Title: Real-World Experiences of Therapy Staff Implementing an Intensive Rehabilitation Protocol in Canadian Stroke Inpatient Rehabilitation Settings: A Multi-Site Survey Study

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Abstract

Importance: While best-practice guidelines recommend intensive rehabilitation for poststroke walking recovery, knowledge of real-world implementation factors is limited.

Objective: The aim was to understand the implementation factors for intensive rehabilitation within real-world inpatient stroke rehabilitation settings.

Design: This was a cross-sectional, online survey study.

Setting: Twelve inpatient rehabilitation units (7 Canadian provinces) were included.

Participants: Eighty-five therapy staff who delivered an intensive rehabilitation protocol within the Walk ’n Watch implementation trial (NCT04238260) were invited.

Intervention: A structured intensive walking rehabilitation protocol was implemented as usual care (>2000 steps, 40-60% heart rate reserve, >30 minutes/session). Step counters and heart rate monitors were provided.

Main Outcomes and Measures: An online survey was used, including close-ended and open-ended questions regarding the protocol practicalities, workplace structure, and training.

Open-ended responses were thematically analyzed using the Consolidated Framework for Implementation Research (CFIR).

Results: Forty-seven participants (85% women) completed the survey. Most agreed they successfully delivered the protocol (87%) and found the step and heart rate targets helpful (72%). However, few participants agreed they had enough time to deliver the protocol (36%); 26% and 47% agreed they achieved the step count and heart rate targets, respectively. The major time-related factor was insufficient therapy time to accommodate the protocol and prescribed step targets (CFIR Work Infrastructure); discharge planning often took priority. Most agreed to future protocol use (87%). However, only about half agreed to future use of the trial-assigned devices (49% step counters; 64% heart rate monitors), likely due to perceived device inaccuracies (CFIR Materials & Equipment).

Conclusions: Therapy staff reported successfully delivering an intensive rehabilitation protocol as usual care under real-world conditions. Strategies to facilitate implementation included incorporating discharge planning considerations, system-level changes, and acquiring more accurate monitoring devices.

Relevance: This study enhanced the understanding of real-world implementation factors and potential strategies for future implementation.

Introduction

Recent practice guidelines recommend intensive rehabilitation (high repetitions of task-specific practice at aerobic exercise intensities) to optimize walking recovery after stroke.[1–3] Specifically, maximizing stepping repetitions with at least moderate exercise intensity [>40% heart rate reserve (HRR)] is recommended,[1–3] and has been shown in clinical trials to improve walking endurance and speed, and quality of life.[4–6] As neuroplasticity is greatest within the first 3 months after stroke,[7] inpatient rehabilitation settings present as an optimal opportunity to deliver intensive rehabilitation. However, implementing intensive rehabilitation within inpatient rehabilitation settings remains challenging. The step counts and heart rate intensities achieved by patients with stroke during usual care remains low**.** Thousands of repetitions and at least 20 minutes of moderate intensity exercise per day has been suggested to promote recovery and neuroplasticity after stroke.[8,9] However, previous studies have reported mean values ranging between 357 to 1167 steps and a mean of 11 minutes moderate exercise intensity within one session per day.[6,10–12] Understanding implementation barriers and facilitators may inform strategies to improve uptake of intensive rehabilitation as part of usual care.

Our team has previously[13,14] evaluated the implementation factors for an intensive, task-specific physical therapist intervention during inpatient rehabilitation in a randomized controlled trial, the Determining Optimal Post-Stroke Exercise (DOSE) trial.[6] The DOSE trial demonstrated that intensive rehabilitation integrated within typical physical therapist sessions improved quality of life and walking endurance over usual care.[6] The key implementation barriers identified included the lack of time and staff, conflicting beliefs between movement quality and quantity, and lack of necessary equipment (example, body-weight support treadmills).[13] Facilitators included using wearable sensors (heart rate monitors

and step counters) and cardiovascular exercise testing to provide safety reassurance for exercise at aerobic intensities.[13]

Given the positive results from DOSE, our team conducted an implementation trial, the Walk'n Watch (WnW) trial, using an intervention protocol informed by the DOSE trial.[15] The WnW trial demonstrated that the WnW protocol significantly improved the primary outcome of the six minute walk test, as well as balance function and quality of life, compared to usual care after 4 weeks of the WnW protocol.[16] Evaluating the implementation factors in the WnW trial offers novel perspectives in several ways. Our previous DOSE trial evaluation only included therapy staff who were trained specifically to deliver the intervention in a research context.[13] In the WnW trial, the entire therapy staff (rehabilitation assistants and physical therapists) within the inpatient rehabilitation units were trained and implemented the WnW protocol as part of enhanced usual care across 12 sites, with a total of 85 therapy staff who had experience delivering the WnW protocol. One previous study evaluated the implementation experience of high intensity rehabilitation in stroke, but only included 10 physical therapists across 2 sites.[17] The WnW trial is a large-scale implementation effort under real-world rehabilitation settings, and included the perspectives of rehabilitation assistants, a profession that is highly involved with stroke rehabilitation.[18] Therefore, implementation barriers and facilitators of intensive rehabilitation across a larger, more generalizable context of inpatient rehabilitation settings remains unclear. This study aimed to understand the experiences of the inpatient rehabilitation therapy staff within the WnW trial to understand the implementation barriers and facilitators of intensive rehabilitation for walking recovery after stroke.

Methods

Design

We used a cross-sectional design with a self-administered online survey. Surveys are ideal for collecting non-observable data, such as beliefs and opinions of past behaviours, and provides a space to comfortably share sensitive information without direct monitoring.[19] Reporting standards, The Checklist for Reporting Results of Internet E-Surveys (CHERRIES), were used.[20] Ethical approval was obtained through the Bruyère Research Ethics Board at the Bruyère Health - Élisabeth Bruyère Hospital (REB Number: M16-22-056), Research Ethics Board at Centre integre universitaire de sante et de services sociaux (MP-13-2020-1947; Québec City), Research Ethics Board at Centre integre universitaire de sante et de services sociaux de l'Estrie - Centre hospitalier universitaire de Sherbrooke (MEO-13-2022-458), and a harmonized application through the University of British Columbia Research Ethics Board (H22-01081) for all remaining sites. All participants provided online, written informed consent prior to participation.

Participants and Recruitment Procedures

Eligible participants were physical therapists or rehabilitation assistants who received training for the WnW protocol and had >2 weeks of experience delivering the WnW protocol to at least one patient during the WnW trial (Clinicaltrials.gov: NCT04238260). In Canada, rehabilitation assistants are non-licensed staff that require supervision by a licensed health professional to practice. The required qualifications of rehabilitation assistants in Canada vary across provinces and regions, but typically consists of accredited and certified diploma training programs specifically for rehabilitation assistant roles that extend 16 to 24 months.[21] Given that the aim of the WnW trial was to implement the WnW protocol as part of usual care, all front-line physical therapists and rehabilitation assistants received the training. Newly onboarded therapy staff also received training via online video recordings and print materials. Given the stepped-wedge study design, study sites participated in delivering the

WnW protocol for 4, 8, 12, or 16-months. Potential participants were identified by local study coordinators and invited by email at least 3 months after each site started the delivery of the WnW protocol, with up to 3 follow-up reminders. The survey was completed using a university-secured online platform (Qualtrics International Inc., Provo, Utah, USA). All study sites were invited to the study (10 English- and 2 French-speaking sites). After submitting the survey, participants were not able to change their answers. An honorarium was provided to compensate for participation time.

The Walk ‘n Watch Trial and Intervention Protocol

The WnW trial protocol has been previously described.[15] Briefly, the WnW trial is a multisite, stepped-wedge, cluster randomized controlled trial including 12 sites across 7 Canadian provinces. A broad study inclusion criterion of participants with stroke was included to reflect real-world stroke rehabilitation caseloads: adults with a confirmed stroke within 12 weeks of rehabilitation admission with walking therapy goals; medically stable (example, stable cardiovascular health); able to walk 5 steps with a maximum of one-person assisting; and able to follow instructions. Consented participants completed assessments at (T1) baseline, (T2) discharge or 4-weeks after baseline (whichever came first), and (T3) 12-months poststroke. The primary outcome was change in 6-Minute Walk Test distance from T1 to T2. Therapists screened and utilized the WnW protocol on any eligible patient admitted to the rehabilitation units as part of usual care, even if they did not consent to the research study outcome measure assessments.

The WnW protocol is a structured intervention focused on completing a minimum of 30 minutes of weight-bearing, walking-related activities with step count and heart rate progressions throughout admission. The structured step count target progressions were individualized based on baseline 6-Minute Walk Test distance (see Table 1[15]), derived from

the DOSE trial.[6,22] The heart rate target was to progress towards a mean 40% to 60% HRR during the session. Commercially available step counters placed on the ankle (Fitbit Inspire**,** version 1 and 2, Alphabet Inc., Mountain View, California, USA) and heart rate monitors on the non-paretic wrist (Garmin Forerunner, version 235 and 735XT, Garmin Ltd., Olathe, Kansas, USA) were provided to track therapy progression. During the implementation phase, the intended frequency of the WnW protocol was 5 days per week (ie, consistent with usual care). Therapy staff received an online 4-hour training workshop, including evidence-based theory, opportunities to practice using the protocol and devices, and provision of print and online resources. To ensure protocol sustainability, training workshops were recorded and used to train new staff or as content review for trained staff. On-going therapy staff meetings were facilitated by local site study coordinators and staff leadership to discuss barriers and facilitators of the WnW protocol.

Site Characteristics of Usual Care (or Therapy)

As part of the implementation evaluation, to provide contextual details regarding the local implementation site settings, characteristics of usual care were described for each site, including the usual, planned amount of time allocated to each physical therapist session and number of therapist sessions per week per patient.

Survey Content Development

The research team developed the survey based on a previously validated survey exploring therapists' experience using a physical therapist intervention during stroke rehabilitation.[23] Multiple iterations of reviews and revisions were involved in the content development with input from a multidisciplinary (ie, physical therapy, exercise physiology, and physical medicine specialists) panel of clinicians, scientists, and one patient receiving stroke

rehabilitation. To ensure valid responses from French-speaking participants, a French version of the survey was translated under the direction of our French-speaking research team member (K.B.). The final survey consisted of 33 questions organized in 6 sections regarding implementation factors of the WnW protocol: (1) patient-level factors (example, patient eligibility), (2) practical experience and opinions about the current and future use of the protocol (example, knowledge of evidence, device usage, number of patients treated with WnW), (3) workplace structure and supports, (4) the heart rate and step targets, (5) the training for the protocol, and (6) participant demographics. The survey included close-ended questions, such as 5-point Likert agreement scale questions (ie, "Strongly agree" to "Strongly disagree"), and open-ended questions (example, what prevented or hindered your own use of the WnW protocol?). Participant demographic questions included age, gender, profession, education, and years of clinical experience. See Supplementary Materials for the full survey.

Data Checking and Analysis

The data were reviewed for completeness and unique responses (ie, IP address check). The French survey responses were translated to English under the direction of our French-speaking research team member (K.B.). Closed-ended responses and characteristics of usual care therapy and participant demographic data were summarized as frequencies, means and standard deviations, where applicable, using Microsoft 365 Excel (Microsoft Corporation, Redmond, WA, USA). Open-ended responses were analyzed thematically using NVivo 14 (Lumivero, Denver, CO, USA). The updated Consolidated Framework for Implementation Research (CFIR)[24] and CFIR Outcome Addendum[25] were used for deductive response coding to provide a comprehensive set of constructs to identify barriers and facilitators associated with effective implementation of interventions in health care settings. Coding was completed by three authors (S.H.H, S.A., and L.C.). Four participant surveys were initially coded

together to establish a shared understanding of the data and coding framework. The remaining surveys were coded independently. Data from the most relevant closed- and open-ended responses were converged and categorized under 4 CFIR domains: Inner Setting, Innovation Characteristics, Individual Characteristics, and Implementation Outcome. The final codes and themes were discussed (S.H.H., S.A., and L.C.), and any discrepancies were resolved by consensus.

Role of the Funding Source

The funders played no role in the design, conduct, or reporting of this study.

Results

Eighty-five therapy staff from all sites (mean 7.1 [3.4] per site] were eligible and invited to participate. Of the 85 invited, 47 (55% response rate) completed the survey (see Table 2 for participant characteristics). Except for 1 site, at least 2 therapy staff from each site participated in the survey. Usual care for therapy characteristics varied widely between sites. Among all sites, therapy session times ranged between 30 to 60 minutes, and, for most sites, each patient received 4 to 6 therapy sessions per week (2 sites provided 30-minute sessions twice daily). There were no missing data from the closed-ended questions. Participants treated a mean 5.5 patients with the WnW protocol. Four participants reported treating patients without stroke using the protocol (ie, did not consent to the study assessments), including people with Parkinson's disease, spinal cord injury, multiple sclerosis, and older patients in general.

To describe the results, we expressed Likert-scale "Strongly agree" and "Somewhat agree" responses as "agreed" and used simplified terms to accompany the CFIR domains and subdomains to aid interpretation of results, where applicable. The collapsed survey responses can be found in Supplementary Tables 1 and 2.

Organizational Context (CFIR Inner Setting domain)

Work Infrastructure

Approximately one-third of staff agreed that they had sufficient time to deliver the WnW protocol (36%). Therapy staff felt it was difficult to meet the step count targets during session times: "The biggest hinderance is time because our physical therapy time slots are 30 minutes long..." (Participant ID 26, Physical therapist)

Therapy staff reported that sufficient staffing would facilitate the delivery of the protocol: "There needs to be enough staff to allow for a minimum of 45 minutes per therapy session to have a full 30 mins of walking/stepping time…set up watches, bracing, walking aides and tracking steps/session." (Participant ID 30, Physical therapist)

The time constraint was also related to including other therapy goals: "The time the protocol takes does not leave much time for other important goals, such as family education, transfers, bed mobility, upper extremity activation…" (Participant ID 16, Physical therapist)

Furthermore, the 30-minute time and 5 weekly sessions for the protocol competed with discharge planning: "The week leading up to a patient's discharge date their sessions are taken up with reassessments and education. Fitting in a 30 min walk n watch session isn't possible in the time frame that we have with patients on the last few days leading up to their discharge date." (Participant ID 39, Physical therapist)

Access to Knowledge and Information

Most therapy staff agreed they were supported by managers (78%) and knew where to seek help (94%) for implementation, and that the protocol training was sufficient and helpful (96%). In addition to the print materials (n = 9; example, manuals) and online resources (n = 23; example, online videos), the therapy staff found it most helpful to practice using the device (n = 18; heart rate monitors and step counters) and reviewing therapy activities aimed to increase step count and heart rate (n = 8).

Materials and Equipment

Most therapy staff agreed they could confidently use the Fitbit to count steps (87%) and the Garmin devices to record and monitor heart rate (82%). Therapy staff appreciated the feedback and ability to monitor patient progress and goals in real-time: "I enjoy the use of technology of the watch and Fitbit, as it allows the client to have visible data every session. Which allows the client to easily set up personal goals for themselves." (Participant ID 33, Rehabilitation assistant)

However, only about half agreed that they would use the devices in their future practice (49% step counter and 64% heart rate monitors). The therapy staff were concerned with the accuracy of both devices (n = 14). Specifically for the step counters, perceived accuracy was particularly an issue for patients with slower gait speeds or atypical gait patterns.

Characteristics of the WnW Protocol (CFIR Innovation Characteristics domain)

Design of the WnW Protocol

Most therapy staff agreed they safely and successfully delivered the protocol (87%) and found the step and heart rate targets helpful for their clinical practice (72%). When asked

which form of measurements were used most frequently to monitor therapy, step targets were the most frequently used (40%), followed by time spent delivering the protocol (34%), heart rate (21%), then rate of perceived exertion (4%). Some therapists reported that the targets provided clear therapy goals and motivation: “I think it is a helpful protocol that is easy to administer for the most part and it gives good feedback to the patients and a good goal for them to work towards each week.” (Participant ID 26, Physical therapist)

While the goals were clear, many therapists found that the targets were unrealistic and unachievable with only 26% and 47% agreeing that they achieved the step and heart rate targets, respectively: “The number of steps is unattainable and demotivating for the caregiver and the patient, because it is a goal impossible to reach.” (Participant ID 41, Physical therapist)

Another therapist reported that patients with lower function levels had the most difficulty attaining the step targets: “Patients with more severe conditions were disappointed they did not reach the targets, which are in my opinion unrealistic for them, so I stopped telling them their step count.” (Participant ID 47, Physical therapist)

This was mentioned similarly for the heart rate targets: “Due to the frequent low level of function these patients have (even though they fit the criteria), it was often hard to increase their heart rate enough to the intended level…” (Participant ID 3, Physical therapist)

Complexity and Adaptability

Some therapists commented on the simplicity of the WnW protocol, in both a positive and negative perspective. For the positive perspectives, some therapists felt it was easy to incorporate into their practice: “Overall, I enjoy the simplicity of the protocol and the ease with which it can be implemented/administered.” (Participant ID 8, Physical therapist)

For negative perspectives, some therapists felt it was too focused on walking and was not adaptable to the variety of patient needs: “Misses a lot of aspect of stroke rehab. Not just ambulation is affected and when time is constrained it is not possible to just focus on high volume steps. Every individual is different and I do not believe a broad brush approach works such as high volume high intensity.” (Participant ID 1, Physical therapist)

Individual Characteristics

Knowledge of Therapists (CFIR Innovation Deliverers: Psychological Capability subdomain)

Most therapy staff agreed they were familiar with the current state of the evidence (94%). Some therapy staff believed that the evidence for the protocol added confidence to incorporate it into their practice: “The fact that it is based on data and ongoing research gives me confidence that this protocol can be beneficial to patients.” (Participant ID 18, Physical therapist)

Most therapy staff agreed they found it easy to determine patient eligibility for the WnW protocol (96%). However, therapy staff felt that the WnW protocol was more appropriate for patients with higher functioning levels: “Patients with good motor return enjoyed the challenge of increasing gait speed and staying within protocol parameters. [Patients] with fatiguability and poor motor control often felt frustrated with push to increase step number.” (Participant ID 10, Physical therapist)

Other patient-level factors included motivation to participate (n = 10), cognitive impairment (n = 8) making it challenging to follow instructions, and co-morbidities (n = 4) that may make increasing heart rate challenging or unsafe, such as cardiovascular disease.

Therapy staff reported that patients enjoyed the protocol and were motivated by the step and heart rate targets and feedback provided. However, therapist reported that some

patients found it was too repetitive or demotivating when they could not achieve the step targets.

Beliefs of Therapists (CFIR Innovation Deliverers: Reflective Motivation subdomain)

Five physical therapists (13%) reported concerns with movement quality while administering the protocol. One physical therapist reported a perspective that movement quality remains more important than quantity: "I personally feel that the quality of gait is more important than the quantity… which means I will ask them to walk slower and take multiple rests to focus on quality which results in less steps and a lower heart rate." (Participant ID 3, Physical therapist)

In contrast, 3 physical therapists mentioned that the WnW protocol contributed to improvements in gait quality: "It has been good in implementing in various conditions, focusing on the quantity as well as quality." (Participant ID 18, Physical therapist)

Of note, no rehabilitation assistant commented on movement quality concerns.

Sustainability (CFIR Implementation Outcome – Sustainment domain)

Most therapy staff agreed that they will use the WnW protocol in their future practice (87%). One therapist reported that they applied WnW related concepts and skills to their daily practice: "I learned things I now apply daily - interval increase of walking speed, decrease of pauses, active pauses, have more walking or specialized walks intervention..." (Participant ID 42, Physical therapist)

Leadership was identified as an essential factor to supporting future practice: "Leadership needs to continue to support it and have it be part of orientation..." (Participant ID 20, Physical therapist)

Discussion

In this study, most therapy staff reported that they were able to identify appropriate patients and perceived successfully delivering the protocol. Key facilitators to delivering intensive rehabilitation were the structured step and heart rate targets and confidence operating the provided wearable devices to monitor these targets. Major barriers were insufficient time during therapy sessions (ie, during the allocated therapy appointment times), inability to meet the step and heart rate targets, and the accuracy of the provided step counter and heart rate monitors. Concerns about the quality of movement were also barrier for some therapy staff.

One previous, smaller study (n = 10 physical therapists) evaluated the experience of implementing intensive rehabilitation in usual care at two inpatient hospitals in Oslo, Norway.[17] They identified similar barriers that included beliefs and knowledge about high intensity training, available equipment (including heart rate monitors), the culture of delivering many interventions within a single treatment session, time management and workflow. However, this study's intensive rehabilitation protocol aimed for high intensity training (70-85% of predicted heart rate maximum) and it is unclear if therapists were involved with screening patients.[12,17] Therefore, the current study findings are more applicable to a variety of inpatient rehabilitation settings, especially within public health systems like Canada.

Insufficient time has been a previously reported barrier to implementing intensive rehabilitation, particularly related to the added time needed for equipment set-up (example, body weight supported treadmills) and prioritizing time for other treatment interventions, such as upper limb rehabilitation.[13,17] In addition to these, this study revealed novel time-related facilitators and barriers within real-world inpatient rehabilitation settings. The proposed time spent delivering the WnW protocol (>30-minute sessions, 5 sessions/week)

often competed with discharge planning goals, which prioritizes functional independence (ie, physical assistance requirements) rather than walking endurance. Discharge planning considerations were not specified in the WnW protocol, and future interventions should include guidelines for transitioning from intensive rehabilitation to discharge planning (example, minimum 6-Minute Walk Test distance achieved before discharge). While the WnW protocol recommends spending the remaining therapy time on other interventions after the 30-minute protocol for 5 days, therapy staff reported that this remaining time was insufficient.

Future intensive rehabilitation trials should test whether interventions prescribing fewer sessions (example, 3 sessions/week) to allow time for other therapy goals would achieve similar walking recovery benefits. Study participants also identified that support staff would be helpful to assist with the logistical elements, such as wearable device set-up and documenting therapy targets. Inpatient rehabilitation units may consider assigning specific staff to assist with these tasks or streamline these processes. In addition, system-level changes, such as increasing therapy time or staffing, may be needed to facilitate therapy staff to uptake best-practice, intensive rehabilitation as usual care.

Most therapy staff reported that patients were not able to meet the WnW protocol step and heart rate targets. While therapy staff reported that this was related to the lack of time, many also perceived that the targets themselves were unrealistic and not achievable, especially for step counts. Furthermore, therapy staff suggested that intensive rehabilitation may be more appropriate to commence when people are higher functioning and more able to participate in therapy to meet the targets. However, the WnW protocol targets were informed by the intervention delivered in the initial DOSE trial[22], which included patients with low function and demonstrated high intervention fidelity.[6] One key difference from the WnW trial may be that the DOSE intervention sessions systematically replaced usual 60-minute therapy

sessions (with the exception of one site with 45 minutes) as part of the study requirements. The WnW trial tested the protocol in real-world settings and did not have strict mandates to replace therapy sessions. Therapy appointment times varied between sites, from 30 to 60 minutes per session, which may explain why the therapy staff perceived the step count targets to be unachievable. Further analyses of the WnW trial fidelity data[15] may improve our understanding of factors associated with step count fidelity and inform strategies for increasing step counts in real-world inpatient rehabilitation settings.

Providing wearable technology to track step counts and heart rate was identified as a facilitator for implementing intensive rehabilitation, similar to previous results.[13] While the provided devices were helpful, about half of the therapy staff were hesitant about future use of the devices likely due to their perception of accuracy issues, especially for patients with lower functioning levels. We previously showed that the Fitbit placed on the ankle was valid to measure steps in patients with stroke in inpatient rehabilitation settings when compared to research-grade ankle-based step counters (StepWatch Activity Monitors; Modus Health, Edmonds, WA, USA).[26] In this validation study, the mean error was largest among participants with slower gait speeds (10.9% mean error at <0.4m/s), and was lowest at faster gait speeds (4.4% at >0.8m/s).[26] Therefore, therapy staff can expect the devices to improve in accuracy as patient function improves throughout rehabilitation, and that the expected errors are smaller compared to the step count progressions.[26] The Garmin Forerunner heart rate devices uses photoplethysmography (PPG) technology, where accuracy of heart rate measurements may be affected by motion artifact and other factors, including variations in contact pressure, increasing exercise intensities, and skin tone.[27–32] The validity of the Garmin Forerunner 235 has been tested in adults who are healthy against electrocardiogram, with relatively small mean errors of 4.8 beats per minute (bpm) for activities without arm movements (example, biking), but larger mean errors upwards of 14.8 bpm for activities

involving arm movements (example, elliptical).[33] Walking-related activities for stroke rehabilitation often involve some arm movements, which may contribute to larger errors. Despite these accuracy issues, the Garmin Forerunner devices were pragmatically selected for the WnW trial for its relative affordability (~$200 each), commercial availability, and convenience to use during physical therapist sessions, making it a realistic option for inpatient rehabilitation settings. The balance between device cost and accuracy should be considered for future studies. Wireless single ECG chest patches that are not dependent on PPG technology are an evolving technology that may provide more accurate heart rate measurements for clinical populations in the future.[34]

The conflict between movement quality versus quantity is a well-known potential barrier to implementing intensive rehabilitation reported in previous studies,[13,35] and was a concern among a minority of physical therapists (13%) who implemented the WnW protocol in real-world settings within this study. The WnW protocol is a task-specific therapy approach, and the training workshop promoted high repetitions of weight-bearing stepping activities, while considering normal biomechanics, safety and pain levels of patients. Recent systematic review evidence (22 randomized trials, n = 1192) concluded that quality-focused therapy approaches, such as neurodevelopmental technique (NDT) and Bobath Concept, can be inferior to task-specific therapy for improving lower limb function.[36] While therapy staff reported awareness of the current evidence, some physical therapists continue to cite conflict between movement quality over quantity and reducing intensity in some instances. No rehabilitation assistants (n = 9) reported movement quality concerns, likely because this profession does not typically attend professional development courses such as NDT/Bobath Concept. However, given that only a minority of physical therapists reported this concern, this may indicate a shift in beliefs about rehabilitation approaches and knowledge about the current evidence. In fact, the recent 2023 stroke rehabilitation clinical guidelines from the

United Kingdom and Ireland have recommended therapy approaches other than Bobath Concept.[37] While the recent 2019 Canadian guidelines recommend task-specific therapy, it does not provide any specific guidelines regarding Bobath Concept or NDT.[1] Further investigation may be needed to understand the preference for prioritizing movement quality during therapy to inform strategies to facilitate uptake of intensive rehabilitation alongside movement quality preferences.

Strengths and Limitations

A key study strength is the inclusion of participants across a variety of clinical experience levels (0.5 to 34 years working with stroke) from 12 real-world inpatient rehabilitation units, including both physical therapists and rehabilitation assistants. The current study has several limitations. The survey was self-administered and self-reported, which potentially introduces self-selection bias. Participants with strong opinions and personal interest in walking recovery or intensive rehabilitation may be over-represented, while those who were indifferent to the topic may be under-represented. Social desirability bias may also be present. Participants may have responded to appear more socially acceptable, and, therefore, be less reflective of their true opinions. However, to reduce response bias and increase opportunity for truthful responses, the survey was emphasized as anonymously administered and analyzed. The survey developed for the current study is not validated for the current study purpose, and, therefore, may have influenced the response validity and reliability. Compared to surveys, qualitative interviews or focus groups may provide further detail and depth on the experiences of delivering the WnW protocol.

Conclusions

Therapy staff reported successfully screening patients and delivering the WnW protocol during usual care and would use the protocol in their future practice. The structured step count and heart rate targets were perceived as useful to progress therapy. Novel time-related barriers to implementing intensive rehabilitation in real-world conditions included difficulty accommodating the 30-minute protocol and step targets within therapy appointment times and throughout the patient's admission whilst prioritizing competing therapies and discharge planning. Discharge planning considerations within intensive rehabilitation interventions and attaining more accurate step count and heart rate monitoring devices may facilitate implementation. System-level policy changes that enable more time or staffing to deliver intensive rehabilitation may also be required.

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CRediT – Contributor Roles

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Clinical Trial Registration

The original trial was registered on ClinicalTrials.gov: NCT04238260

Disclosures and Presentations

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest.

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Data Availability

Select data that support the findings of this study are openly available in the Borealis

Dataverse at https://borealisdata·ca/dataverse/eng

References

1. Teasell R, Salbach NM, Foley N, et al. Canadian Stroke Best Practice Recommendations: Rehabilitation, Recovery, and Community Participation following Stroke. Part One: Rehabilitation and Recovery Following Stroke; 6th Edition Update 2019. *Int J Stroke*. 2020;15(7):763-788.

2. Winstein CJ, Stein J, Arena R, et al. Guidelines for Adult Stroke Rehabilitation and Recovery. *Stroke*. 2016;47(6):e98-e169.

3. Hornby TG, Reisman DS, Ward IG, et al. Clinical Practice Guideline to Improve Locomotor Function Following Chronic Stroke, Incomplete Spinal Cord Injury, and Brain Injury. *J Neurol Phys Ther*. 2020;44(1):49.

4. Moore JL, Roth EJ, Killian C, Hornby TG. Locomotor Training Improves Daily Stepping Activity and Gait Efficiency in Individuals Poststroke Who Have Reached a "Plateau" in Recovery. *Stroke*. 2010;41(1):129-135.

5. Holleran CL, Straube DD, Kinnaird CR, Leddy AL, Hornby TG. Feasibility and potential efficacy of high intensity stepping training in variable contexts in subacute and chronic stroke. *Neurorehabil Neural Repair*. 2014;28(7):643-651.

6. Klassen TD, Dukelow SP, Bayley MT, et al. Higher Doses Improve Walking Recovery During Stroke Inpatient Rehabilitation. *Stroke*. 2020;51(9):2639-2648.

7. Bernhardt J, Hayward KS, Kwakkel G, et al. Agreed definitions and a shared vision for new standards in stroke recovery research: The Stroke Recovery and Rehabilitation Roundtable taskforce. *Int J Stroke*. 2017;12(5):444-450.

8. Kleim JA, Jones TA. Principles of Experience-Dependent Neural Plasticity: Implications for Rehabilitation After Brain Damage. *J Speech Lang Hear Res*. 2008;51(1).

9. De Las Heras B, Rodrigues L, Cristini J, et al. Measuring Neuroplasticity in Response to Cardiovascular Exercise in People With Stroke: A Critical Perspective. *Neurorehabil Neural Repair*. 2024;38(4):303-321.

10. Rand D, Eng JJ. Disparity between functional recovery and daily use of the upper and lower extremities during subacute stroke rehabilitation. *Neurorehabil Neural Repair*. 2012;26(1):76-84.

11. Lang CE, Macdonald JR, Reisman DS, et al. Observation of amounts of movement practice provided during stroke rehabilitation. *Arch Phys Med Rehabil*. 2009;90(10):1692-1698.

12. Moore JL, Nordvik JE, Erichsen A, et al. Implementation of High-Intensity Stepping Training During Inpatient Stroke Rehabilitation Improves Functional Outcomes. *Stroke*. 2020;51(2):563-570.

13. Connell LA, Klassen TK, Janssen J, Thetford C, Eng JJ. Delivering Intensive Rehabilitation in Stroke: Factors Influencing Implementation. *Phys Ther*. 2018;98(4):243-250.

14. Gaskins NJ, Bray E, Hill JE, Doherty PJ, Harrison A, Connell LA. Factors influencing implementation of aerobic exercise after stroke: a systematic review. *Disabil Rehabil*. 2021;43(17):2382-2396.

15. Peters S, Lim SB, Bayley MT, et al. Implementation of increased physical therapy intensity for improving walking after stroke: Walk 'n watch protocol for a multisite stepped-wedge cluster-randomized controlled trial. *Int J Stroke*. 2023;18(1):117-122.

16. Peters S, Hung S, Bayley M, et al. Safety and effectiveness of the Walk 'n Watch structured, progressive exercise protocol for inpatient stroke rehabilitation: a phase 3, multi-site, pragmatic, stepped-wedge, cluster-randomised controlled trial. *Lancet Neurol*.:in press.

17. Moore JL, Bø E, Erichsen A, et al. Development and Results of an Implementation Plan for High-Intensity Gait Training. *J Neurol Phys Ther*. 2021;45(4):282-291.

18. Biggs J. The Impact of Level of Physical Therapist Assistant Involvement on Patient Outcomes Following Stroke. *Phys Ther*. 2020;100(12):2165-2173.

19. Sharma A, Minh Duc NT, Luu Lam Thang T, et al. A Consensus-Based Checklist for Reporting of Survey Studies (CROSS). *J Gen Intern Med*. 2021;36(10):3179-3187.

20. Eysenbach G. Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). *J Med Internet Res*. 2004;6(3):e34.

21. Penner JD, Snively A, Packham TL, Henderson J, Principi E, Malstrom B. Viewpoints of the Occupational Therapist Assistant–Physiotherapist Assistant Role on Inter-Professional Teams: A Mixed-Methods Study. *Physiother Can*. 72(4):394-405.

22. Peters S, Klassen T, Schneeberg A, et al. Step Number and Aerobic Minute Exercise Prescription and Progression in Stroke: A Roadmap. *Neurorehabil Neural Repair*. 2022;36(2):97-102.

23. Auchstaetter N, Luc J, Lukye S, et al. Physical Therapists' Use of Functional Electrical Stimulation for Clients With Stroke: Frequency, Barriers, and Facilitators. *Phys Ther*. 2016;96(7):995-1005.

24. Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated Consolidated Framework for Implementation Research based on user feedback. *Implement Sci*. 2022;17(1):75.

25. Damschroder LJ, Reardon CM, Opra Widerquist MA, Lowery J. Conceptualizing outcomes for use with the Consolidated Framework for Implementation Research (CFIR): the CFIR Outcomes Addendum. *Implement Sci*. 2022;17:7.

26. Klassen TD, Semrau JA, Dukelow SP, Bayley MT, Hill MD, Eng JJ. Consumer-Based Physical Activity Monitor as a Practical Way to Measure Walking Intensity During Inpatient Stroke Rehabilitation. *Stroke*. 2017;48(9):2614-2617.

27. Jo E, Lewis K, Directo D, Kim MJ, Dolezal BA. Validation of Biofeedback Wearables for Photoplethysmographic Heart Rate Tracking. *J Sports Sci Med*. 2016;15(3):540-547.

28. Horton JF, Stergiou P, Fung TS, Katz L. Comparison of Polar M600 Optical Heart Rate and ECG Heart Rate during Exercise. *Med Sci Sports Exerc*. 2017;49(12):2600.

29. Scardulla F, D'Acquisto L, Colombarini R, Hu S, Pasta S, Bellavia D. A Study on the Effect of Contact Pressure during Physical Activity on Photoplethysmographic Heart Rate Measurements. *Sensors*. 2020;20(18):5052.

30. Temko A. Accurate Heart Rate Monitoring During Physical Exercises Using PPG. *IEEE Trans Biomed Eng*. 2017;64(9):2016-2024.

31. Orini M, Guvensen G, Clare Jamieson A, Chaturvedi N, D. Hughes A. Movement, sweating, and contact pressure as sources of heart rate inaccuracy in wearable devices. *Comput Cardiol*. 2022;49:1-4.

32. Koerber D, Khan S, Shamsheri T, Kirubarajan A, Mehta S. Accuracy of Heart Rate Measurement with Wrist-Worn Wearable Devices in Various Skin Tones: a Systematic Review. *J Racial Ethn Health Disparities*. Published online November 14, 2022:1-9.

33. Gillinov S, Etiwy M, Wang R, et al. Variable Accuracy of Wearable Heart Rate Monitors during Aerobic Exercise. *Med Sci Sports Exerc*. 2017;49(8):1697-1703.

34. Lee MA, Song M, Bessette H, Roberts Davis M, Tyner TE, Reid A. Use of wearables for monitoring cardiometabolic health: A systematic review. *Int J Med Inform*. 2023;179:105218.

35. Eng JJ, Tang PF. Gait training strategies to optimize walking ability in people with stroke: A synthesis of the evidence. *Expert Rev Neurother*. 2007;7(10):1417-1436.

36. Scrivener K, Dorsch S, McCluskey A, et al. Bobath therapy is inferior to task-specific training and not superior to other interventions in improving lower limb activities after stroke: a systematic review. *J Physiother*. 2020;66(4):225-235.

37. Crow J, Smith A. National Clinical Guideline for Stroke for the United Kingdom and Ireland: Part I – An overview of the updated recommendations. *Br J Occup Ther*. 2023;86(10):661-664.

Tables

Table 1. Step Count Progression of the Walk ‘n Watch Protocol

6-Minute Walk Test Distance at Baseline	Step Targets, Number of Steps per Physical Therapist Session		
	Week 1	Week 2	Week 4
Less than 100m	1000	1500	2000
100 to 200 m	2000	2500	3000
More than 200 m	3000	3500	4000

Table 2. Participant Characteristics

Participant Characteristics	N = 47
Age category, y, n (%)	
20-29	12 (25%)
30-39	14 (30%)
40-49	16 (34%)
50-59	4 (9%)
60+	1 (2%)
Gender, n (%)	
Men	7 (15%)
Women	40 (85%)
Transgender, Nonbinary, or Two-Spirit	0 (0%)
Highest educational degree or diploma obtained, n (%)	
Bachelor's degree	16 (34%)
Master's degree	22 (47%)

Doctoral/PhD degree	1 (2%)
Post-secondary diploma	8 (17%)
Job titles, n (%)	
Physical therapist	38 (81%)
Rehabilitation assistants	9 (19%)
Number of patients treated with the Walk ‘n Watch Protocol, mean (SD), min-max	5.5 (3.9), 1 to 20
Years of experience as health professional, mean (SD), min-max	13.4 (10.0), 1 to 39
Years of experience working with patients with stroke, mean (SD), min-max	9.0 (8.6), 0.5 to 34