



Original Research

Integrating Technology Into Clinical Practice for the Assessment of Balance and Mobility: Perspectives of Exercise Professionals Practicing in Retirement and Long-term Care



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KEYWORDS

Gait;
Long-term care;
Mobility limitation;
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Technology assessment,
biomedical

Abstract Objective: To explore exercise professionals' perspectives on technology integration for balance and mobility assessment practices in retirement and long-term care.

Setting: A private residential care organization in Ontario, Canada, with 18 sites providing accommodation and services for older adults.

Design: A qualitative descriptive approach was used including semistructured focus group interviews. Open-ended questions explored perceptions of technology integration along with factors influencing its adoption. Analysis involved preliminary coding based on research questions, review and discussion of emerging themes, and final, resultant coding for each category.

List of abbreviations: LTC, long-term care

Disclosures: none.

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Participants: Exercise professionals (kinesiologists and exercise therapists) (N = 18).

Interventions: Not applicable.

Main Outcome Measures: Not applicable.

Results: All participants felt that technology could enhance their practice by supporting programming, communication, and/or information management. Potential barriers to technology integration related primarily to the need to accommodate the broad range of complex health conditions present among clients, which would impact (1) their ability to engage with the technology and (2) relevance of technology-derived outcomes. Specific concerns related to individuals with significant cognitive and/or functional impairment. Solutions to these barriers emphasized the need for flexible technology and appropriate normative data to maximize the potential for uptake.

Conclusions: The participating exercise professionals working in a retirement and long-term care setting saw technology as a potentially effective addition to current clinical practice. To increase the likelihood for clinical uptake, technology must be maximize flexibility in order to accommodate a wide range of physical and cognitive abilities and meet specific needs related to setting and job responsibilities. The findings emphasize the need for continuous dialogue between technology producers and end users for successful development and implementation.

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The population is aging, and increasing numbers of individuals are living with complex health conditions affecting functional ability, independence, and quality of life. Studies report that 20%-50% of older adults experience balance and/or mobility impairment that negatively affects their fall risk and other health-related outcomes.^{1,2} Fall-related injuries among individuals 65 years or older are a significant burden to the health care system, accounting for 80% of injury hospitalizations among older adults in Canada³ and costing the Canadian economy \$2 billion per year.⁴ To reduce this burden, we need to account for the complex and heterogeneous changes in function that occur with age. Advancing balance and mobility assessment in a way that allows clinicians to develop targeted treatment strategies is an important step toward addressing this need.

Comprehensive evaluation of balance control and mobility is a recommended component of rehabilitation best practice.⁵ Current balance and mobility assessment practice principally relies on standardized tools such as the Berg Balance Scale⁶ or the timed Up and Go test.⁷ Despite the reliability, validity, and practicality of many of these tests, they rely to some extent on individual expertise and are limited both by lack of sensitivity to detect subtle changes in function⁸⁻¹¹ and by an inability to determine underlying causes of impairment.^{12,13} Technologies such as body-worn sensors capture more objective and sensitive measures of balance and gait (eg, changes in dynamic stability) and have been proposed to address the shortcomings of existing standardized tools.^{11,14,15} However, little evidence is available on technology uptake in practice settings.¹⁶⁻¹⁹

Recent studies have demonstrated the validity and reliability of specific technologies for characterizing how and why balance or gait performance is impaired.^{11,14,15} Evidence demonstrates the ability for technology to successfully detect age- and disease-related differences in balance control and gait patterns,²⁰⁻²² capture transient events related to postural instability,^{23,24} chart recovery progress,²⁵ and examine effectiveness of interventions.^{26,27} Few studies,

however, have examined users' views on technology use, which are essential for determining the feasibility, acceptance, and utility of technology integration. A study by Pak et al reported that both patients with stroke and physiotherapists valued the objective information afforded by technology.¹⁷ Therapists, however, had mixed opinions about the data influencing their treatment. They also considered clinical interpretation of the technology-derived data challenging and expressed the need for technical support to use the technology and conduct postprocessing of the data.

Understanding factors that influence uptake of knowledge, systems, or processes is a well-described element of process frameworks in implementation science.²⁸ This study aimed to gather views regarding technology use from clinicians who assess balance and mobility in older adults with complex health conditions as a critical source of information to guide their work. To do so, we consulted exercise professionals who practice in retirement and long-term care (LTC) settings. These clinicians focus on improving function, promoting physical activity, and preventing or managing injury, disease, and disability²⁹ and are largely responsible for both the routine assessment of balance and mobility and the daily provision of mobility-related care to residents within the study setting. The objectives of this study were to (1) understand exercise professionals' views regarding the integration of technology and the use of technology-derived data for balance and mobility assessment and (2) identify barriers and solutions to integrating technology into balance and mobility assessment practices for older adults in a residential care setting.

Methods

Study design

A qualitative descriptive study design was used.³⁰ This naturalistic approach is considered valuable for

understanding a phenomenon from the perspectives of the individuals involved.^{31,32} It has been noted for producing practical answers to real-world questions of particular relevance to practitioners and policy makers³⁰ and has been used previously in clinical and implementation research (eg, Sullivan-Bolyai et al³³).

Setting

The study was conducted within a private residential care organization in Ontario, Canada. The organization provides accommodation and services for 1500 retirement care and 2500 LTC residents across 18 sites. At each site, exercise professionals work collaboratively with physical and occupational therapists and are responsible for routinely assessing balance and mobility to inform exercise prescription, mobility aid prescription, transfer needs assessment, and daily activity.

Participants

All exercise professionals employed by the organization (n=21) were invited to participate in the study via e-mail. Invitations included an explicit statement that participants would not be paid and that a decision to decline involvement would have no effect on their employment. Participants (N=18) reflected a range of years' experience working with older adults both within and outside of a residential care setting. The University of Waterloo Ethics Review Board approved the study, and all participants provided written informed consent.

Data collection and analysis

Two focus group interviews were scheduled during a regular quarterly team meeting to facilitate participation with minimal disruption to clinical care and were considered appropriate because the topic was not of a sensitive nature. Interviews were semistructured and lasted approximately 60 minutes; each group included 9 participants with a mix of clinician type (kinesiologist/exercise therapist), setting within the organization (retirement/LTC), and site. Interviews were conducted by 2 nonclinical, research team members (K.V.O. and a research assistant) with backgrounds in kinesiology and expertise in the areas of balance and mobility assessment. Both interviewers were involved in research activities within the provider's facilities and had previously engaged with some of the participants.

To avoid response bias, no specific definition of technology was given prior to or during the interview. Rather, participants were introduced to sample technologies including accelerometers, Nintendo Wii balance boards, and a tablet-based data collection system at the start of the interview session. The technologies were described as relatively low cost and commercially available, and participants were given information about the types of outcomes that could be generated from the data. Specifically, participants were told that the sample technologies could capture measures of standing balance (eg, center-of-pressure displacement while standing), postural transitions (eg, time to regain balance following sit-to-stand),

and walking (eg, step time variability), which could be measured while conducting routine clinical tests such as the repeated sit-to-stand and 10-m walk. The decision to highlight these outcomes was driven by evidence supporting their ability to identify underlying causes of balance impairment, track change in function over time, and predict fall risk,^{34–38} although this was not explicitly stated to participants. No direction regarding potential implementation was given.

An interview guide composed of open-ended questions and probes was used (supplemental appendix S1, available online only at <http://www.archives-pmr.org/>). The questions were reviewed for clarity with nonparticipant clinician-researchers prior to the meeting. Interviews were digitally recorded and transcribed verbatim using a commercial service. A member of the research team (K.V.O.) reviewed transcripts prior to data analysis.

Using the objectives as broad categories, 2 research team members (K.V.O., K.M.S.) read, reread and open-coded the transcripts and then met to develop a coding schema. K.V.O. reread and open-coded the transcripts using the coding schema and collated the transcripts into themes using NVivo 10 software.^a Throughout data analysis, K.V.O. and K.M.S. discussed and refined codes and themes for each category until agreement was reached. Credibility was established by maintaining an audit trail of discussions and decisions made throughout data collection and analysis. Trustworthiness of the data was enhanced through investigator triangulation to establish emerging themes, member checking, and the use of extensive participant quotes. Member checking involved purposively selecting 2 participants to represent different organizational roles, sexes, site, and experience, having them review preliminary thematic summaries and asking them to provide feedback that was incorporated into the final analysis.

Results

Participants

Eighteen exercise professionals agreed to participate. Participants represented 13 sites within the organization and included 4 exercise professionals working in retirement care, 13 working in LTC and 1 working across settings (Table 1). A majority of the participants had no experience using the provided sample technology. Fifteen participants were female, and the average age was 31±8.4 years. Length of time working with older adults was distributed across 0-3 years (n=8), 4-10 years (n=6), and more than 10 years (n=2). Two participants declined providing details regarding age and experience.

Summary of findings

In general, participants viewed technology integration as complementary to traditional clinical assessment and felt that it could enhance their practice by supporting programming, communication, and information management. Potential barriers to implementation related to the complex and heterogeneous health conditions present among older adults in their practice setting. The need for flexible

Table 1 Participant characteristics (N = 18)*

Characteristic	Descriptive Summary
Practice setting	
Retirement care	4
Long-term care	13
Both	1
Clinical designation	
Registered kinesiologist	12
Exercise therapist	6
Clinical experience, older adults (y)	
Range	1.5-15
Mean \pm SD	5 \pm 4.4
Median	4
Age (y)	
Range	23-50
Mean \pm SD	31 \pm 8.4
Sex (no. female)	15
Sites (no. represented)	13

* One participant declined providing details regarding age and another regarding experience.

technology and appropriate normative data was emphasized to maximize potential for uptake (table 2).

Views on technology integration and use of technology-derived data

Participants generally had positive views regarding technology integration into practice but acknowledged that it would take time to build into their workflow. Two main themes emerged from the interviews: (1) technology needs and considerations specific to practice setting and (2) value of the type or format of technology-derived data. All participants, whether they practiced in retirement or LTC, stressed the need to consider the broad range of physical and cognitive abilities of their clients. Participants who practiced in LTC felt that in many cases, technology-derived data would be more useful for clinicians and families than for their clients, specifically those clients with cognitive impairment who would have limited ability to interpret the feedback. Apart from this, no specific comments were made about the feasibility of technology integration in retirement care vs LTC.

Having objective data for clinical decision making was identified as the key benefit of technology integration. Participants thought that objective, quantitative results would assist with program development and communication about residents' balance and mobility status. Specifically, clinicians discussed the use of data for developing individual treatment plans and group exercise programs (ie, what types of programs to offer and who to refer) and for goal setting based on client abilities. Two participants noted that the small changes captured with technology would be useful for tracking progress and helping to keep residents motivated. Participants also felt there would be value in understanding the population as a whole or based on an area within the center (eg, "memory care" floors for residents with cognitive impairment). Several participants

described how the data could improve mobility aid prescription and transfer-assist recommendations. In particular, they commented that the data would be helpful for communicating with other health care practitioners, residents, and family members who were either unaware of deficits or declines in mobility or did not agree on the required level of assistance. They also described using data more broadly to report on resident status to family members of residents with whom they are less able to communicate, specifically those with cognitive impairment.

Availability of electronic data was also discussed as a benefit of technology integration. Participants identified reduced paperwork, the ability to make inter- and intra-individual comparisons, and the potential to integrate balance and mobility assessment data with other medical information in an electronic medical record as useful for monitoring progress and overall health status.

Barriers and solutions to technology integration

Barriers

Two themes emerged surrounding barriers to technology implementation: (1) feasibility of assessment with respect to resident willingness or ability to complete and (2) availability of appropriate reference data for technology-derived outcomes. Specifically, participants expressed concern about the feasibility of assessment among residents with cognitive impairment because of the need to understand instructions and maintain attention. Many participants felt that the wide range of abilities present among their clients could create challenges for sourcing appropriate normative data and result in output that lacked meaning, and for this reason had concerns about technology's readiness for clinical use in their setting. Many also felt that if clinicians were given only 1 option to administer a *full* assessment, acceptability would be low. One participant commented on the need for staff training in a resource-limited environment as an additional barrier. No clinician-related barriers (lack of skills, lack of interest, etc) were identified.

Solutions

Two themes also emerged related to solutions and facilitators. These included (1) developing technology to include features that maximize workflow and flexibility and (2) targeted assessment elements. Participants considered it important to have a modular assessment approach that would allow users to choose relevant elements of an assessment and/or to complete it in stages. Examples included clients with limited mobility for whom there may be specific interest in transfers and seated balance or instances when a clinician wishes to supplement a routine needs assessment. A suggestion was also made to include an alert feature that reminds clinicians when to conduct an assessment.

Discussion surrounding proposed solutions highlighted the desire to target balance and mobility elements important for people with limited function. Specific requests included measurement of trunk control, sitting and reaching, wheelchair propulsion, posture during transfers, and force exerted by the arms vs legs for sit-to-stand either

Table 2 Summary of findings and representative quotes**General Views on Technology Integration****Summary**

1. Participants perceive technology to have potential value as an adjunct to traditional clinical assessment but acknowledge need for (a) time to integrate into workflow and (b) system flexibility to accommodate individuals' functional and cognitive capacity
2. Technology itself (integration and use) was perceived to be less of a barrier than adapting it to meet their needs.
3. Perceived benefits centered on (a) objective results from multiple functional domains with improved ability to detect change and (b) electronic format.

Representative Quotes

- "I think with anything, always at first it feels like a hindrance but once you get it going and you make a routine of it, you make time for it, it always becomes something that's more efficient for you." (Clinician 1-II)
- "I don't think the technology would be an issue to be integrated, it'd be more how will we adapt it for our kind of residents. Some [residents] are not going to remember the information we're giving them or they're not able to walk so they're going to do all of the tasks in a wheelchair. That would be more of the issue than the actual technology." (Clinician 1-II)
- "I think you could definitely use it [the data] for goal setting and treatment planning and creating really specific goals which are usually more attainable." (Clinician 1-I)

Benefits**Summary**

1. Programming
 - a. Develop individual program and/or treatment plans
 - b. Guide group-based exercise programs
 - c. Help residents to set specific goals and keep them motivated (tracking progress)
 - d. Mobility aid prescription and transfer-assist recommendations
2. Communication
 - a. Data/reports to guide resident, family member or substitute decision maker, and health care team conversations surrounding aid prescription and level of care requirements
3. Electronic data storage
 - a. Reduced paperwork
 - b. Ability to easily make intra- and interindividual comparisons
 - c. Opportunity to integrate with other electronic medical data

Representative Quotes

- "It would give us as clinicians, reference to other people in the [residence] and [the ability to] track their performance. If we have that [data] to put them on a program and then see, a quarter later how they've improved, then we can show the resident that she is actually improving her balance by this much. That's good because a lot of our residents ask "how long is it going to be until I walk?" but they don't see the improvements that they make. [The data] may keep them a little more motivated to keep in the program." (Clinician 2-I)
- "I had one resident whose children were arguing about whether the resident needed a walker or a cane when he was outside [the residence]. Having balance and walking measures using both of the aids would have helped me to give them a recommendation." (Clinician 2-II)
- "If it's something that's on a computer, then you can make charts and graphs. It would make it easier to look back and compare, as opposed to just looking through a previous paper assessment." (Clinician 3-II)

Barriers (B) and Solutions (S)**Summary**

1. (B): Diverse range of abilities, lack of functional or cognitive capacity to perform tasks
(S): Option to "pick and choose" what tasks to perform (modular, "plug and play" technology)
(S): Target functionally relevant tasks, including those important for people with limited function (eg, trunk control, posture during transfers)
2. (B): Lack of meaningful norms because of population heterogeneity
(S): Use acquired data to perform group and/or subgroup analyses
3. (B): Need for training and multiple staff to conduct assessment in an environment where turnover is high
(S): None proposed

Representative Quotes

- "I definitely think there are some residents who just wouldn't be eligible for any tasks." (Clinician 1-II)
- "It'd be tough to get some of my residents [with cognitive impairment] to follow the instructions. Being able to get them onto the Wii boards and then stay there. Some of the people we want to assess, they just can't follow all those instructions." (Clinician 1-I)
- A lot of people who self-transfer, that's when they're falling, right, or it's the first few steps, that's when they're falling. So if we're able to know what it is, is it leaning back too far, then we could put the necessary aids in place. I think in long-term care that would help a lot of people." (Clinician 1-I)
- "You have so many different abilities in LTC and if you're comparing them all to the same thing, then the results aren't really going to make much sense." (Clinician 2-I)
- "Would you need two people? It's very difficult to get a second person [to help with assessments] and a lot of times we have volunteers, it would take a bit to train them and then they don't stick around." (Clinician 4-I)

with the arms of a chair or a transfer pole. The need for functional relevance was also highlighted (eg, seated balance for safe toileting).

Discussion

Evidence suggests that technology-supported balance and mobility assessment can improve measurement of functional capacity and targeted treatment by providing insight into the underlying causes of impairment with greater sensitivity than current methods allow.^{11,14,16} However, little research has been conducted to examine technology uptake in a clinical setting. Results of this study suggest that exercise professionals have positive views about technology use, with some concerns about building technology into their workflow and the capacity to account for the wide range of physical and cognitive abilities present among their clients. Findings raise several important issues that need to be addressed to facilitate technology integration, emphasizing the need for continuous dialogue between technology producers and end users.

None of the participants expressed concerns about the feasibility of using technology, although views may have been influenced by the presence of sample technologies and there was no specific discussion about processes for implementation. The need for flexible technology to meet the needs of clinicians and their clients was most commonly discussed in the context of residents with cognitive impairment for whom practical considerations about technology use was also mentioned as a potential barrier. Given that up to 80% of individuals living in LTC have dementia³⁹ and there is a higher prevalence of falls among those who are cognitively impaired,⁴⁰ this subgroup of older adults should be specifically considered in technology development. Attention to individuals with dementia is consistent with a growing body of literature examining balance and mobility assessment-related issues, such as feasibility and validity of existing clinical tests, and use of technology in this population.^{41–44}

The participants in this study practice in a residential setting. Unlike the study by Pak et al that reported physical therapists' had mixed views on whether technology-derived data influenced their treatment,¹⁷ clinicians in this study felt that the data would influence their practice. This difference may be explained by the residential vs hospital setting, the type of treatment provided by exercise professionals vs physical therapists (ie, tracking change over time in residents who may not be receiving treatment vs therapists providing inpatient rehabilitation treatment), or the prospective vs retrospective nature of the interviews (ie, participants in the Pak et al study had been using technology in their practice).

Participants identified 2 primary purposes for technology-derived data including programming/prescription and communication regarding balance and mobility status with clients, families, and health care providers. For both, the value of technology was considered to be its ability to identify small changes in function or performance. Despite the quantitative nature of many existing clinical tests (eg, Timed Up and Go), participants thought technology-derived data would "back up their clinical decisions with numbers",

allowing them to "prove" a change in client's functioning. These views were distinct from broader comments about the value of electronically stored data—the ability to make comparisons easily, integrate with other health data, etc, which are not unique to technology-derived data. These results are consistent with those of Pak et al who highlighted the benefits of objective data.¹⁷

The suggestion to maximize flexibility as a solution to existing barriers of clinicians' time and needs reflected the desire to evaluate elements of balance and mobility important for treatment and monitoring of individuals with greater functional impairment. For example, several participants suggested it would be important to evaluate seated balance, posture during transfers and wheelchair propulsion, and tasks linked directly to activities of daily living. These items are, however, not well-represented in the literature, a gap that requires additional work. For example, although many activities of daily living-oriented tools address balance and mobility, many do not target the abovementioned tasks⁴⁵ or they are validated only in specific populations.⁴⁶ While participants positively viewed technology-supported assessment, their emphasis on the need for specific tasks and measures highlights the importance of perceived relevance on the eventual uptake of technology.

Study limitations

In this study, participants were previously known to each other and in the presence of their coordinator, a registered kinesiologist, who was also a participant. These relationships may have affected participants' willingness to express their thoughts, although a recent study comparing individual interviews and focus groups suggests these methods produce similar data.⁴⁷ Second, lack of concern about using the technology may have been because of a relatively young cohort who, given their age, may have had a high degree of technical literacy. Finally, we did not explicitly ask participants to compare traditional clinical assessments with technology-derived measures of balance and mobility and therefore cannot rule out that existing assessment tools captured and reported in digital format may be perceived to be equally beneficial to technology-derived data.

Conclusions

The exercise professionals in this study perceived technology and technology-derived data to have utility for balance and mobility assessment. The results of this study highlight several important requirements for uptake into clinical practice: technology must be adaptable and consideration must be given to the influence of practice setting and client abilities, with specific attention paid to advancing technology in support of people with cognitive impairment. Future work should include gathering older adults' perspectives on the use of technology for balance and mobility assessment, larger surveys with other clinician types and organizational structures, and observational studies that include guided user test sessions or other user-centered design principles to inform technology development.^{48,49}

Supplier

a. NVivo 10 software; QSR International.

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