). Asking questions: techniques for semistructured interviews. *Political Science and Politics , 35* (4), 665-668.

Levins, S., Redenbach, D., & Dyck, I. (2004). Individual and societal influences on participation in physical activity following spinal cord injury: a qualitative study. *Physical Therapy , 84*, 496-509.

Lewinter, M. (2003). Reciprocities in caregiving relationships in Danish elder care. *Journal of Aging Studies , 17* (3), 357-377.

Lin, C. A., Neafsey, P. J., & Strickler, Z. (2009). Usability testing by older adults of a computer-mediated health communication program. *Journal of Health Communication , 14* (2), 102-118.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry.* Newbury Park, CA: Sage Publications.

Lindquist, N., Loudon, P., Magis, T., Rispin, J., Kirby, R., & Manns, P. (2010). Reliabiltiy of the performance and safety scores of the Wheelchair Skills Test version 4.1 for manual wheelchair users. *Archives of Physical Medicine and Rehabilitation , 91*, 1752-1757.

Liu, L., Cruz, A., Rincon, A., Buttar, V., Ranson, Q., & Goertzen, D. (2014). What facctors determine therapists' acceptance of new technologies for rehabilitation - a study using the Unified Theroy of Acceptance and Use of Technology (UTAUT). *Disability and Rehabilitation , Early online*, 1-9.

Luo, N., Johnson, J., & Coons, S. (2010). Using instrument-defined health state transitions to estimate minimally important differences for four preference-based health-related quality of life instruments. *Medical Care , 48* (4), 365-371.

MacPhee, A., Kirby, R., Coolen, A., Smith, C., MacLeod, D., & Dupuis, D. (2004). Wheelchair skills training program: A randomized clinical trial of wheelchair users undergoing initial rehabilitation. *Archives of Physical Medicine and Rehabilitation , 85*, 41-50.

Madara Marasinghe, K. (2015, Sept 15). Assistive technologies in reducing caregiver burden among informal caregivers of older adults: a systematic review. *Disability and Rehabilitation: Assistive Technology* , 1-8.

Magill, R. (2011). *Motor learning and control: concepts and applications* (9th Edition ed.). New York: McGraw-Hill.

Mallinson, T., & Fischer, H. (2007). Rehabilitation research. *Americn Journal of Occupational Therapy , 64*, 506-514.

Mandryk, R., Gerling, K., & Stanley, K. (2014). Designing games to discourage sedentary behaviour. In A. Nijholt, *Playful user interfaces, gaming media and social effects* (pp. 253-274). Singapore: Springer Science+Business Media.

Mann, W. C., Lllanes, C., Justiss, M. D., & Tomita, M. (2004). Frail older adults' self-report of their most important assistive device. *Occupational Therapy Journal of Research , 24*, 4-12.

Marston, H., Kroll, M., Fink, D., & Gschwind, Y. (2016). Flow experience of older adults using the iStoppFalls exergame. *Games and Culture , 11* (1-2), 201-222.

McClain, L., Medrano, D., Marum, M., & Schukar, J. (2000). A qualitative assessment of wheelchair users' experience with ADA compliance, physical barriers, and secondary health conditions. *Topics in Spinal Cord Injury Rehabilitation , 6*, 99-118.

McMurdo, M., Roberts, H., Parker, S., Wyatt, N., May, H., Goodman, C., et al. (2011). Improving recruitment of older people to research through good practice. *Age and Ageing , 40*, 659-665.

Merriam, S., Caffarella, R., & Baumgartner, L. (2007). *Learning in adulthood: A comprehensive guide* (3rd Edition ed.). San Francisco, CA: John Wiley & Sons, INc.

Merriam-Webster.com. (2015). Retrieved Nov 30, 2015, from http://www.merriam-webster.com/dictionary/confidence

Meyers, A., Anderson, J., Miller, D., Shipp, K., & Hoenig, H. (2002). Barriers, facilitators and access for wheelchair users: substantie and methodologic lessons from a pilot study of environmental effects. *Social Science and Medicine , 55*, 1435-1446.

Miles, M., & Huberman, A. (1994). *Qualitative data analysis* (2nd Edition ed.). London, England: Sage Publications.

Miles-Tapping, C. (1996). Power wheelchairs and independent life styles. *Canadian Journal of Rehabilitation , 10*, 137-145.

Miles-Tapping, C., & MacDonald, L. (1994). Lifestyle implications of power mobility ... electric wheelchair and scooter users. *Physical and Occupational Therapy in Geriatrics , 12*, 31-49.

Miller, W., Bakas, T., Buelow, J., & Habermann, B. (2013). Research involving participants with chronic diseases: overcoming recruitment obstacles. *Clinical Nurse Specialist , 27* (6), 307-313.

Miller, W., Garden, J., & Mortenson, W. (2011). Measurement properties of the wheelchair outcome measure in individuals with spinal cord injury. *Spinal Cord , 49*, 995-1000.

Miller, W., Sakakibara, B., & Rushton, P. (2012). The prevalence of low confidence with using a wheelchair and its relationship to wheelchair skills. *The Gerontologist , 52* (Suppl 1), 205.

Mitzner, T., Boron, J., Fausset, C., Adams, A., Charness, N., Czaja, S., et al. (2010). Older adults talk technology: Technology usage and attitudes. *Computers and Human Behavior , 26*, 1710-1721.

Moffett, J. (1991). Randomized controlled trials. *Clinical Rehabilitation , 5*, 1-4.

Molloy, D., Alemayehu, E., & Roberts, R. (1991). Reliability of a Standardized Mini-Mental State Examination compared with the traditional Mini-Mental State Examination. *American Journal of Psychiatry , 148*, 102-105.

Montgomery, M., Peters, T., & Little, P. (2003). Design, analysis and presentation of factorial randomised controlled trials. *BMC Medical Research Methodology , 3*, 26-30.

Moon, M., Guo, J., & McSorley, V. (2015). Is 65 the best cut off for defining "older Americans?". *Age , 60* (64), 65-69.

Mortenson, W., & Miller, W. (2008). The wheelchair procurement process: perspective of clients and prescribers. *Canadian Journal of Occupational Therapy , 75* (3), 167-175.

Mortenson, W., Demers, L., Fuhrer, M., Jutai, J., Lenker, J., & DeRuyter, F. (2013). Effects of an assistive technology intervention on older adults with disabilities and their informal caregivers: an exploratory randomized controlled trial. *American Journal of Physical Medicine and Rehabilitation , 92* (4), 297-306.

Mortenson, W., Miller, W., & Auger, C. (2008). Issues for the selection of wheelchair-specific activity and participation outcome measures: A review. *Archives of Physical Medicine and Rehabilitation , 89*, 1177-1186.

Mortenson, W., Miller, W., Backman, C., & Oliffe, J. (2012). Association between mobility, participation and wheelchair-related factotrs in long-term care residents who use wheelchairs as their primary means of mobility. *Journal of the American Geriatrics Society , 60* (7), 1310-1315.

Muratori, L., Lamberg, E., Quinn, L., & Duff, S. (2013). Applying principles of motor learning and control to upper extremity rehabilitation. *Journal of Hand Therapy , 26* (2), 94-103.

Murray, E. (2012). Web-based interventions for behavior change and self-management: potential, pitfalls, and progress. *Med 2.0 , 1* (2), e3.

Narici, M., Maffulli, N., & Maganaris, C. (2008). Ageing of human muscles and tendons. *Disability and Rehabilitation , 30*, 1548-1554.

Nelson, A., Groer, S., Palacios, P., Mitchell, D., Sabharwal, S., Kirby, R., et al. (2010). Wheelchair-related falls in veterans with spinal cord injury residing in the community: a prospectcive cohort study. *Archives of Physical Medicine and Rehabilitation , 91* (8), 1166-1173.

Nichols, B. (2009). Use of the Nintendo Wii Fit and outddor challenge for rehabilitation of an elderly female patient with age-related balance impairments. *Journal of Geriatric Physical Therapy , 33*, 123.

Nilsson, L., & Durkin, J. (2014). Assessment of learning powered mobility use: applying grounded theory to occupational performance. *Journal of Rehabilitation Research and Development , 51* (6), 963-974.

Nsieh, H., & Shannon, S. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research , 15*, 1277-1288.

Nunkoosing, K. (2005). The problems with interviews. *Qualitative Health Research , 15* (5), 698-706.

O'Connor, E., Farrow, M., & Hatherly, C. (2014). Randomized comparison of mobile and web-tools to provide dementia risk reduction education: use, engagement and participant satisfaction. *Journal of Medicine and Internet Research Mental Health , 1* (1), e4.

Ohman, A. (2005). Qualitative methodology for rehabilitation research. *Journal of Rehabilitation Medicine , 37*, 273-280.

Osmanovic, S., & Pecchioni, L. (2016). Beyond entertainment: motivations and outcomes of video game playing by older adults and their younger family members. *Games and Culture , 11* (1-2), 130-149.

Ozturk, A., & Ucsular, F. (2011). Effectiveness of a wheelchair skills training programme for communityliving users of manual wheelchairs in turkey: A randomized controlled trial. *Clinical Rehabilitation , 25*, 416-424.

Page, S., & Persch, A. (2013). Recruitment, retention, and blinding in clinical trials. *American Journal of Occupational Therapy , 67* (2), 154-161.

Patrician, P. (2002). Multiple imputation for missing data. *Research n Nursing & Health , 25*, 76-84.

Pew Research Center. (2014, April). *Older adults and technology use.* Retrieved December 22, 2014, from PEW Research Internet Project: http://www.pewinternet.org/2014/04/03/older-adults-and-technology-use/

Phang, S., Martin Ginis, K., Routhier, F., & Lemay, V. (2012). The role of self-efficacy in the wheelchair skills-physical activiity relationship among manual wheelchair users with spinal cord injury. *Disability and Rehabilitation , 34* (8), 625-632.

Pichierri, G., Wolf, P., Murer, K., & de Bruin, E. (2011). Cogniive and cognitive-motor interventions affecting physical functioning: a systematic review. *BMC Geriatrics , 11*, 29.

Polatajko, H., Davis, J., Steward, D., Cantin, N., Amoroso, B., Purdie, L., et al. (2007). Specifying the domain of concern: Occupation as core. In E. Towsend, & H. Polatajko, *Enabling occupation II: Advancing an occupational therapy vision for health, well-being & justice through occupation* (pp. 13-37). Ottawa: CAOT Publications ACE.

Pope, M., & Tarlov, A. (1991). *Disability in America: toward a national agenda for prevention.* Washington, DC: National Academy Press.

Porter, J., & Magill, R. (2010). Systematically increasing contextual interference is beneficial for learning sport skills. *Journal of Sports Sciences , 28* (12), 1277-1285.

Portney, L., & Watkins, M. (2009). *Foundations of clinical research: applications to practice.* Upper Saddle River, NJ: Prentice-Hall, Inc.

Protheroe, J., Blakeman, P., Bower, P., Chew-Graham, C., & Kennedy, A. (2010). An intervention to promote patient participation and self-management in long term conditions: development and feasibility testing. *BMC Health Service Research , 20*, 206.

Rand, D., Kizony, R., & Weiss, P. (2008). The Sony PlayStation II EyeToy: low-cost virtual reality for use in rehabilitation. *Journal of Neurological Physical Therapy , 32*, 155-163.

Rauscher, L., & Greenfield, B. (2009). Advancements in contemporary physical therapy research: use of mixed methods designs. *Physical Therapy , 89*, 91-100.

Reimer, L. (2006). Telerehabilitation: occuaptional therapy beyond borders. *Occupational Therapy Now , 8* (1), 5-7.

Riemer-Reiss, M., & Wacker, R. (2000). Factors associated with assistive technology discontinuance among individuals with disabilities. *Journal of Rehabilitation , 6*, 44-50.

Ripat, J., & Woodgate, R. (2012). Self-perceived participation among adulsts with spinal cord injury: a grounded theory study. *Spinal Cord , 50* (12), 908-914.

Risk, A., Rogers, W., Charness, N., Czaja, S., & Sharit, J. (2004). *Designing for older adults: Principles and creative human factors approach.* Boca Raton, FL: CRC PRess.

Rodriguez, A., & Gonzalez-Rothi, L. (2008). Principles in conducting rehabilitation research. In D. Stuss, G. Winocur, & I. Robertson, *Cognitive neurorehabilitation: evidence and application* (2nd Edition ed., pp. 79-90). New York: Cambridge University Press.

Roelands, M., Van Oost, P., Depoorter, A., & Buysse, A. (2002). A social-cognitive model to predict the use of assistive devices for mobility and self-care in elderly people. *Gerontologist , 42*, 39-50.

Routhier, F. (2011). Personal Communication. *Centre for Interdisciplinary Research in Rehabilitation and Social Integration* . Centre interdisciplinaire de recherche en réadaptation et intégration sociale CIRRIS.

Routhier, F., Kirby, R., & Demers, L. (2008). Does age influence wheelchair-skills performance and improvement following a training program. *21st Wrold Congress of Rehabilitation International.* Quebec City.

Routhier, F., Kirby, R., Demers, L., Depa, M., & Thompson, K. (2012). Efficacy and retention of the the French-Canadian version of the wheelchair skills training program for manual wheelchair users: a randomized controlled trial. *Archives of Physical Medicine and Rehabilitation , 93* (6), 940-948.

Rubin, D. (1977). Formalizing subjective notions aboutt he effect of nonrespondents in sample survey. *Journal of the American Statistical Association , 72*, 538-598.

Rushton, P., Miller, W., Kirby, R., & Eng, J. (2013). Measure for the assessment of confidence with manual wheelchair use (Wheelcon-M) version 2.1: reliability and validity. *Journal of Rehabilitation Medicine , 45*, 61-67.

Rushton, P., Miller, W., Kirby, R., Eng, J., & Yip, J. (2011). Development and content validation of the Wheelchair Use Confidence Scale: a mixed-methods study. *Disability and Rehabilitation: Assistive Technology , 6*, 57-66.

Rushton, P., Miller, W., Mortenson, W., & Garden, J. (2010). Satisfaction with participation using a manual wheelchair among individuals with spinal cord injury. *Spinal Cord , 48*, 691-696.

Russell, T. (2009). Telerehabilitation: a coming of age. *Australian Journal of Physiotherapy , 55*, 5-6.

Sakakibara, B., & Miller, W. (2015). Prevalence of low mobility and self-management self-efficacy in manual wheelchair users and the association with wheelchair skills. *Archives of Physical Medicine and Rehabilitation , 96* (7), 1360-1363.

Sakakibara, B., Miller, W., & Rushton, P. (2015). Rasch analyses of the Wheelchair Use Confidence Scale. *Archives of Physical Medicine and Rehabilitation , 96* (6), 1036-1044.

Sakakibara, B., Miller, W., Eng, J., Backman, C., & Routheir, F. (2014). Influences of wheelchair-related efficacy on life-space mobility in adults who use a wheelchair and live in the community. *Physical Therapy , 94*, 1604-1613.

Sakakibara, B., Miller, W., Eng, J., Backman, C., & Routhier, F. (2013). Preliminary examination of the relation between participation and confidence in older manual wheelchair users. *Archives of Physical Medicine and Rehabilitation , 94* (4), 791-794.

Sakakibara, B., Miller, W., Routhier, F., Backman, C., & Eng, J. (2014). Association between self-efficacy and participation in community-dwelling manual wheelchair users aged 50 years or older. *Physical Therapy , 94* (5), 664-674.

Sakakibara, B., Miller, W., Souza, M., Nikolova, V., & Best, K. (2013). Wheelchair skills training to improve confidence with using a manual wheelchair among older adults: a pilot study. *Archives of Physical Medicine and Rehabilitation , 94*, 1031-1037.

Sama, P., Eapen, Z., Weinfurt, K., Shah, B., & Schulman, K. (2014). An evaluation of mobilie health application tools. *JMIR mHealth uHealth , 2* (2), e19.

Sandelowski, M. (1986). The problem of rigor in qualitative research. *Advances in Nursing Science , 8* (3), 27-37.

Sanford, J., Griffiths, P., Richardson, P., Hargraves, K., Butterfield, T., & Hoenig, H. (2006). The effects of in-home rehabilitation on task self-efficacy in mobility-impaired adults: A randomized clinical trial. *Journal of the American Geriatrics Society , 54*, 1641-1648.

Sanford, J., Hoenig, H., Griffiths, P., Butterfield, T., Richardson, P., & Hargraves, K. (2007). A comparison of televideo and traditiona in-home rehabilitation in mobility impaired older adults. *Physical & Occupational Therapy in Geriatrics , 25* (3), 1-18.

Schaper, L., & Pervan, G. (2007). ICT and OTs: a model of information and communication technology acceptance and utilisation by occupational therapists. *International Journal of Medical Informatics , 76* (S1), S212-2221.

Schein, R., Schmeler, M., Holm, M., Saptono, A., & Brienza, D. (2010). Telerehabilitation wheeled mobility and seating assessments compared with in person. *Archives of Physical Medicine and Rehabilitation , 91* (6), 874-878.

Schmidt, R. (1991). *Motor learning and performance: from principles to practice.* Champaign, IL: Human Kinetics.

Seale, J., McCreadie, A., Turner-Smith, A., & Tinker, A. (2002). Older people as partners in assistive technology research: the use of focus groups in the design process. *Technology and Disability , 14* (2), 21-29.

Shaughnessy, M., & Resnick, B. (2009). Using theory to develop an exercise intervention for patients post stroke. *Topics in Stroke Rehabilitation , 16*, 140-146.

Shea, J., & Morgan, R. (1979). Contextual interference effects on the acquisition, retention and transfer of a motor skill. *Journal of Experimental Psychology , 5* (2), 179-187.

Shields, M. (2004). Use of wheelchairs and other mobility support devices. *Health Reports* (15), 37-41.

Simmons, S., Schnelle, J., MacRae, P., & Ouslander, J. (1995). Wheelchairs as mobility restraints: predictors of wheelchcair activity in nonambultatory nursing home residents. *Journal of the American Geriatric Society , 43*, 384-388.

Smith, C., & Kirby, R. (2011). Manual wheelchair skills capacity and safety of residents of a long-term care facility. *Archives of Physical Medicine and Rehabilitation , 92* (4), 663-669.

Smith, E., & Miller, W. (2014). Demographics of older community dwelling Canadian wheelchair users. *Canadian Association on Gerontology: Landscapes of Aging.* Niagara Falls.

Smith, E., Giesbrecht, E., Mortenson, W., & Miller, W. (2016). The prevalence of wheelchair and scooter use among community-dwelling Canadians. *Physical Therapy , Epub ahead of print*.

Sonenblum, S., Sprigle, S., & Lopez, R. (2012). Manual wheelchair use: bouts of mobility in everyday life. *Rehabilitation Research and Practice , 753165*, 7 pages.

Sonenblum, S., Sprigle, S., Caspall, J., & Lopez, R. (2012). Validation of an accelerometer-based method to measure the use of manual wheelchairs. *Medical Engineering & Physics , 34* (6), 781-786.

Souders, D., Boot, W., Charness, N., & Moxley, J. (2016). Older adult video game preferences in practice: investigating the effects of competing or cooperating. *Games and Culture , 11* (1-2), 170-200.

Statistics Canada. (2013). *Disability in Canada: initial findings from the Canadian Survey on Disability.* Ottawa: Ministry of Industry.

Statistics Canada. (2013). *Education in Canada: attainment, field of study and location of study.* Ottawa: Minister of Industry.

Statistics Canada. (2008). *Participation and Activity Limitation Survey 2006.* Ottawa: Ministry of Industry.

Stokes, D., & Bergin, R. (2006). Methodology or methodolatry? An evaluation of focus groups and depth interviews. *Qualitative Market Research , 9* (1), 26-37.

Sullivan-Bolyai, S., Bova, C., & Harper, D. (2005). Developing and refining interventions in persons with health disparities: the use of qualitative description. *Nursing Outlook , 53* (3), 127-133.

Sygna, K., Johansen, S., & Ruland, C. (2015). Recruitment challenges in clinical research including cancer patients and their caregivers: a randomized controlled trial study and lessons learned. *Trials , 16*, 428.

Tabachnick, B., & Fidell, L. (2007). *Using multivariate statistics* (5th ed.). Boston, MA: Pearson Education Inc.

Tate, D. (2006). The state of rehabilitation research: art or science? *Archives of Physical Medicine and Rehabilitation , 87*, 160-166.

Taylor, R., Dalal, H., Jolly, K., Sawada, A., Dean, S., Cowie, A., et al. (2015). Home-based versus centre-based cardiac rehabilitation. *Cochrane Database Systematic Reviews , 8* (CD007130).

Thabane, L., Ma, J., & Chu, R. (2010). A tutorial on pilot studies: the what, why and how. *BMC Medical Research Methodology , 10*, 1.

Thong, J., Hong, S., & K, T. (2006). The effects of post-adoption beliefs on the expectation-confirmation model of information technology continuance. *International Journal of Human-Computer Studies , 64* (9), 799-810.

Thorndike, E. (1932). *The fundamentals of learning.* New York: Teachers College PRess.

Tickle-Degnen, L. (2013). Nuts and bolts of conducting feasibility studies. *American Journal of Occupational Therapy , 67*, 171-176.

Tinetti, M., Baker, D., McAvay, G., Claus, E., Garrett, P., Gottschalk, M., et al. (1994). A mjultifactorial intervention to reduce the risk of falling among elderly people living in the community. *New England Journal of Medicine , 331*, 821-827.

Torrance, G., Furlong, W., & Feeny, D. (2002). Health utility estimation. *Expert Review of Pharmacoeconomics & Outcomes Research , 2*, 99-108.

Tousignant, M., Boissy, P., Corriveau, H., & Moffet, H. (2006). In home telerehabilitation for older adults after discharge from an acute hospital or rehabilitation unit: A proof-of-concept study and costs estimation. *Disability and Rehabilitation: Assistive Technology , 1*, 209-216.

Tousignant, M., Dubuc, N., Hebert, R., & Coulombe, C. (2007). Home-care programmes for older adults with disability in Canada: How can we assess the adequacy of serices provided compared with the needs of users? *Health and Social Care in the Community , 15*, 1-7.

Townsend, E., & Polatajko, H. (2007). *Enabling occupation II: Advancing an occupational therapy vision for health, well-being & justice through occupation.* Ottawa: CAOT.

Tunney, N., Taylor, L., Gaddy, M., Rosenfeld, A., O'Pearce, N., Tamanini, J., et al. (2003). Aging and motor learning of a functional motor task. *Physical and Occupational Therapy in Geriatrics , 21*, 1-16.

Turcotte, M., & Schellenberg, G. (2007). *A portrait of seniors in Canada.* Ottawa: Ministry of Industry.

Turner Goins, R., Jones, J., Schure, M., Rosenberg, D., Phelan, E., Dodson, S., et al. (2014). Older adults' perceptions of mobility: a metasynthesis of qualitative studies. *Gerontologist , Epub*, 1-15.

Tyson, S., Thomas, N., Vail, A., & Tyrrell, P. (2015). Recruiting to inpatient-based rehabilitation trials: lessons learned. *Trials , 16*, 75.

van der Heijden, H. (2004). User acceptance of hedonic information systems. *MIS Quarterly , 28* (4), 695-704.

van Ginkel, F., & Kroonenberg, P. (2014). Analysis of variance of multiply imputed data. *Multivariage BehavioralResearch , 49*, 78-91.

van Hedel, H., & Dietz, V. (2004). The influence of age on learning a locomotor task. *Clinical Neurophysiology , 115*, 2134-2143.

Van Teijlingen, E., & Hundley, V. (2002). The importance of pilot studies. *Nursing Standard , 16* (40), 33-36.

Van Teijlingen, E., Rennie, A., Hundley, V., & Graham, W. (2001). The importance of conducting and reporting pilot studies: the example of the Scottish Births Survey. *Journal of Advanced Nursing , 34*, 289-295.

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: toward a unified view. *MIS Quarterly , 27* (3), 425-478.

Venkatesh, V., Thong, J., & Xu, X. (2012). Consumer acceptance and use of information technology: extending the Unified Theory of Acceptance and Use of Technology. *MIS Quarterly , 36* (1), 157-178.

Voelcker-Rehage, C. (2008). Motor-skill learning in older adults: A review of studies on age-related differences. *European Review of Aging and Physical Activity , 5*, 5-16.

Walker, K., Morgan, K., Morris, C., DeGroot, K., Hollingsworth, H., & Gray, D. (2010). Development of a community mobility skills course for people who use mobility devices. *American Journal of Occupational Therapy , 64*, 547-554.

Waller, A., Franklin, V., Pagliari, C., & Greene, S. (2006). Participatory design of a text message scheduling system to support young people with diabetes. *Health Informatics Journal , 12* (4), 304-318.

Wang, Y., & Shih, Y. (2009). Why do people use information kiosks? A validation of the Unified Theory of Acceptance and Use of Technology. *Government Information Quarterly , 26*, 158-165.

Watkins, I., & Xie, B. (2014). eHealth literacy interventions for older adults: a systematic review of the literature. *Journal of Medical Internet Research , 16* (11), e225.

Webb, T., Joseph, J., Yardley, L., & Mitchie, S. (2010). Using the internet to promote health behavior change: a systematic review and meta-analysis of the impact of theoretical basis, use of behavior change techniques, and mode of delivery on efficacy. *Journal of Medicine and Internet Research , 12* (1), e4.

Whiteneck, G., & Dijkers, M. (2009). Difficult to measure constructs: Conceptual and methodological issues concerning participation and environmental factors. *Archives of Physical Medicine and Rehabilitation , 90*, S22-35.

Whyte, J., & Barrett, A. (2012). Advancing the evidence base of rehabilitation treatments: a developmental approach. *Archives of Physical Medicine and Rehabilitation , 93* (8 Suppl 2), S101-110.

Whyte, J., Gordon, W., & Rothi, L. (2009). A phased developmental approach to neurorehabilitation research: the science of knowledge building. *Archives of Physical Medicine and Rehabilitation , 90* (11), S3-10.

Whyte, W., Greenwood, D., & Lazes, P. (1989). Participatory Acction Research: through practice to science in social research. *American Behavioral Scientist , 32*, 513.

Winnett, R. W., & Davy, B. (2009). Initiating and maintain resistance training in older adults: A social cognitive theory-based approach. *British Journal of Sports Medicine , 43*, 114-119.

Winstein, C. (1991). Knowledge of results and motor learning - implicatons for physical therapy. *Physical Therapy , 71*, 149-149.

Wolfson, N., Cavanagh, T., & Kraiger, K. (2014). Older adults and technology-based instruction: optimizing learning outcomes and transfer. *Academy of Management Learning & Education , 13* (1), 26-44.

World Health Organization. (2008). *Guidelines on the provision of manual wheelchairs in less resourced settings.* Geneva: World Health Organization.

World Health Organization. (2001). *International classification of functioning, disability and health: ICF.* Geneva: World Health Organization.

World Health Organization. (2011). *mHealth: new horizons for health through mobile technologies.* Geneva: World Health Organization.

Zauszniewski, J. (2012). Intervention development: assessing critical parameters from the intervention recipient's perspective. *Applied Nursing Research , 25* (1), 31-39.

Zurakowski, T., Taylor, M., & Bradway, C. (2006). Effective teaching strategies for the older adult with urologic concerns. *Urology Nursing , 26*, 355-360.

APPENDICES

Appendix A: Phase 1 focus group discussion guides

Interview Guide: MWC Users

Focus Group 1

- Introductions and housekeeping
- Brief study overview and purpose
- Purpose of engaging collaborative teams and overview of Participatory Action Design
- Expectations of participants and collaborators

Global wheelchair use (content)

- What has been your experience using a wheelchair?
    - Tell me about how you learned to use your wheelchair?
- What would you like to be able to do using your wheelchair?
    - What do you find most challenging to do in a wheelchair?

Motivation (content and process)

- Would you like to be more independent/proficient with your wheelchair?
- What would motivate you to improve/practice wheelchair skills?

Learning new skills (content, process, interface)

- How would you like to learn wheelchair skills?
- What makes learning easier/effective for you?
- What would you like to see in a skills training program?

- Introduce conceptual model for delivery of a home-program using storyboard
- Introduce variety of potential interface devices and circulate through group

- What do you think about a program like this? (Initial response/evaluation)
    - Would you enjoy a program like this?
    - Would you be motivated to practice new skills in your wheelchair?
    - Does this feel appropriate for you?
- Are there things you think we should eliminate? Add? Change?
- Do you have any other comments or responses?

Focus Group 2

- Reintroduce participants and housekeeping
- Review purpose of study and PAD
- Review data analysis summary from previous group.

- Does this reflect your experience of the focus group discussion?
- Do you have any other responses, reflections or comments?

Provide overview of the revised home program (content and delivery).

- What do you think of the components?
- Would you find this helpful? Why or why not?
- What is missing that you think needs to be included?
- How would you adapt the program?

Introduce the alpha prototype and circulate.

Encourage participants to interact with the device and to try some of the activities.

- What is your impression of the device?
- Would you like to use something like this at home?
- Do you find the device easy to operate? To navigate?
- What would you like to see different about the device?
- Do you have any other comments or suggestions?

Interview Guide: Care Providers

Your experience with wheelchair use

- Tell us about your experience assisting an older adult who uses a wheelchair
- Tell us about situations or activities that have been most challenging when using a wheelchair?
- What skills or techniques in using a wheelchair have been most helpful?
- What skills would you like to see in a training program for older adults?
- When do you think is the best time for older adults to receiving training? (e.g., in hospital, after discharge, after being home for a while)

Supporting learning strategies:

- Would you be willing or interested in assisting or supervising training at home (for safety)?
- If so, how much or how frequently would you be willing to do this?
- Do you think the older adult(s) you are assist would be willing to practice at home?
- If so, what would be a reasonable amount of practice to expect from them?

Introduce the alpha prototype and circulate.

Training Program

- Do you think the older adult(s) that you assist would be open to using a tablet for training?
- Do you see any issues with using a home training program like this?
- Are there things that are missing, that we should add?
- Are there things we should eliminate?
- Are there things we should change?

Interview Guide: Clinicians

Provide overview of rationale for the study and wheelchair skills training for older adults.

- Which situations, activities and obstacles are the biggest problems?
- What skills or strategies are the most helpful (or difficult) to learn?
- What are the most important issues with teaching older adults these skills?
- When is the optimal time for older adults to learn wheelchair skills?

Introduce the prototype and circulate.

- What is your impression of the …
    - User interface
    - Complexity/menu structure
- Other impressions?

Appendix B: Phase 1 themes and subthemes

Sources of Learning

Expert clinician training in Rehab (GF Strong)	Not all skills learned in Rehab Not all skills from Rehab applicable Some skills learned weren't used/lost
Learning in the community/Independently	Trial and error By necessity Innovation/ingenuity Solutions must be figured out on your own Moving out/getting a car meant learning new skills Exposed to new situations
Other MWC users • Siblings • Peers • Mentors • Younger (more adept) users	Watching others; analyzing others Listening to others WC Sports (advanced activities/skills) Mentor provided demo/input
Training only provided in select facilities	
No training provided	Received as a child (age or time/era) No formal training No propulsion training; maneuvering
Selective training	Only basic ADL skills (forward propelling) Basic transfer skills; car transfer; tub; kitchen skills
Other	Sense of being overwhelmed Self-learning is slow

Barriers/Facilitators to Learning

Type of disability/impairment	Which skills are required How environment must be adapted/access The way you learn/perform the skill
Physical capacity impacts capacity for skill	
The wheelchair	Advances in MWC design make skills easier Individualized configuration –making optimal use of it Provide info on how configuration affects performance Lack of proper fit/adjustment No removable wheels
Confidence	Look at others and feel less skilled – whether you feel it's achievable Older adults often look 'scared' of using the MWC Embarrassment due to lack of skills Falls are embarrassing
Not all scenarios can be covered in training	Can't tell (if you can do it) until you try it Resort to old habits in new contexts (challenge of applying new skills to different contexts)

Aging makes it more challenging	Physical changes make 'standard' situations difficult (e.g., 1:12 ramps) Lack of strength; decline in fitness Strength an issue for women especially Shoulder/wrist pain (age or long term use) Leaning over is more difficult (especially for ramps and curbs Long term use hard on shoulders Research focuses on younger users Less able to be ingenious/innovate solutions Getting back into WC after fall is difficult
Inadequate equipment and environmental adaptation	Poorly functioning equipment (toilet seats) Poor configuration (elevator buttons) Pseudo-accessible (only 1 curb cut) Stairs
Lack of assistance/support	No support/spouse No assistance = learning skills
Acceptance/Transition	Recognize MWC use is long term = impetus to learn Hard work; takes time/effort; not intuitive That you won't/can't have assistance all the time
Injury	Bumped obstacles – injury while learning Lack of knowledge = falls/tips
Recognizing/asking for help	Especially re: safety Modify your plan/approach

Difficult Contexts/Difficult or Important Skills

Moving around the home	Narrow doorways Carrying an object Maneuvering in small/crowded space; obstacles (apartment) Pets
Higher resistance surfaces	Grass Carpet; Thicker carpet Gravel Not all environments/surfaces are hard/flat/smooth
Park (see surfaces above)	Outdoor skills
Wheel locks	Putting brakes on (Not) Leaving the brakes on
Finding the 'balance point' in the MWC Body position	Weight shift & leans to prevent tips Position impacts performance of skills
Multiple obstacles	Ramp + ledge/curb Sudden stop at base of ramp
Public transit	Ticket kiosk (too high to reach)
Doors	

Inclines/Ramps	Inclines are difficult; frightening Side slopes Uncontrolled descent Rear tips/Fwd tips Too steep ramps
Curbs/steps/rises	tips
Vehicle	Getting MWC in the car Car transfer
Smooth & straight/avoid walls	
Malls	Due to ramps
Casters – orient to increase wheelbase	
Reach to floor	Danger of falls
Uneven sidewalks/heaves	
Carrying objects in MWC	
Small, unexpected obstacles – front tip	Getting over cords
Getting around corners	

Motivation

Seeing others (peers) perform well	Inspiration
Encouragement from others	Pressure/pushed to develop by others
On your end, tend to 'give up'	Learning is slow Injury during training
Desire for efficiency	Get from A to B To prevent injury/accidents

Strategies for learning

Must 'do it' to develop skill	Need to venture out (risk) to identify obstacles to performance
Someone to assist/supervise	For safety more than for assistance
1:1 mentoring (expert) • Personal contact • Provide feedback • Provide motivation/push	Like assist initially, then independent practice Someone to evaluate performance critically Demo by skilled real user
Peer support	Provides motivation
Problem-solving approach	Break down performance issues Feedback – specific to performance barriers
Demonstration (visual info)	Actual demo; video; illustration Real (older adult) users – verisimilitude – is motivating In real contexts; real obstacles
Interactive learning	Dialogue – see, ask questions, problem-solve
Innovative strategies	
Must be engaging	Often cautious; need to be drawn in to try
Provide mobile info when physical assist is not available	Reference material

Individualize program	Knowledge of home/environment to customize learning and skills Focus on elements important to user (customize)
Repetition/practice	Requires rote repetition

Content related to learning

Identify rationale for learning (to motivate) Link to real life applications/situations	Increased activity performance Risks with limited skills Link the skill to specific activities of relevance (list provided) What is the benefit to user
Safety information	Risks of specific situations Risks with change in body position & MWC orientation
What NOT to do	Common mistakes Demo incorrect methods Identify implications of incorrect performance Consolidate description of issues and demo
Info that MWC type, configuration, fit influence skill performance	Prompt that if skill is very hard to do, consider changes to MWC

Program Delivery

Grade activities	From easy/safe to more advanced Progression needs to be gradual Keep speed low
Include 'real'/actual activities	Real obstacles
Concern about attending to the tablet (directions) and the activity (performance) simultaneously?	
Should rely on performance evaluation, not self report	Need for independent performance
Some way for user to monitor progress – motivation/adherence	Checklist
Access to a real person (mentor)	Quick access/no delays or waiting Provide info in real time Motivation
Being able to go to specific skills (control)	
Should have a spotter	Thought most would have a care provider avail Spotter doesn't need to be an expert Spotter only there for safety
Learning skills & computer technology simultaneously	

Device

Multiple delivery formats	Tablet, phone, TV
Small devices are easy to lose	(Misplaced telephone at FG!) Potential for being stolen
Portability	
The tablet has a highly reflective surface	
VR/VA would be nice	
Concern whether OA would have computer skills to operate/navigate	Issues with learning to use device (based on personal experience with their parents) Would prefer DVD format (especially re: set-up) Less concerned with <70 group OA: Confusion/memory with multiple icons & menus Concentration/attention to stick with it Patience/interest to watch demo's? User group felt very comfortable with tablet and similar devices Fewer OA are totally unfamiliar with electronic devices Many OA would have basic skills; may take longer to learn
Feasibility of video recording	
Requirement for internet access?	Will this be available Can you train without internet access
Tablet has great potential	
Viewing area	Would prefer a TV (larger)
Location of tablet	Would it fall off lap?

Other

Need to self-advocate for accessibility changes	
Research focuses on younger users	
Not everyone uses anti-tippers	
Program should be available to everyone	Distributed with any MWC purchase Accessible via internet or other avenue Collaborate with funders/distributors to make it widely available

APPENDIX C: Sample size calculations

Data subset from Routhier (2012) study of MWC users > 50 years of age undergoing WSTP training:

Change score (*m*): 9.3%
Change score (*s*): 9.5%
Correlation (ρ): .488
$\alpha = .10$
$\beta = 90\%$

Formula for sample size calculation for ANCOVA in RCT designs (Borm et al, 2007; McDonald, 2009):

$$n = 2(Z_{1-\alpha/2} + Z_{1-\beta})^2 (1 - \rho^2) \sigma^2/(M_B - M_A)^2 + 1$$

$n = 2(1.64 + 1.28)^2 (1 - .238) (90.25/86.49) + 1$

$n = 13.55 + 1 = 14.55 = 15$ per group;

Adjusting for Extra Wheeling subgroups: 15/2 = 7.5 = 8 per subgroup x 2 = 16

Accommodating for 25% loss = 16/.75 = 21.3 = 22 subjects per group

N = 2*n* = 44 subjects total

Minimal Clinically Important Difference (MCID) Estimates
(Beaton et al., 2002)

1. Smallest Detectable Difference (SDD) based on Bland & Altman bounds of agreement
   = *m* Δ score of stable group ± 2 *s* (control group from Best et al., 2005)
   = 3.4% + 2(2.9%) = **9.2%**

2. Minimal Detectable Change (MDC) based on Reliability Change Index (RCI)
   = *m* Δ score of stable group/ √SEM
   SEM estimated as *s* (√[2(1 – R)] where R is test-retest reliability coefficient
   = 2.9(√[2(1 - .904)] = 1.27
   = 3.4% / √1.27% = **3.0%**

Appendix D: EPIC Wheels home program content library

Safety	Equipment Supervision & Spotting Spotter Information Tipping and Falling Spotter's strap Types of Injuries

Components	Wheelchair Parts	*Wheel Locks*	Wheel Locks Activity 1 Activity 2
		Footrests	Footrests Activity 1 Activity 2
		Folding mechanism	Folding Mechanism Activity 1 Activity 2
		Anti-tippers	Anti-tippers Activity 1 Activity 2
		Drive Wheels	Drive Wheels
		Casters	Casters Activity 1 Activity 2 Activity 3 Activity 4
		Arm Rests	Arm Rests Activity 1
	Body Position	*Body Position*	Body Position Activity 1 Activity 2
		Weight Shift	Weight Shift Activity 1

Propelling	*Basic Propulsion*	Hand Position Activity 1 Activity 2A Activity 2B Activity 2C Activity 2D Activity 3	
	Pushing Techniques	Pushing Techniques	
	Coasting	Coasting Activity 1 Activity 2	

Skills Section A	Propelling Forwards	*Propelling Forwards*	Propelling Activity 1 Activity 2
		Making Corrections 1	Corrections 1 Activity 1
		Making Corrections 2	Corrections 2 Activity 1
	Propelling Backwards		Propelling Backwards Activity 1
	Turns	*Turning*	Turning Activity 1 Activity 2 Activity 3
		Spin Turns	Spin Turns Activity 1 Activity 2 Activity 3
		Quick Spin Turns	Quick Spin Turns Activity 1 Activity 2 Activity 3
		Moving Turns 1	Moving Turns 1 Activity 1 Activity 2

	Turns (con't)	*Moving Turns 2*	Moving Turns 2 Activity 1 Activity 2 Activity 3 Activity 4
		Narrow Spaces	Narrow Spaces Activity 1 Activity 2
		Backward Turns	Backward Turns Activity 1 Activity 2 Activity 3
		Moving Sideways	Moving Sideways Activity 1 Activity 2
	Avoiding Obstacles	*Avoiding Obstacles* *Activity 1* *Activity 2* *Activity 3* *Activity 4* *Activity 5*	
	Reaching	*Reaching Sideways* *Reaching Down* *Reaching Up*	Sideways Activity 1 Down Activity 1 Up Activity 1
	Carrying Objects	*Carrying Objects 1* *Carrying Objects 2* *Carrying Objects 3* *Carrying Objects 4* *Carrying Objects 5* *Carrying Objects 6* *Carrying Objects 7*	

Skills Section B	Popping Casters	*Self*	Popping Casters Activity 1 Activity 2 Activity 3 Activity 4 Activity 5
		Assisted	Popping Casters
	Small Obstacles	*Forwards*	Forwards Activity 1 Activity 2 Activity 3 Activity 4
		Backwards	Backwards Activity 1
		Foot-Assisted	Foot-Assisted Activity 1 Activity 2
		Momentum	Momentum Activity 1 Activity 2
		Assisted	Assisted
	Gaps	*Forwards*	Forwards
		Backwards	Backwards Activity 1 Activity 2 Activity 3
		Assisted	Assisted
	Soft Surfaces	*Carpet*	Carpet
		Grass	Grass
		Snow	Snow
		Activities	Activity 1A Activity 1B Activity 2 Activity 3 Activity 4
		Assisted	Assisted

	Shallow Inclines	*Inclines - Up*	Forwards Activity 1 Backwards
		Inclines - Down	Inclines Down Activity 1 Activity 2
		Assisted	Assisted
	Side Slopes	*Side Slopes* *Activity 1*	
	Doors	*Doors* *Activity 1* *Activity 2*	
	Steep Inclines	*Inclines Up*	Inclines Up Activity 1
		Inclines Down	Inclines Down Activity 1 Activity 2
	High Obstacles	*Up with Assist* *Up without Assist* *Down with Assist* *Down without Assist*	
	Steps & Stairs	*Steps/Stairs with Assist*	

Appendix E: Wheelchair Specifications Form

Wheelchair Specification Form

Participant ID: ______________________ Date: ______________________

Name of person completing: ______________________

☐ Initial wheelchair specification collection
☐ Recheck, wheelchair specifications are the same as initial data collected
☐ Recheck, some wheelchair specifications differ from initial data collection and are indicated below

Manufacturer:
☐ Invacare ☐ Quickie
☐ Pride ☐ Everest & Jennings
☐ Other (specify)

Model name:

Frame: Manual: ☐ folding ☐ rigid
Manual: ☐ tilt ☐ recline
Other:

Size: ☐ 16"wide X 16"deep
☐ 16"wide X 18"deep
☐ 18"wide X 16"deep
☐ 18"wide X 18"deep
☐ Other: wide x deep

Height: front seat height

Seat: ☐ sling ☐ pan ☐ dropbase

Cushion:
Type:

Back: Type:

Front rigging: ☐ L ☐ R ☐ both ☐ none

Hanger angle (measured down from seat rails):
☐ 60° ☐ 70° ☐ 90° ☐ Elevating

Armrests:
☐ full length ☐ desk length
☐ adjustable height
Other:

Brake Extensions:
☐ present ☐ not present

Anti-tippers:
☐ present ☐ not present

Positioning belt:
☐ present ☐ not present

Type:

Rear Wheel Diameter (edge of tire to edge of tire):
☐ 24" ☐ 26" ☐ 22" ☐ 20"

Comments/other features:

Note: Where features are bilateral, it will be assumed that the left and right sides are symmetrical unless otherwise stated.

Appendix F: Demographics Form

Date (DD/MM/YY): ____/____/____ Subject #: _______

☐Van ☐Wnpg

EPIC Wheels Feasibility Study
Participant Demographic Form

1) Year of Birth: ______________	**2) Age (years):** ________	**3) Sex:** 1 – Male 2 – Female
4) Marital Status: 1 – Single 2 – Widowed 3 – Separated/Divorced 4 – Married 5 – Common-Law		**5) Lives:** 1 – Alone 2 – With someone
6) Highest Level of Education: 1 – < high school 2 – High school 3 – Some post-secondary/diploma 4 – Bachelor's 5 – Master's 6 – PhD 7 – Other: ____________________		
7) Primary Diagnosis/Reason for Using Manual Wheelchair: ____________________		
8) Length of Time Using Manual Wheelchair: ____________ (months)		
9) Propulsion Method: 1 – Two hands only 2 – Two hands + one foot 3 – Two hands + both feet 4 – Other: ____________________		
10) Handgrip Strength: a) Right: ____________ (lbs/kg) Average: _______ (lbs/kg)		

Appendix G: Primary and secondary outcome measures

Wheelchair Skills Test 4.1
Manual Wheelchair - Wheelchair User

Name: ______________________________

Date: ________________ Time start: __________

Tester: ________________ Time finish: __________

Scoring Guide
✓ = pass ✗ = fail
NT = not tested (easier skill has been failed)
No Part = wheelchair has no such part

Individual Skills		Skill		Safety			Comments
		✓	✗	✓	✗	NT	
1.	Rolls forward 10m						
2.	Rolls forward 10m in 30s						
3.	Rolls backward 5m						
4.	Turns 90° while moving forward L&R						
5.	Turns 90° while moving backward L&R						
6.	Turns 180° in place L&R						
7.	Maneuvers sideways L&R						
8.	Gets through hinged door in both directions						
9.	Reaches 1.5m high object						
10.	Picks object from floor						
11.	Relieves weight from buttocks						
12.	Transfers from WC to bench and back						
13.	Folds and unfolds wheelchair						No Part ☐
14.	Rolls 100m						
15.	Avoids moving obstacles L&R						
16.	Ascends 5° incline						
17.	Descends 5° incline						
18.	Ascends 10° incline						
19.	Descends 10° incline						
20.	Rolls 2m across 5° side-slope L&R						
21.	Rolls 2m on soft surface						
22.	Gets over 15cm pot-hole						
23.	Gets over 2cm threshold						
24.	Ascends 5cm level change						
25.	Descends 5cm level change						
26.	Ascends 15cm curb						
27.	Descends 15cm curb						
28.	Performs 30s stationary wheelie						
29.	Turns 180° in place in wheelie position L&R						
30.	Gets from ground into wheelchair						
31.	Ascends stairs						
32.	Descends stairs						
	Total Percentage Scores						(Total passed skills/Total applicable skills)

Additional comments: ______________________________

Data Collection Form FORM WST_M_WCU 4.1.4 April 2007 a place of mind

Date: T1:(DD/MM/YY) _______________
T2:(DD/MM/YY) _______________
SubjectID: ___________________________

Wheelchair Use Confidence Scale for Manual Wheelchair Users (WheelCon-M, version 3.0)

Instructions: A number of situations are described below that can challenge confidence when using a manual wheelchair. Please rate how confident you are ***as of now*** for each of the situations described using the following scale:

0	10	20	30	40	50	60	70	80	90	100
Not Confident										Completely Confident

For example, a person may be 82% confident they can memorize a grocery list of 5 items, but only 63% confident they can memorize a grocery list with 10 items.

For items requiring physical ability, rate your confidence in performing the activity in a **safe** manner. For this assessment, confidence refers to your **belief** in your ability to perform each item independently.

Answer **all items** even if it is not a situation you would normally experience. If you have **never** experienced the situation, please rate your confidence as if you had to safely attempt it today.

Some questions include measurement, such as 5cm. Please refer to the ruler on the last page of this assessment if you are uncertain about these measurements.

<u>As of now</u>, how confident are you that you ...	Confidence (0-100)	
	T1	T2
1. Can move your wheelchair over carpet?		
2. Can move your wheelchair around furniture in your own home?		
3. Can move your wheelchair over thresholds, such as between rooms?		
4. Can manoeuvre your wheelchair in small spaces, such as a bathroom?		
5. Can transfer from your wheelchair to **your** bed?		
6. Can transfer from your wheelchair to **your** toilet?		
7. Can transfer from your wheelchair into **your** bathtub (including use of bathseats) OR using your commode to get into your shower stall?		
8. Can transfer from the floor to your wheelchair by yourself?		
9. Can transfer from your wheelchair to **your** vehicle?		
10. Can make a light meal while using your wheelchair?		
11. Can carry a hot drink while moving in your wheelchair?		
12. Can move your wheelchair through a door that opens automatically?		
13. Can open, go through, and then close a standard 81cm (32") lightweight door?		
14. Can open and go through a spring-loaded door, such as a door at your local mall?		
15. Can move your wheelchair **up** a standard ramp, built to code (5º incline)?		

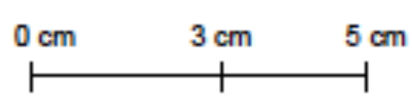
<u>As of now</u>, how confident are you that you …	**Confidence (0-100)**	
	T1	**T2**
16. Can move your wheelchair **down** a standard ramp, built to code (5° incline)?		
17. Can move your wheelchair **up** a dry steep slope (> 5° incline)?		
18. Can move your wheelchair **down** a dry steep slope (> 5° incline)?		
19. Can move your wheelchair down a dry steep slope (> 5° incline) and stop **as soon as** you are off the slope?		
20. Can move your wheelchair **up** a curb cut?		
21. Can move your wheelchair **down** a curb cut?		
22. Can move your wheelchair over a drainage grate and then up a curb cut?		
23. Can move your wheelchair down a curb cut then over a drainage grate?		
24. Can move your wheelchair through a puddle then up a curb cut?		
25. Can move your wheelchair down a curb cut then through a puddle?		
26. Can move your wheelchair through slush then up a curb cut?		
27. Can move your wheelchair down a curb cut then through slush?		
28. Can move your wheelchair down a curb cut then though 5 cm (2") snow?		
29. Can move your wheelchair through 5 cm (2") snow then up a curb cut?		
30. Can move your wheelchair up a standard height curb 15 cm (6") without a curb cut?		

<u>As of now</u>, how confident are you that you ...	**Confidence (0-100)**	
	T1	**T2**
31. Can move your wheelchair down a standard height curb 15 cm (6") without a curb cut?		
32. Can manoeuvre your wheelchair to press the crosswalk button and cross the street before the traffic light changes?		
33. Can cross a street with light traffic at a crosswalk with no traffic lights?		
34. Can move your wheelchair across 3m (10ft) of flat, freshly mowed, dry grass?		
35. Can move your wheelchair through a pothole that is wider than your wheelchair and 5 cm (2") deep?		
36. Can move your wheelchair along a paved sidewalk that is cracked and uneven?		
37. Can move your wheelchair along a flat dirt path or trail with some tree roots and rocks?		
38. Can move your wheelchair across 3m (10ft) of flat, unpacked gravel?		
39. Can move your wheelchair along a sidewalk with 5 cm (2") of snow?		
40. Can move your wheelchair through a crowd of people without hitting anyone?		
41. Can ask people to move out of your way while moving in your wheelchair?		
42. Can move your wheelchair down a store aisle that has just enough room for your wheelchair without knocking items over?		
43. Can manage all toileting activities while in an accessible public bathroom?		
44. Can use public transportation in your town?		

<u>As of now</u>, how confident are you that you ...	Confidence (0-100)	
	T1	T2
45. Can do your chosen leisure activities in your manual wheelchair?		
46. Can transport items in a backpack that is on the back of your wheelchair?		
47. Can use strategies, such as humour, that will help people feel comfortable if they are unsure how to act because you use a wheelchair?		
48. Can correct others' mistaken beliefs about people who use wheelchairs?		
49. Can present yourself as you wish to be seen while in your wheelchair around acquaintances, colleagues, or peers?		
50. Can present yourself as you wish to be seen while in your wheelchair when you are in public and feel people are watching you?		
51. Can present yourself as you wish to be seen while in your wheelchair when you want to impress others, such as during a job interview?		
52. Can problem solve how to get to your destination when there is an unexpected situation, such as construction detours on a sidewalk?		
53. Can figure out how to negotiate a challenging, and unusual physical obstacle?		
54. Can continue to move your wheelchair in a situation that is making you feel anxious or nervous?		
55. Know when your wheelchair is not working properly?		
56. Know what your wheelchair can and can't do, separate from your own abilities? For example, a wheelchair can go down stairs but many individuals do not go down stairs with their wheelchair due to their inability to do so.		

<u>As of now</u>, how confident are you that you ...	Confidence (0-100)	
	T1	T2
57. Can tell someone how to move your wheelchair if it gets stuck?		
58. Can ask someone for help?		
59. Can tell a cab driver how to fold/unfold your wheelchair, making sure all parts are taken off and put back on properly?		
60. Can tell a stranger how to help you safely get back into your wheelchair if you tip over?		
61. Know what to do if you fall out of your wheelchair?		
62. Can advocate for changes you want made to your wheelchair, such as a different cushion to be more comfortable?		
63. Can advocate for changes you want in your home, such as doorways widened or a ramp installed?		
64. Can advocate for your needs at work or school, such as modifications in the bathroom?		
65. Can advocate for changes in your community, such as having a curb cut added in your neighborhood to improve your accessibility?		

Measurement Scale 0-5cm



Name / ID #:______________________________ **THE WhOM**

Part I: PARTICIPATION

Instructions for Administration:

Ask the client to identify activities they perform in their wheelchair that <u>are important to them</u> by asking the two questions outlined below. Have the client score the importance of these activities and then ask them to rate their current level of satisfaction in performing these activities. If the client has scored their satisfaction with an activity ≤ 7, determine the underlying conditions (wheelchair/seating device or environmental barriers) that impair performance of this activity to assist with intervention planning.

1) Some people use their wheelchairs because they want to participate in activities in or around their home, such as preparing meals, watching TV, or gardening. What activities <u>in your home</u> would you use your wheelchair to perform?

Use this numerical scale to help fill in the table:										
0	1	2	3	4	5	6	7	8	9	10

Initial assessment Date:				Reassessment Date:	
Participation goals: *Eg. Making a meal* *Watching favourite TV show*	**Importance** *How important is this activity to you?* **(0 - 10)** 0 = Not at all important 10 = Extremely important	**Satisfaction 1** *How satisfied are you with your current level of performance of this activity?* **(0 –10)** 0 = Not satisfied at all 10 = Extremely satisfied	**Importance x Satisfaction 1**	**Satisfaction 2** *How satisfied are you with your current level of performance of this activity?* **(0 – 10)** 0 = Not satisfied at all 10 = Extremely satisfied	**Importance x Satisfaction 2**
i.					
ii.					
iii.					
iv.					
v.					
		Total of importance x satisfaction 1 scores =	**Score 1**	**Total of importance x satisfaction 2 scores =**	**Score 2**
		Change in satisfaction = Score 2		**– Score 1**	**=**

Version #1: May 6 2004; Version #2: June 11, 2004

Name / ID #:______________________________ **THE WhOM**

Part II: BODY FUNCTION

Use this numerical scale to help fill in the table:
0 1 2 3 4 5 6 7 8 9 10

Initial assessment Date: **Questions**	**Time 1**	**Reassessment** Date: **Time 2**
1. *How would you rate your comfort while sitting in your wheelchair?* **(0 – 10)** 0 = Not at all comfortable 10 = Extremely comfortable		
2. *How satisfied you are with the way your body is positioned in your wheelchair?* **(0 – 10)** 0 = Not at all satisfied 10 = Extremely satisfied		
3. *Over the past month have you had any episodes of skin breakdown on your bottom?* **(Please circle)**	**Y N**	**Y N**
3a. *If yes, in your opinion, how severe has your skin breakdown been*? **(0 - 10)** 0 = Extremely severe 10 = Not at all severe		
	Score 1 **Total =**	**Score 2** **Total =**
Change = Score 2 ____ **- Score 1** ____ **=** ____		

Version #1: May 6 2004; Version #2: June 11, 2004

Life-Space Assessment

ID:							Date:	
These questions refer to your activities just within the past month.								
LIFE-SPACE LEVEL			**FREQUENCY**				**INDEPENDENCE**	**SCORE**
During the past four weeks, have you been to . . .			**How often did you get there?**				**Did you use aids or equipment? Did you need help from another person?**	Level X Frequency X Independance
Life-Space Level 1. . . **Other rooms of your home besides the room where you sleep?**	Yes 1	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = personal assistance 1.5 = equipment only 2 = no equipment or personal assistance	
Score	______ X		________		X		___________ =	______ *Level 1 Score*
Life-Space Level 2. . . **An area outside your home such as your porch, deck or patio, hallway (of an apartment building) or garage, in your own yard or driveway?**	Yes 2	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	______ X		________		X		___________ =	______ *Level 2 Score*
Life-Space Level 3. . . **Places in your neighborhood, other than your own yard or apartment building?**	Yes 3	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	______ X		________		X		___________ =	______ *Level 3 Score*
Life-Space Level 4. . . **Places outside your neighborhood, but within your town?**	Yes 4	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	______ X		________		X		___________ =	______ *Level 4 Score*
Life-Space Level 5. . . **Places outside your town?**	Yes 5	No 0	Less than 1 /week 1	1-3 times /week 2	4-6 times /week 3	Daily 4	1 = Personal assistance 1.5 = Equipment only 2 = No equipment or personal assistance	
Score	______ X		________		X		___________ =	______ *Level 5 Score*
							TOTAL SCORE (ADD)	______ *Sum of Levels*

Wheeling While Talking: Data Collection Form

Participant #:__________ Date: _____________

A. Explanation and Demonstration: □ Completed

B. Baseline: Obstacle Course

[T_1] Time: ________ seconds Number of Pylons hit: _________

C. Dual-Task: Obstacle Course While Reciting Alternate Letters

Circle each letter the participant says:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

[T_2] Time: ________ seconds Number of Pylons hit: _________

Total number of letters recited: ________

Number of Errors: _______

D. Summary

Change [T_2 - T_1] : ______ seconds

Relative Change: (Change / T_1 x 100): ________%

Due to restricted distribution rights, the HUI3 is not available for publication in this thesis.

Appendix H: Post-treatment Participant Questionnaire

Participant: ________ **Date (DD/MM/YY): ____________________**

1. Receiving wheelchair skills training is valuable or important for me.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

2. The method of training I received was reasonable and appropriate for me.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

3. The kinds of wheelchair skills taught were reasonable and appropriate for me.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

4. The trainer working with me was reasonable and appropriate for me.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

5. The expectations for participating in training and practice sessions were manageable and practical for me.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

6. The essential components of the training program were provided as described at the study outset.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

7. I was able to perform or improve skills taught in the training program.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

8. I did not experience an injury or undue physical or mental stress.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

9. The training program was successful in improving my wheelchair skills.

☐ Strongly agree ☐ Agree ☐ Disagree ☐ Strongly disagree

Appendix I: Reference material for maintaining control group enthusiasm

Maintaining Control Group Enthusiasm

As part of the Control group intervention, it will be important that you instill enthusiasm and a sense that this training program will be beneficial. I have highlighted a few points below to help with this. First, it will ensure that the Control Group trainers are providing similar/comparable training and second, it will help you keep these participants interested and invested (and stay in the study).

1. Begin by highlighting that the EPIC Wheels study is providing *several different training programs* to participants to help establish which is the **best** training program for older adult manual wheelchair users. You can tell them there are different approaches to improving skills – whether it's using a wheelchair, learning to use a computer, riding a bike or any other skillful activity. You can also tell them that by the end of the study all participants will have access to similar information about wheelchair use (i.e., because of the DVD, but I suggest not mentioning the DVD at the early stages). [*They may have an idea about this already from the consent form or if they have heard from someone along the way that there is a demonstration video approach to training; if this happens, you can say that there are several different training approaches being used and that, by the end of the study, everyone will have access to the core skills of wheelchair use*].
2. Provide some very brief background information about teaching older adults new skills and ways of learning new gross and fine motor skills (or activities that require you to control things with large movements and those that require precision and subtle movements).
3. You can support #2 by relating that many research studies have found that practicing **regularly** with computer activities and games can be very helpful for older adults learning new skills. There are at least two reasons for this. First, games that require concentration, problem-solving, memory and thinking can actually improve your ability to **problem-solve and figure out solutions** in new/novel situations, like trying to get your wheelchair past an awkward obstacle. Improving your memory and concentration through computer games and activities is also helpful in **remembering** how to perform new skills and **staying focused** in complex or confusing situations. Second, computer games, especially ones on a tablet where you need to use your hands, help improve your **dexterity (coordination), control and especially your reaction/response time**. In other studies, practicing with computer games has increased coordination and reaction time for older adults, which in turn improves their ability to perform complex skills. So, by working on both mental skills and fine motor/dexterity skills, we might expect their ability to manage their wheelchair to also improve (as we have seen in some other research with older adults).
4. During the study (e.g. at the 2nd session or with follow-up phone calls), you can inquire about whether they have seen changes in their memory/concentration, or in their coordination and ability to perform skilled movements. You can talk to them about whether they have seen this helping with their wheelchair use and managing with the wheelchair. Again, you can remind them about how both cognitive and physical training activities can help with performing other skilled tasks, like using the wheelchair.

5. One strategy to keep participants engaged and invested in the games is to monitor and inquire about how they are advancing in their scores – "are you becoming better at the games", "have you increased your high score this week", getting them to track their 'performance' each week (formally or informally). For example, you could have them keep a chart of the games they are playing and their high score etc. for each week.

6. If you are sensing some decline in their practice or engagement, or they are starting to talk about how it is not making a difference or you are worried they might want to drop out of the study, you can mention to them at this point about the DVD. I would suggest you integrate it into their computer training: you might indicate that there will also be a wheelchair-specific training component after the 4 weeks of tablet training. You can tell them this will help bring together the cognitive/dexterity training and some specific wheelchair maneuvering/management skills, but it is important that they complete the tablet training aspect first. You can, if necessary, mention that a DVD with audio-visual training will be provided at the 4-week point, which they will be able to keep. Try, if possible, not to use this too early as it may be challenging to find another incentive after this, but if you need to do it, go ahead. You can always revisit the idea of the DVD to keep this incentive in mind if you have had to mention it early on in the training. You can remind them that some training takes time and to be patient with it.

Appendix J: Data collection protocol checklist

EPIC Wheels Data Collection Session 1: Tester Protocol

Participant ID#: ____________ Date (DD/MM/YY): ____________________

- ☐ Set up WST and WheelTalk equipment prior to participant arrival.
- ☐ Ensure you have Equipment and Forms prior to participant arrival.
- ☐ Meet participants and bring them to the testing lab.
- ☐ **Obtain 2 copies (each) of Consent from Wheelchair User and Caregiver before proceeding**. *Have spare copies of the consent form available. If not already signed, briefly review the consent form and ensure it is completed entirely (see below). If the Caregiver is not present, let the Coordinator know so the Trainer can obtain their consent.*
  - ☐ Each page is initialed; ☐video recording choice is checked; ☐participant signature and date; ☐your signature and date; ☐optional interview consent.
  - ☐ Place consent form in Participant file.
  - ☐ Provide a signed copy to each participant.
  - ☐ If video consent is provided, video record the WST procedure only.
- ☐ Complete the Demographics Form.
- ☐ Administer 3 trials of grip strength testing with the right hand, recording these on the Demographics form. [Calculate the mean after the participant has left]
- ☐ Complete the Wheelchair Specifications Form - **ensure you measure rear wheel diameter**.
- ☐ Administer the SMMSE – see script.
- ☐ Administer the Outcome Measures in order using the script.
  - ☐ Administer the WhOM.
  - ☐ Administer the WST.
  - ☐ Administer the WWT/WheelTalk.
  - ☐ Administer the LSA.
  - ☐ Administer the HUI.
  - ☐ Administer the WheelCon.
- ☐ **Note:** *The WheelCon should be left for last as it is the most time-consuming. If there is insufficient time to complete the outcome measures, you can send any uncompleted forms home with the participant in a SASE to complete and mail back.*
- ☐ **Ensure** you have all of the study forms and they are all complete including ID# and date **on each**; and put them in the participant file. Confirm the file has the same ID#.
- ☐ Give the **Wheelchair User only** (not the Caregiver) a card with $25 stipend and thank them.
- ☐ **Tell the participant** they will be contacted by the Study Coordinator shortly via telephone or email to set up their first appointment with a Trainer. ***If asked****, do not indicate what type of training this will entail – you can tell them you are only involved in the data collection and the study requires you to remain blind to all training activities.*
- ☐ Ensure the participants can find their way out and confirm they have transportation.
- ☐ Let the **Study Coordinator know ASAP** that you are finished data collection, so they can arrange an appointment with the Trainer.
- ☐ Input data from paper forms to electronic format (Excel spreadsheet: **DC1 Form**).
- ☐ Provide an electronic copy of the data to the Study Coordinator (as a back-up).
- ☐ Make a photocopy of the WhOM (without the scores) and forward to the Study Coordinator.
- ☐ Put the participant file in the EPIC filing cabinet for future reference.

EPIC Wheels Tester Protocol
DC2: Data Collection Session 2

- ☐ Set up WST and WWT equipment prior to participant arrival.
- ☐ Ensure you have Equipment and Forms prior to participant arrival (see equipment list).
- ☐ Meet participants and bring them to the testing lab.
- ☐ Re-administer the Outcome Measures in order using the script.
  - ☐ Re-administer the WhOM using the **same** sheet as DC1.
  - ☐ Re-administer the WST using a **new** sheet.
  - ☐ Re-administer the WWT using a **new** sheet.
  - ☐ Re-administer the LSA using a **new** sheet.
  - ☐ Re-administer the HUI using a **new** sheet.
  - ☐ Re-administer the WheelCon using the **same** sheet as DC1.
- ☐ **Note:** *The WheelCon should be left for last as it is the most time-consuming. If there is insufficient time to complete the outcome measures, you can send any uncompleted forms home with the participant in a SASE to complete and mail back.*
- ☐ **Ensure** you have all of the study forms and they are all complete including ID# and date; and put them in the participant file. Confirm the file has the same ID#.
- ☐ Give the **Wheelchair User only** (not the Caregiver) a card with $25 stipend and thank them.
- ☐ **Take the participant** to the Study Coordinator so they can complete the final components of data collection.
- ☐ *If, for some reason, you are unable to bring the participant to the Study Coordinator, thank them and ensure they find their way out and have transportation. ASAP let the Study Coordinator know DC2 was completed so they can follow-up with the participant.*
- ☐ Input data from paper forms to electronic format using the same ID# Excel spreadsheet.
- ☐ Provide an electronic copy of the data to the Study Coordinator (as a back-up).
- ☐ Give the Study Coordinator the participant file.

Appendix K: EPIC Wheels trainer intervention protocol

Treatment Protocol Checklist
EPIC Wheels Group - Session 1

Subject #: _________________ **Date** (DD/MM/YY): _____________________
☐ **Training Start Time** (00:00)**:** ________________

Introduction (5-10 min). Rapport building.
☐ Explain that you will be spending the next hour practicing and learning MWC skills and then about ½ hour going over their home program.
☐ Discuss current MWC mobility, important activities performed using the MWC, and general interests and life experience.
☐ Review goals and relevant activities identified on the WhOM.

Safety (5-10 min).
☐ Identify whether their MWC has anti-tippers; if so, ensure subject/caregiver know how to disengage/engage (have them demonstrate).
☐ Demonstrate application of the safety strap; ensure caregiver can demonstrate performance.
☐ Demonstrate correct spotting with strap; ensure caregiver can demonstrate performance.
☐ Make subject/caregiver aware of spotter strap document.
☐ Explain and offer use of gloves.

Training (40-50 min).
- Have subject demonstrate MWC mobility following sequence of progressive difficulty.
- Use spotter strap for skills that might require your intervention.
- Evaluate Participant performance and safety as per WSTP guidelines.
- If safety is an issue, intervene immediately: identify the hazard/risk and provide information (verbal and/or demonstration) regarding safe performance.
- If performance issues, provide feedback (verbal and/or demonstration) regarding optimal performance.
- Do not spend more than **10 minutes** per skill.
- Document skills performed and trained on Skills Sequence sheet.

☐ Provide the menu outline and highlight homework/skills to target.
☐ **Training Finish Time** (00:00): _________________
☐ **Total Treatment Time**: ______________________ minutes

Reason for stopping:
- ☐ Time (1 hour) had elapsed
- ☐ Participant became fatigued and further progress was unlikely
- ☐ Participant became frustrated and further progress was unlikely
- ☐ Participant indicated they did not want to continue current session
- ☐ Other: ____

☐ **Adverse Events**: YES _____ NO _____
If yes, how many: _______ Description:
____

Orientation to Tablet Device

☐ **Orientation Starting time** (00:00): ____________

Introduction

☐ Explain to subject/caregiver that they will take the tablet device home and use it to help them practice the skills they've learned, but in addition they can also practice without the device/home program.
☐ Explain that you will provide a demonstration but there is also a user guide they can take home for reference (show).
☐ Provide a brief description: "it's like a little computer that's easy to use; you don't need to use a keyboard or mouse, you can just touch the screen."
☐ Describe/demo turning it on; have the subject/caregiver demonstrate.
☐ Describe/demo checking the battery level and charging; have subject/caregiver demonstrate.
☐ Demo how to log on; have subject/caregiver demonstrate.
☐ Demo how to navigate, including voicemail, checking progress, practicing skills and learning new skills.
☐ Demo how to mount the tablet on their lap and adjust tablet view.
☐ Demo volume adjustment and headphone use, if necessary.
☐ Demo hotspot device and instruct them to plug it in, leave it turned on, and in a common location in their home.
☐ Explain tablet application buttons: Pause, Stop, Previous, Next, Play, Menu

Describe expectations for home program:

☐ Practice the skills learned in session using activities and games
☐ Try to use the skills in different situations/contexts
☐ Always have CP present for activities and skills that are higher risk (the ones with prompts)
☐ Try to have CP present for low risk activities and skills, but not required
☐ Goal is to practice 1 or 2 times per day for a total of 30 minutes, at least 5 days a week (Total 150 minutes/week). These can be any days of the week, doesn't have to be Monday through Friday. You can do more if you like, but try and space training sessions at least 3 hours apart to allow the information to 'settle in'.
☐ Explain the Start/Stop function and how it keeps track of training time
☐ Explain the 3 pop-up questions on the tablet, including non-tablet training time
☐ Explain the Safety question with higher risk skills (review Safety material) and **if no caregiver**, that these are performed at their own risk.
☐ Review the training kit

****If they are in the Extra Wheeling Sub-group:**

☐ Explain that you want them to also spend some time just wheeling their chair for 15 minutes, at least 5 days per week (**total 75 minutes**). This is not necessarily working on a particular skill, but just wheeling their chair for practice.
☐ Review the **pop-up question on the tablet** they use to monitor this wheeling time.

Describe the next steps:

- ☐ Tell subject they can start their training program immediately.
- ☐ Tell subject they can send you a voicemail via the tablet if they have any questions and provide your phone number in case of emergency.
- ☐ You will call them by phone to see how things are going at the end of weeks 1 and 3.
- ☐ When is a good time to call? ___________________________
- ☐ Who should you ask for? _______________________________
- ☐ Book an appointment for 14 days from now for next training session
- ☐ If an emergency arises, if they have an incident (explain), or if the participant can't get a hold of you, they should call the PI: (Winnipeg) Ed Giesbrecht at 204-XXX-XXXX or (Vancouver) Dr. Bill Miller at 604-XXX-XXXX.

Install the Data Logger:

- ☐ Ensure the data logger is turned on (blue light is blinking); usually easier to do prior to install.
- ☐ Install the data logger on one of the drive wheels following the data logger install documents.

Preparing the Subject:

Ensure the subject has the following items:

- ☐ Appointment slip for next session with your phone number for any questions
- ☐ PI Phone number for emergencies
- ☐ The EPIC Wheels tablet
- ☐ Written instructions (user guide) for the tablet
- ☐ Spotter strap
- ☐ Wheeling Gloves if desired/required
- ☐ Tablet menu layout/progress sheet and highlighted skills to focus on/homework
- ☐ Kit

Time

- ☐ Orientation Finish Time (00:00): _______________
- ☐ Total Orientation Time: ______________ minutes
- ☐ Total Session Time [training + orientation]: ____________ minutes

Breaks from Protocol: Yes _____ No _____

Describe:

Issues:

Treatment Protocol Checklist
EPIC Wheels Group - Session 2

Subject #: _________________ **Date** (DD/MM/YY): _______________
Training Start Time (00:00)**:** ________________

Introduction (5-10 min). Rapport building.

- ☐ Explain that you will be spending the next hour practicing and learning MWC skills and planning for the remaining 2 weeks of their home program.
- ☐ Discuss previous 2 weeks of home practice: what they have been working on; what went well and poorly; questions or issues that arose; tablet issues; specific needs for remaining 2 weeks.
- ☐ Review amount/frequency of practice at home using monitoring data; create strategies if necessary to meet objectives.
- ☐ Review goals and relevant activities identified on the WhOM.

Safety (5 min).

- ☐ Review any safety concerns; confirm any incidents or injuries; safety equipment (gloves, spotter strap) are still intact.

Training (40-50 min).

- Have subject demonstrate MWC mobility following sequence of progressive difficulty (see Skills Sequence on separate sheet). Review briefly previous skills; progress to more advanced (new) skills for training.
- Use spotter strap for skills indicated.
- Evaluate Participant based on performance and safety guidelines outlined in the WSTP. If safety is an issue, intervene immediately: identify the hazard/risk and provide information (verbal and/or demonstration) regarding safe performance.
- If performance is an issue, provide feedback (verbal and/or demonstration) regarding optimal performance.
- Do not spend more than **10 minutes** per skill.
- Document skills performed and trained on Skills Sequence sheet.
- ☐ Provide the menu outline and highlight homework/skills to target.

☐ **Training Finish Time** (00:00): _________________
☐ **Total Treatment Time**: ______________________ minutes

Reason for stopping:

- ☐ Time (1 hour) had elapsed
- ☐ Participant became fatigued and further progress was unlikely
- ☐ Participant became frustrated and further progress was unlikely
- ☐ Participant indicated they did not want to continue current session
- ☐ Other: ____

☐ **Adverse Events**: YES _____ NO _____
If yes, how many: _______ Description:
____

Describe the next steps:

- [ ] Tell subject to continue practicing, using revised plan.
- [ ] Tell subject they can phone you/contact you via the tablet voicemail program if they have any questions and provide your phone number.
- [ ] You will call them by phone to see how things are going at the end of next week.
- [ ] When is a good time to call? ___________________________
- [ ] Who should you ask for? _______________________________
- [ ] If an emergency arises, if they have an incident (explain), or if the participant can't get a hold of you, they should call the PI: (Winnipeg) Ed Giesbrecht at 204-XXX-XXXX or (Vancouver) Dr. Bill Miller at 604-XXX-XXXX.
- [ ] Tell them they will be contacted for another appointment in 2 weeks for data collection and return of the equipment.

Preparing the Subject:

Ensure the subject has the following items:

- [ ] Contact number (Study Coordinator/Tester) for final data collection.
- [ ] Your phone number and PI Phone number for questions and emergencies
- [ ] The EPIC Wheels tablet
- [ ] Written instructions (user guide) for the tablet
- [ ] Spotter strap
- [ ] Wheeling Gloves if desired/required
- [ ] Tablet menu layout/progress sheet and highlighted skills to focus on/homework
- [ ] Any other equipment that they brought with them to the training session

Data Logger

- [ ] **Remove the data logger and return to the SC with the subject ID#**

Breaks from Protocol: Yes _____ No _____

Describe:

Issues:

Appendix L: Control group trainer intervention protocol

Control Protocol Checklist
EPIC Wheels Control Group - Session 1

Subject #: _________________ **Date** (DD/MM/YY): _____________________

Orientation to Tablet Device

☐ **Orientation Starting time** (00:00): ____________

Introduction

☐ Explain to subject/caregiver they will have the tablet device to use in their home for 4 weeks.
☐ Explain that some research has demonstrated that older adults who engage in mentally-stimulating video games have shown improvements, not only in cognitive areas like memory and concentration, but also in their coordination, reflexes, and physical skills. We want to see whether their engaging in these games has an impact on their mobility in the wheelchair.
☐ Explain that you will provide a demonstration but there is also a user guide you will leave with them (show).
☐ Provide a brief description: "it's like a little computer that's easy to use; you don't need to use a keyboard or mouse, you can just touch the screen."
☐ Describe/demo turning it on; have the subject/caregiver demonstrate.
☐ Describe/demo checking the battery level and charging; have subject/caregiver demonstrate.
☐ Demo how to log on; have subject/caregiver demonstrate.
☐ Demo how to navigate to the different activities from the main screen.
☐ Demo volume adjustment and headphone use
☐ Go through the question that pop up periodically (every 24 hours)

Describe expectations for home program:

☐ Explain the goal is to practice 1 or 2 times per day for a total of 30 minutes, at least 5 days a week (Total 150 minutes/week). These can be any days of the week – it doesn't have to be Monday through Friday.

****If they are in the Extra Wheeling Sub-group:**

☐ Explain that you want them to also dedicate some time to just wheeling their wheelchair for 15 minutes, at least 5 days per week (**total 75 minutes/week**). They can do this in their home or community, and should be beyond what they normally do in the course of their day.
☐ Review the pop-up question they use to monitor this wheeling time.

Describe the next steps:

☐ Tell subject they can start their training program immediately.
☐ Tell subject they can phone you if they have any questions and provide your phone number.
☐ You will call them by phone to see how things are going at the end of weeks 1 and 3.
☐ When is a good time to call? ___________________________
☐ Who should you ask for? _______________________________

- [ ] Book an appointment for 14 days from now for the follow-up session
- [ ] If an emergency arises, if they have an incident (explain), or if the participant can't get a hold of you, they should call the PI: (Winnipeg) Ed Giesbrecht at 204-XXX-XXXX or (Vancouver) Dr. Bill Miller at 604-XXX-XXXX.

Preparing the Subject:
Ensure the subject has the following items:

- [ ] Appointment slip for next session with your phone number for any questions
- [ ] PI Phone number for emergencies
- [ ] The EPIC Wheels tablet with cognitive games and charger
- [ ] Written instructions (user guide) for the tablet

Install the Data Logger:

- [ ] Ensure the data logger is turned on (blue light is blinking); usually easier to do prior to install.
- [ ] Install the data logger on one of the drive wheels following the data logger install documents.

Time

- [ ] Orientation Finish Time (00:00): _______________
- [ ] Total Orientation Time: ______________ minutes

Breaks from Protocol: Yes _____ No _____
Describe:

Issues:

Control Protocol Checklist
EPIC Wheels Control Group - Session 2

Subject #: _________________ **Date** (DD/MM/YY): _____________________

- ☐ Start time: (00:00) __________
- ☐ Initiate interview with the participant using the guide below

1. Introduction and rapport building.
   a. Greeting
   b. How have things been going for you?
   c. How has your health been?
2. Review of activities identified in the WhOM.
   a. So you are active participating in _________. How has that been going for you lately?
   b. How often do you participate in __________?
   c. Do you enjoy _____________?
   d. What about ___________; have you also been engaging in that activity?
   e. Are there any new activities that you have started lately?
3. Experiences with using their wheelchair during activities.
   a. Do you take your wheelchair when you participate in ___________?
   b. Do you manage the wheelchair on your own or do you need help? Tell me more about that.
   c. What about _____________; do you use your wheelchair for that activity too?
4. Issues identified as barriers to wheelchair use.
   a. What's been your biggest struggle with using the wheelchair?
   b. Do you run into situations where it is difficult to use?
   c. What are the most frustrating barriers you run into?

Describe the next steps:

- ☐ Tell the participant to continue practicing as they have been.
- ☐ Indicate they can contact you if they have any questions and provide your phone #.
- ☐ You will call them by phone to see how things are going at the end of next week.
- ☐ When is a good time to call? ___________________________
- ☐ Who should you ask for? _______________________________
- ☐ If an emergency arises, if they have an incident (explain), or if the participant can't get a hold of you, they should call the PI: (Winnipeg) Ed Giesbrecht at 204-XXX-XXXX or (Vancouver) Dr. Bill Miller at 604-XXX-XXXX.
- ☐ Tell them they will be contacted for another appointment in 2 weeks for data collection and return of the equipment.
- ☐ Contact the study coordinator to make arrangements for the follow-up data collection.

Data Logger

- ☐ **Remove the data logger and return to the SC with the subject ID#**
- ☐ Finish time: (00:00) __________
- ☐ Total Session Time: __________ minutes

Appendix M: Epic Wheels trainer post-treatment evaluation form

Post-treatment Evaluation Form

Participant #: ____________

Were there any major deviations from the intervention protocol? Yes ☐ No ☐
If yes, describe below:

Were there any minor deviations from the intervention protocol? Yes ☐ No ☐
If yes, describe below:

Was the intervention protocol clear? Yes ☐ No ☐
If not, describe below:

Was administration of the intervention protocol reasonable in the time allotted? Yes ☐ No ☐
If not, describe below:

Are there any issues with the intervention protocol that remain? Yes ☐ No ☐
If yes, describe below:

Appendix N: Detailed participant demographics

ID[a]	Age	Sex	Marital Status	Living Situation	Education	MMSE Score	Health Condition[b]	MWC use (months)	Propulsion Method[c]	Grip Strength[d]
W01	65	M	Married	Not alone	Post-secondary	30	PD	7	2 H + 2 F	54.0
W02	84	M	Married	Not alone	High school	28	PD	5	2 H + 2 F	63.8
W03	66	F	Separated	Alone	< High school	29	MS	14	2 H	31.0
W04	70	M	Married	Not alone	Post-secondary	29	Amp	2	2 H + 1 F	95.0
W05	76	M	Married	Not alone	Post-secondary	29	MS	2	2 H + 2 F	38.3
W06	65	F	Single	Alone	High school	30	CVA	18	2 H + 2 F	29.0
V01	82	M	Married	Not alone	Bachelor's	25	AVM	1	2 H	56.7
V02	73	F	Married	Not alone	High School	29	Arthritis	1	2 H	20.7
V03	60	M	Married	Not alone	Post-secondary	24	MS	7	2 H	38.7
V04	50	M	Separated	Alone	< High school	25	Ortho	22	2 H + 2 F	92.3
V05	65	M	Separated	Alone	< High school	27	Ortho	19	2 H + 2 F	41.0
V06	71	M	Single	Alone	Post-secondary	27	Amp	24	2 H + 1 F	46.0
V07	61	M	Married	Not alone	Master's	30	SCI	84	2 H	98.3
V08	50	M	Separated	Alone	Post-secondary	30	SCI	6	2 H	97.3
V09	61	M	Separated	Alone	Post-secondary	30	Ortho	36	2 H	87.7

[a] W = Winnipeg; V = Vancouver
[b] PD = Parkinson's Disease; MS = Multiple Sclerosis; Amp = lower limb amputation; AVM = arteriovenous malformation; Ortho = orthopedic injury; CVA = cerebral vascular accident
[c] H = hands; F = feet
[d] Mean of three trials with right hand (in pounds)

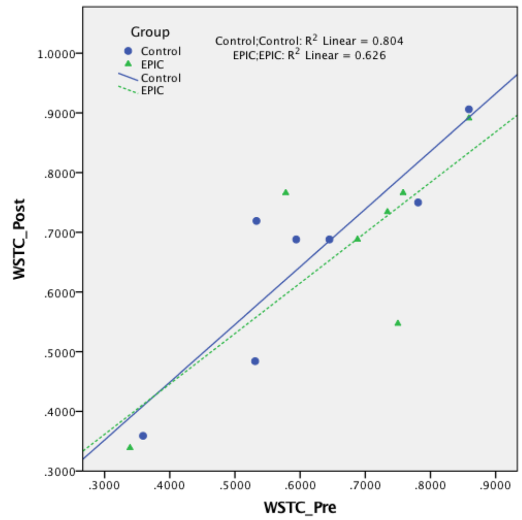
Appendix O: Participant wheelchair specifications

ID[a]	Make/Model[b]	Frame	Size[c]	Seat height	Seat Style	Cushion	Back Style	Arm Rests[d]	Lap belt	Anti-tippers	Wheel Diameter
W01	Sunrise Breezy 2000	Folding	19x16	19”	Sling	None	Sling	Full	Yes	No	24”
W02	Sunrise Breezy 2000	Folding	18x16	18”	Sling	None	Sling	Full	Yes	No	24”
W03	E & J Traveler	Folding	16x16	19”	Sling	None	Sling	Full	No	No	24”
W04	Sunrise Breezy 4000	Folding	20x20	21”	Sling	Foam	Sling	Desk	No	No	22”
W05	Sunrise Breezy Rubix	Folding	16x16	15”	Sling	Foam	Sling	Desk	Yes	Yes	23”
W06	Invacare MyON Active	Folding	18x18	15”	Pan	Fluid/gel	Sling	Full	Yes	Yes	22”
V01	Motion Helio	Folding	18x18	16”	Pan	Foam	Sling	Desk	No	Yes	24”
V02	Sunrise Breezy 600	Folding	16x16	20”	Sling	Foam	Sling	Full	No	Yes	19”
V03	TiLIte	Rigid	18x22	14”	Sling	Foam	Sling	None	No	Yes	23”
V04	Sunrise Quickie2	Folding	16x18	19”	Sling	Foam	Sling	Desk	No	Yes	24”
V05	Unknown	Folding	18x16	16”	Sling	None	Sling	Desk	No	Yes	22”
V06	Invacare ProSPIN X4	Folding	18x16	16”	Sling	None	Sling	Desk	Yes	No	21”
V07	Panthera X	Rigid	16x17	18”	Sling	Air/Foam	Sling	None	No	No	26”
V08	Quickie GTi	Rigid	14x17	18”	Sling	Foam	Rigid	None	No	No	24”
V09	Quickie GP	Rigid	18x20	20”	Sling	Air	Sling	Desk	No	Yes	23”

[a] W = Winnipeg; V = Vancouver
[b] E & J = Everest & Jennings
[c] Width x Depth (in inches)
[d] Full = full length; Desk = desk length; None = no armrests

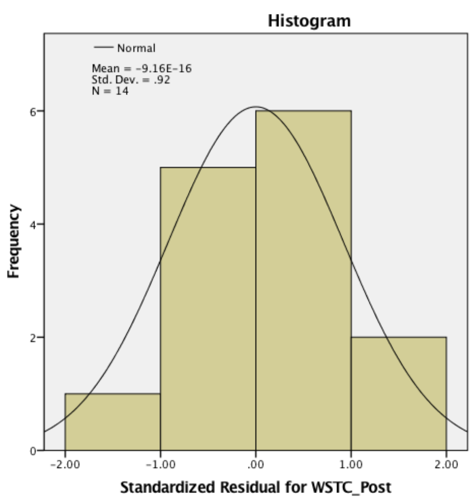
Appendix P: Assumptions testing for ANCOVA analysis

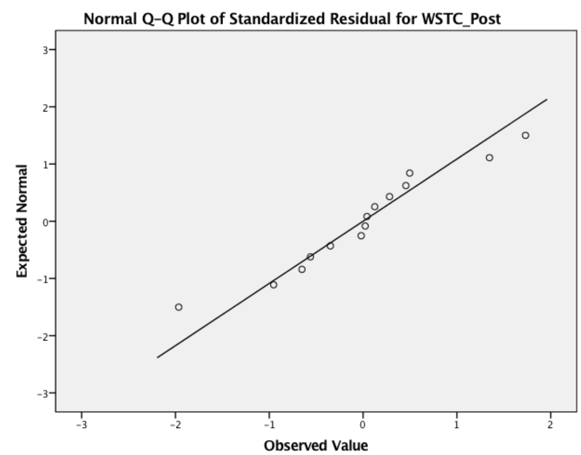
1. **Linearity**: There was a linear relationship between the covariate (WSTC_Pre) and dependent variable (WSTC_Post) for each intervention group, as assessed by visual inspection of a scatterplot.



2. **Homogeneity of regression slopes**: confirmed as the interaction term (WSTC_Pre*Group) was not statistically significant ($F(1,10) = 0.16$, $p = 0.74$).

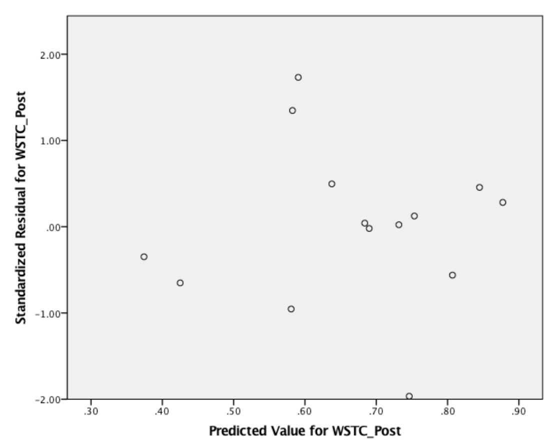
3. **Normality of the model**. Standardized residuals for the interventions were normally distributed, as assessed by Shapiro-Wilk's test (0.966, df 14, $p = 0.82$) as well as visual inspection of a frequency histogram and the quantile Q-Q plot.





Skewness (Statistic -0.125 / SE 0.597 = -0.209) and Kurtosis (Statistic 1.020 / SE 1.154 = 0.884) were within the acceptable range.

4. Homoscedasticity & homogeneity of variance. There was homoscedasticity and homogeneity of variances, as assessed by visual inspection of a scatterplot (Standardized Residuals vs Predicted Values) and a non-significant result in Levene's Test of Equality of Error Variance (F 1,12 = 0.02, $p = 0.89$), respectively.



5. Outliers. There were no outliers in the data, as assessed by no cases with standardized residuals greater than ±3 standard deviations.

Appendix Q: Detailed summary of two-way ANCOVA analysis

Descriptive Statistics

Dependent Variable: WSTC_Post

Group	Wheeling	Mean	SD	N
Control	No	0.599	0.210	3
	Yes	0.699	0.173	4
	Total	0.656	0.180	7
EPIC	No	0.727	0.055	2
	Yes	0.655	0.216	5
	Total	0.675	0.181	7
Total	No	0.650	0.167	5
	Yes	0.675	0.187	9
	Total	0.666	0.174	14

Levene's Test of Equality of Error Variances[a]

Dependent Variable: WSTC_Post

F	df1	df2	Sig.
0.908	3	10	0.47

Tests of Between-Subjects Effects

Dependent Variable: WSTC_Post

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	.283[a]	4	.071	5.80	0.01	0.72
Intercept	.006	1	.006	0.53	0.49	0.06
WSTC_Pre	.257	1	.257	21.09	0.00	0.70
Group	.002	1	.002	0.17	0.69	0.02
Wheeling	.001	1	.001	0.08	0.79	0.01
Group * Wheeling	.002	1	.002	0.17	0.69	0.02
Error	.110	9	.012			
Total	6.604	14				
Corrected Total	.393	13				

Estimated Marginal Means

1. Group

Dependent Variable: WSTC_Post

Group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Control	0.679[a]	0.043	0.582	0.775
EPIC	0.652[a]	0.047	0.546	0.758

a. Covariates are evaluated at the following values: WSTC_Pre = 0.643.

2. Wheeling

Dependent Variable: WSTC_Post

Wheeling	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
No	0.657[a]	0.050	0.543	0.771
Yes	0.674[a]	0.037	0.590	0.758

a. Covariates appearing in the model are evaluated at the following values: WSTC_Pre = 0.643.

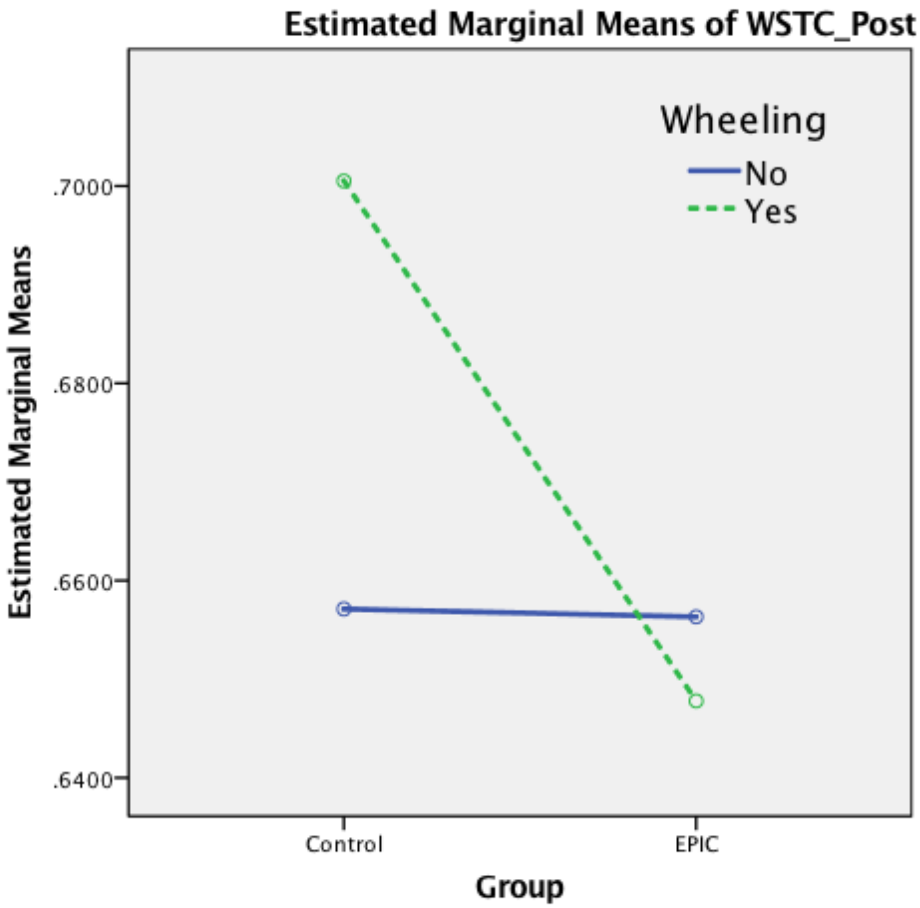
3. Group * Wheeling

Dependent Variable: WSTC_Post

Group	Wheeling	Mean	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
Control	No	0.657[a]	0.065	0.510	0.804
	Yes	0.701[a]	0.055	0.576	0.825
EPIC	No	0.656[a]	0.080	0.476	0.836
	Yes	0.648[a]	0.049	0.536	0.760

a. Covariates appearing in the model are evaluated at the following values: WSTC_Pre = 0.643.

Profile Plot



Covariates appearing in the model are evaluated at the following values: WSTC_Pre = .643429

Appendix R: Follow-up interview question guide

Qualitative Interview Guide
Wheelchair User

Introduction (5 min)

For the next 60-90 minutes, I want to talk to you about your experience participating in the EPIC Wheels training program. As you recall, the EPIC Wheels program involved you meeting with your trainer for two personal training sessions – one at the beginning of the program and then again after two weeks of home training. You also completed a total of four weeks of training at home using the computer tablet, which had demonstrations, activities, and games to learn a variety of techniques for using your wheelchair. We want to talk about your impressions of working with your trainer, training at home with the tablet, and what sort of impact the EPIC Wheels program had on using your wheelchair for activities that are important to you. If there are other things that you want to share with us about your experience, we would love to hear about those too and we'll save some time for that near the end of the interview.

We would like you to be as honest as you can about your experience, both good and bad; that is how we will be able to evaluate the EPIC Wheels program most effectively. We are recording the interview so that we can remember everything, but whatever you say will remain anonymous. If you have any questions or concerns during the interview, please let me know.

A. Perceptions of the Trainer Component (10-15 min)

Let's start with you meeting together with [Trainer]. Can you tell me what your experience was like coming in to the lab for those two training sessions with [Trainer]?

- How convenient/easy was it to come in for the appointments? Why? [Issues related to transportation, cost, time commitment, effort/scheduling, location, etc.]
- Tell me about your trainer … what was your interaction like? What qualities do you feel make a good trainer?
- Was it important to have a personal connection with your trainer?
- Tell me about communication between you and the trainer … Did you use the voicemail feature on the tablet and how important or useful was this? Why?
- Were the weekly telephone check-ins helpful or necessary for you? Did you feel like your trainer was there enough for you? What do you think about the contact schedule?

How important was it to have at least ***some training*** *with [Trainer]? Do you think you could have been successful with the program using ONLY the tablet home program?*

B. Perceptions of the Tablet Component (20-30 min)

Now I want to talk to you about training at home with the computer tablet.
What was it like practicing with the home program?

- Did you find it simple or complicated to use?
- Was the program too fast or didn't move along quick enough? Too long or were there not enough activities? Too detailed or not detailed enough? Can you expand on this?
- Was it engaging or boring? Can you expand on this?

What did you think about using a computer tablet for training? What was it like to use?

- Was it difficult to use/ learn to use? Can you expand …
- What parts of the tablet program were positive? Layout of the content; Getting stars and awards; Progress updates; Games; Training activities; Playback features … Can you expand …
- Did you like having your progress displayed on the tablet? Can you expand …
- What parts of the tablet program were not positive? Can you expand …

You were asked to try and practice 4-5 times a week for 15-30 minutes at a time, and try to perform 150 minutes of practice per week for 4 weeks. What did you think of these expectations?

- How manageable was this (too much/ too little)? Why – was it hard to find the time, did you forget, was it too much effort, was it too easy, too boring?
- Was the program long enough for you to learn everything you wanted/needed to learn, or long enough for you to become proficient with the skills you were learning? Should it have been shorter/longer?

If the Participant was in the Extra Wheeling group:
You were also asked to perform additional wheeling in your wheelchair, aside from the tablet-based program. What impact do you think this had on your progress or development of skills?

- Did having this expectation make the program any more or less effective?

If the Participant was NOT in the Extra Wheeling group:
If you had also been asked to perform additional wheeling in your wheelchair, aside from the tablet-based program, what impact do you think this would have had on your progress or development of skills?

- Would having this expectation make the program any more or less effective?

C. Impact of Skills Training on Participation (15-25 min)

Now I want to talk to you about how EPIC Wheels training affected your wheelchair use.
What impact do you think the program had on your ability to use your wheelchair easily and effectively?

- Were there specific skills that you learned or improved because of the program? Expand …
- Were there any skills that you did not learn in the program that you wish you would have or were missing from the program? Expand on this …
- What were the most important/valuable things/skills you learned? Expand on this …

What impact did the program have on your confidence using the wheelchair?

Did the training program have an impact on your involvement in activities that are important to you outside of your home?
[Examples might be appointments, shopping, visiting others, social events, outings like dinner or movie, attending a house of worship, clubs, going for a walk/roll, etc.]

- What did you think of the skill that were taught in the program? Appropriate and applicable to your daily life? Expand …
- Were there changes in the types of activities you were able to participate in?
- Were there changes in your ability to participate in those activities more easily?
- Were there changes in your ability to participate in those activities more often?
- Which activities

What impact, if any, did your skills training have on assistance you require to participate in these activities?

D. Wrap-up (10-15 min)

At the end of the training program, you also received a DVD with the EPIC Wheels program (show them a copy) – do you recall this? Did you ever look at or use the DVD?

- If not, why not? Not interested, didn't get around to it, DVD not a good format, already felt comfortable with skills …

If so, what was your impression?

- Did you find it helpful? Did you learn more skills or refine some of the skills you had already learned?

Those are all of the questions that I had prepared for you. Is there anything else that you think is important for us to know or that you would like to share?

Do you have any questions for me?

I want to thank you very much for agreeing to participate in this interview and in the EPIC Wheels study. You input and insight is valuable to us and we appreciate you taking the time to meet. As a small token of appreciate, we have a card and $25 we'd like to give you. Also, if you have any questions, you are always free to contact Ed Giesbrecht/Bill Miller, who is the principal investigator in this study. I will leave you his card if you should ever want or need to get a hold of him.

Qualitative Interview Guide
Care Provider

Introduction (5 min)

For the next 60-90 minutes, I want to talk to you about your experience participating in the EPIC Wheels training program. As you recall, the EPIC Wheels program involved you and [name of participant] meeting with [Trainer] for two personal training sessions – one at the beginning of the program and then again after two weeks of home training. [Name of participant] completed a total of four weeks of training at home using the computer tablet, which had demonstrations, activities, and games to learn a variety of techniques for using a wheelchair. We want to talk about your impressions of working with the trainer, [name of participant] training at home with the tablet, and what sort of impact the EPIC Wheels program had for both you and [name of participant]. If there are other things that you want to share with us about your experience, we would love to hear about those too and we'll save some time for that near the end of the interview.

We would like you to be as honest as you can about your experience, both good and bad; that is how we will be able to evaluate the EPIC Wheels program most effectively. We are recording the interview so that we can remember everything, but whatever you say will remain anonymous. If you have any questions or concerns during the interview, please let me know.

A. Perceptions of the Trainer Component (10-15 min)

Let's start with you meeting together with [Trainer]. Can you tell me what your experience was like coming in to the lab for those two training sessions with [Trainer]?

- How convenient/easy was it to come in for the appointments? Why? [Issues related to transportation, cost, time commitment, effort/scheduling, location, etc.]
- Tell me about the trainer … what was the interaction like? What qualities do you feel make a good trainer?
- Tell me about communication between you and the trainer … How important was it to have a personal connection with the trainer? Was this helpful to you in addition to [participant]? Was communication with the trainer, such as the voicemail feature on the tablet, important or useful?
- Were the weekly telephone check-ins helpful or necessary? Can you expand on this?
- Did you feel like your trainer was sufficiently involved or did you feel like things fell to you? Can you expand on this?

How important was it to have at least ***some training*** *with [Trainer]? Do you think [participant] could have been successful with the program using ONLY the tablet home program?*

B. Perceptions of the Tablet Component (20-30 min)

Now I want to talk to you about [participant] training at home with the computer tablet. What was it like having [participant] practice with the home program?

- How much supervision did you need to provide? Did this take a lot of your time? Was it inconvenient? Can you expand on this?
- What concerns did you have about supervision, such as safety for you or [participant]?

What did you think about using a computer tablet for training?

- Was it difficult to use/ learn to use? How much did you have to help [participant]? Were you clear on how to use and navigate the program? Can you explain?
- Was the program too fast or didn't move along quick enough? Too long or were there not enough activities? Too detailed or not detailed enough? Can you explain?
- What parts of the tablet program were positive? Layout of the content; Getting stars and awards; Progress updates; Games; Training activities; Playback features … Can you explain?
- What parts of the tablet program were not positive? Can you explain?

[Participant] was asked to practice 4-5 times a week for 15-30 minutes at a time, and try to perform 150 minutes of practice per week for 4 weeks. What did you think of these expectations?

- How manageable was this (too much/ too little)? Why – was it hard to find the time, did you forget, was it too much effort, was it too easy, too boring?
- Did you need to prompt or encourage [participant] to do their training? What was that like?
- Was the program long enough for [participant] to learn everything they wanted/needed to learn, and become proficient with the skills? Should it have been shorter/longer?

If the Participant was in the Extra Wheeling group:
[Participant] was also asked to perform additional wheeling in their wheelchair, aside from the tablet-based program. What impact do you think this had on their progress or development of skills?

- Did having this expectation make the program any more or less effective?

If the Participant was NOT in the Extra Wheeling group:
If [Participant] had also been asked to perform additional wheeling in their wheelchair, aside from the tablet-based program, what impact do you think this would have had on their progress or development of skills?

- Would having this expectation make the program any more or less effective?

C. Impact of Skills Training on Participation (15-25 min)

Now I want to talk to you about how EPIC Wheels training affected [participant's] wheelchair use.
What impact do you think the program had on [participant's] ability to use their wheelchair easily and effectively?

- Were there specific skills that [participant] learned or improved because of the program? Can you expand on this?
- Were there any skills that they did not learn and you wish they would have or were missing from the program? Can you expand on this?
- What were the most important/valuable things/skills learned? Can you expand on this?

What impact did the program have on [participant's] confidence using the wheelchair?

Did the training program have an impact on [participant's] involvement in activities that are important to them outside of the home?
[Examples might be appointments, shopping, visiting others, social events, outings like dinner or movie, attending a house of worship, clubs, going for a walk/roll, etc.]

- What did you think of the skills taught?
- Were the skills taught in the program appropriate and applicable to daily life?
- Were there changes in the types of activities [participant] was able to participate in?
- Were there changes in his/her ability to participate in those activities more easily?
- Were there changes in his/her ability to participate in those activities more often?
- Which activities

Did the training program have any impact on the amount or type of assistance you provide to [participant] to participate in these activities?

- Are things any easier for you? Do you need to assist less or is [participant] more independent? Can you tell me why?
- How safer do you feel with [participant] engaging in these activities? How confident do you feel? Can you expand on this?

D. Wrap-up (10-15 min)

At the end of the training program, [participant] also received a DVD with the EPIC Wheels program (show them a copy) – do you recall this? Did [participant] or you ever look at or use the DVD?

- If not, why not? Not interested, didn't get around to it, DVD not a good format, already felt comfortable with skills …

If so, what was your impression?

- Did you find it helpful? Can you explain why?
- Did you learn more skills or refine some of the skills you had already learned?

Those are all of the questions that I had prepared for you. Is there anything else that you think is important for us to know or that you would like to share?

Do you have any questions for me?

I want to thank you very much for agreeing to participate in this interview and in the EPIC Wheels study. You input and insight is valuable to us and we appreciate you taking the time to meet. As a small token of appreciate, we have a card and $25 we'd like to give you. Also, if you have any questions, you are always free to contact Ed Giesbrecht/Bill Miller, who is the principal investigator in this study. I will leave you his card if you should ever want or need to get a hold of him.