Understanding Approaches to Balance Assessment in Physical Therapy Practice for Elderly Inpatients of a Rehabilitation Hospital

Tanner Gervais, MScPT, BKin;* Nicole Burling, MScPT, BScKin;*
Justin Krull, MScPT, BPHE;* Carrie Lugg, MScPT, BScHK;* Maria Lung, MSc, BScPT;†
Sharon Straus MD, MSc;‡ Susan Jaglal, PhD;§ Kathryn M. Sibley, PhD§

ABSTRACT

Purpose: Balance is a critical modifiable risk factor for falls in older adults. The purpose of this study was to identify the physiotherapy assessment tools used to evaluate balance in clinical practice and to determine the components of balance assessed through the use of standardized and/or other measures.

Methods: A retrospective chart review was performed on 250 patients aged 65 and older undergoing in-patient rehabilitation with a clinical diagnosis associated with a balance impairment (stroke, musculoskeletal conditions, lower limb amputation, deconditioning, or cardiac surgery) at a rehabilitation hospital in Ontario. **Results:** All patients received at least one assessment that incorporated a balance component. Standardized balance measures were performed for 73% of patients; the timed up-and-go test (48%) and Berg Balance Scale (36%) were most commonly used for this assessment. Reactive movement strategies and cognitive processing were the least commonly assessed components of balance. Balance was assessed least often among people with cardiac surgery. **Conclusions:** Considerable variation exists in the assessment of balance, and the data suggest that not all relevant components are equally considered. Future research should be conducted in other clinical settings and should include other health care practitioners' assessments to develop a more complete understanding of current balance assessment procedures.

Key Words: aged; outcome assessment (health care); postural balance.

RÉSUMÉ

Objectif : L'équilibre constitue un facteur modifiable critique de risque de chutes chez les adultes âgés. Cette étude visait à déterminer les outils utilisés en physiothérapie pour évaluer l'équilibre en pratique clinique et les éléments constitutifs de l'équilibre évalués au moyen de mesures normalisées ou autres.

Méthodes : On a procédé à un examen rétrospectif des dossiers de 250 patients âgés de 65 ans et plus qui ont suivi une réadaptation en service interne après avoir reçu un diagnostic clinique associé à une déficience de l'équilibre (accident vasculaire cérébral, problèmes de l'appareil locomoteur, amputation d'un membre inférieur, déconditionnement et chirurgie cardiaque) à un hôpital de réadaptation de l'Ontario. **Résultats :** Tous les patients ont fait l'objet d'au moins une évaluation comportant un volet équilibre. On a pris des mesures normalisées de l'équilibre chez 73 % des patients : le test chronométré lever-marcher (48 %) et le test d'équilibre de Berg (36 %) ont servi le plus souvent pour cette évaluation. Les stratégies de mouvement réactifs et le traitement cognitif ont été les éléments de l'équilibre évalués le moins souvent. L'équilibre a été évalué le moins souvent chez les personnes qui avaient subi une chirurgie cardiaque. **Conclusions :** Il existe une variation importante au niveau de l'évaluation de l'équilibre et les données indiquent qu'il n'est pas tenu compte également de tous les éléments pertinents. Les recherches à venir dans d'autres contextes cliniques devraient inclure les évaluations d'autres professionnels de la santé afin de permettre de comprendre plus complètement les procédures actuelles d'évaluation de l'équilibre.

Falls occur in 30% of people over the age of 65 each year¹ and are the leading cause of injury-related hospitalizations among seniors in Canada.² Balance, the ability to keep the centre of mass (COM) within the limits of

the base of support (BOS), is a critical modifiable risk factor for falls.³ Balance impairments are common, occurring in up to 75% of people aged 70 years and older.⁴ While they are well recognized in several neurological

From the: *Department of Physical Therapy, University of Toronto; †Sunnybrook Health Sciences Centre, St. John's Rehab, Toronto; ‡St. Michael's Hospital, Toronto; §Toronto Rehabilitation Institute—University Health Network, Toronto.

Correspondence to: Kathryn Sibley, Toronto Rehabilitation Institute, Rm 11-173, 550 University Ave., Toronto, ON M5G 2A2; k.sibley@utoronto.ca.

Contributors: All authors designed the study, collected the data, and analyzed and interpreted the data; drafted or critically revised the article; and approved the final draft.

Competing interests: None declared.

S. Jaglal holds the Toronto Rehabilitation Institute Chair at the University of Toronto. S. Straus holds a Tier 1 Canada Research Chair in Knowledge Translation and Quality of Care. K. Sibley was supported by a Canadian Institutes for Health Research Fellowship.

Acknowledgements: The authors acknowledge and thank the University of Toronto.

Physiotherapy Canada 2014; 66(1);6–14; doi:10.3138/ptc.2012-57

and musculoskeletal (MSK) conditions, such as stroke, osteoporosis, and arthritis, balance impairments are also prevalent in association with a wide range of medical and post-surgical conditions,^{5–7} including significant deconditioning,⁷ cardiac conditions,⁶ and amputations.^{5,8–10} Consequently, the assessment of balance and its related components is critical in guiding clinical decision making and preventing falls in people with these conditions.¹¹

Balance is a complex multi-factorial system^{12–15} in which motor, sensory, and cognitive components interact with one another and with the environment under varying task demands and situational contexts.¹⁶ This systems framework for postural control highlights that all underlying components must work together and that a deficiency in any individual element can lead to a balance impairment.¹⁴ Each component, therefore, needs to be included in a balance assessment to develop individualized treatment approaches.¹⁶

Understanding how physiotherapists (PTs) assess balance in clinical practice is an essential first step in optimizing quality of care, as the appropriate assessment of balance can guide clinical decision making to prevent future falls. Standardized measures, in particular, are important physiotherapy tools, and their use is positively associated with patient outcomes.¹⁷ A recent survey of 369 Ontario PTs¹⁸ reported that the majority of respondents regularly assessed many components of balance and used at least one standardized balance measure in their practice. However, the self-report assessments used in the survey may have overestimated actual performance,¹⁹ and there was no attempt to verify how respondents assessed each component of balance. The survey also reported significant variation in both assessment tools and the components of balance assessed by therapists working with orthopaedic, neurological, geriatric, and general rehabilitation populations but did not identify the assessment tools used in specific populations with balance impairments.

The present study was undertaken as a follow-up to this survey.¹⁸ Our primary objective was to document and compare the assessment tools used to evaluate balance in specific clinical populations undergoing in-patient rehabilitation. Both standardized balance measures (those that have been validated in the literature to assess balance and have an established assessment protocol) and other physiotherapy (PT) assessments (standardized measures and/or non-standardized tools that are not typically used to address balance specifically but incorporate one or more components of postural control) were included. Our secondary objective was to identify the components of balance assessed through the use of standardized balance measures and/or other PT assessments.

METHODS

This study was completed in partial fulfillment of a Master of Science in Physical Therapy degree at the University of Toronto. It was approved by the university and

hospital research ethics boards associated with the study. Identifiable patient information was kept strictly confidential in accordance with the study ethics requirements of the university and the hospital.

Study design and participants

We performed a retrospective chart review of people aged 65 years and older who had a clinical diagnosis associated with balance impairment and had undergone in-patient rehabilitation at an urban specialized rehabilitation hospital in Ontario, Canada in 2010. At the time of the study (operational year 2009/2010), the hospital had 160 beds, 2,640 inpatient discharges, and an average length of stay (LOS) of 19.5 days. The clinical diagnoses identified for this study were (1) stroke (ischemic or hemorrhagic); (2) complex MSK condition (osteoporotic fractures, total hip replacement, total knee replacement, rheumatoid arthritis, osteoarthritis); (3) lower-extremity amputation; (4) deconditioning after acute illness (surgical and medical diagnoses participating in a short-term active reconditioning program); and (5) cardiac surgery (coronary artery bypass grafts, valve replacements). Patients were excluded if they (1) were discharged back to the acute-care setting, (2) were discharged while still non-weight bearing, (3) were unable to participate in a balance assessment because of a language barrier, or (4) died during the inpatient rehabilitation stay.

Sampling

We randomly sampled a total of 250 charts that met the eligibility criteria, stratified by clinical diagnosis (50 charts from each of the 5 diagnostic groups) for patients discharged between January 1, 2010, and December 31, 2010. This number represented a sample of convenience that was considered feasible and would provide an adequate representation of clinical practice. A 1-year time frame was considered appropriate to extract the desired number of charts across each population and to avoid any impact of internal program modifications at the rehabilitation hospital. The administration staff at the rehabilitation hospital assisted in chart extraction, using adapted computer software that allowed them to search the patient database with the inclusion and exclusion criteria identified above.

Data abstraction

To ensure consistency in extracting variables, we created a 57-item chart abstraction form before data collection began. The form allowed us to describe patient characteristics (age, gender, comorbidities, length of inpatient stay, falls during admission, medications) and identify standardized and other PT assessment measures related to balance used during the inpatient rehabilitation stay. A literature review informed our choice of standardized balance measures to be included on the form, and we identified other PT assessments (standardized or non-standardized) that capture relevant components of balance. The use of relevant measures at any point during

Table 1 Components of Balance Assessed with Each Standardized Measure and Other Physiotherapy Assessment Tools

Assessment tools	Balance components							
	Control of dynamics	Biomechanical constraints	Static stability	Reactive movement strategies	Anticipatory movement strategies	Cognitive processing	Individual sensory strategies	Orientation in space
Standardized balance measure								
BBS	X	X	X		X		X	X
FR		X	X		X			X
SLS		X	X					
TUG	X	X			X			X
Other physiotherapy assessment tools								
2MWT	X				X			
6MWT	X				X			
Activity tolerance	X		X					
AROM		X	X					
CMSA*		X	X		X			
DTR							X	
Distance walked	X				X			
Gait observation	X	X			X			X
Kinesthesia					X		X	
Leg length assessment		X						
Light touch							X	
Pain/temperature							X	
Perturbations		X	X	X	X			X
Postural alignment		X	X					
PROM		X						
Proprioception							X	
Stairs assessment	X	X			X			X
Strength		X			X			X
Swelling		X						
Transfers assessment		X			X			X
Vision testing							X	
Vestibular assessment							X	
Coordination	X				X			X

BBS = Berg Balance Scale; FR = Functional Reach; SLS = Single Leg Stance; TUG = timed up-and-go; 2MWT = 2-Minute Walk Test; 6MWT = 6-Minute Walk Test; AROM = Active Range Of Motion; CMSA = Chedoke-McMaster Stroke Assessment; DTR = Deep Tendon Reflex testing; PROM = Passive Range Of Motion

*For the purposes of this study, "CMSA" refers to the Impairment Inventory, which in most cases included only the staging of the arm, hand, leg, and foot.

patients' stay was examined, including upon admission, at discharge, and during any subsequent reassessment. The chart abstraction form was pilot-tested on 14 charts to ensure accuracy, comprehensiveness, and consistency of data extraction among investigators.²⁰

Data analysis

We used descriptive statistics to summarize patient characteristics and frequencies of use of standardized and other PT assessments related to balance. Group differences were compared with Chi-square tests, using predicted proportions for the expected values or one-way ANOVAs, as appropriate.

The components of balance evaluated by the standardized measures and other PT assessments used were analyzed using a two-step process. First, student investigators examined the individual items in the standardized measures and other PT assessments and mapped the components of balance evaluated in each measure according to the systems framework for postural control

(see Table 1),^{12–14,16} achieving consensus through comparison and discussion with senior investigators. This model identifies eight related but distinct components that are important for maintaining balance: (1) biomechanical constraints (joint range of motion, capsule stiffness, muscle length, strength, endurance, and biomechanical relationships among linked body segments); (2) orientation in space (appropriate processing of sensory inputs with a focus on perceived head and body position relative to gravity); (3) individual sensory contributions (inputs from each perceptual system of the body including visual, vestibular, and somatosensory systems as well as the processing and integration of these inputs for the maintenance of postural control); (4) static stability (the ability to maintain the COM within a BOS when the BOS is stable); (5) control of dynamics (control of the COM when the BOS is changed during dynamic movements such as walking); (6) anticipatory movement strategies (COM adjustments before voluntary movement); (7) reactive movement strategies (ability to regain control of

Table 2 Patient Demographics

Patient characteristics	No. (%) ^a of clinical diagnoses						<i>F</i> or χ^2	<i>p</i> -value
	Entire sample (<i>n</i> = 250)	Stroke (<i>n</i> = 50)	Complex MSK (<i>n</i> = 50)	Amputation (<i>n</i> = 50)	Deconditioned (<i>n</i> = 50)	Cardiac surgery (<i>n</i> = 50)		
Age, mean (SD), y	77.8 (7.2)	79.1 (8.2)	77.7 (6.3)	73.6 (6.4)	81.5 (6.2)	77.3 (6.4)	9.0	<0.001
Sex							13.76	<0.001
Male	113 (45)	23 (46)	11 (22)	39 (78)	11 (22)	28 (56)		
Female	137 (55)	27 (54)	39 (78)	11 (22)	39 (78)	22 (44)		
Comorbidities; mean (SD)	4.9 (2.4)	4.3 (2.4)	4.7 (2.7)	5.1 (2.4)	5.2 (2.4)	5.1 (2.4)	1.4	0.25
Falls during inpatient stay	34 (14)	6 (12)	1 (2)	16 (32)	5 (10)	6 (12)	5.6	<0.001
Medications								
Antianxiety	176 (70)	23 (46)	43 (86)	39 (78)	26 (52)	43 (86)	11.3	<0.001
Antidepressants	35 (14)	8 (16)	4 (8)	8 (16)	7 (14)	4 (8)	0.5	0.74
Hypnotics	5 (12)	3 (6)	0 (0)	0 (0)	1 (2)	0 (0)	1.5	0.19
Diuretics	107 (43)	18 (36)	10 (20)	28 (56)	21 (42)	30 (60)	5.7	<0.001
Medication associated with increased fall risk	214 (86)	36 (72)	47 (94)	45 (90)	37 (74)	49 (98)		
Length of stay; mean (SD), d	23.2 (16.2)	29.2 (17.5)	13.9 (8.4)	41.5 (17.2)	18.8 (7.6)	12.8 (3.4)	49.0	<0.001

^aUnless otherwise indicated.

the COM following a perturbation to stability); and (8) cognitive contributions to balance (such as devoting adequate attentional resources). Second, we used this map to determine which components of balance were assessed by standardized measures and other PT assessment measures in each patient. We summarized the components of balance assessed using descriptive statistics and compared them across groups using Chi-square tests.

All statistical analyses were carried out using SPSS 16.0 for Windows. Throughout the data analysis, an alpha level of 0.05 ($p < 0.05$) was used to determine statistical significance.

RESULTS

Patient characteristics

For each group, we reviewed 50 randomly sampled charts. All patients were discharged from inpatient rehabilitation in 2010, with the exception of 17 people with amputations discharged in 2009 whose charts we also reviewed to meet sample-size targets. Mean patient age was 77.8 (SD 7.2) years; 45% were male and 55% female (see Table 2). Groups were found to be significantly different in age (the deconditioned group had the highest mean age, $p < 0.001$) and in gender (women were in higher proportion in all clinical groups except the amputation and cardiac groups, $p < 0.001$). The overall average LOS was 23.2 (SD 16.2) d; the amputation group had the longest LOS (41.5 [SD 17.2] d) and the cardiac surgery group the shortest (12.8 [SD 3.4] d; $p < 0.001$). A total of 34 patients in the entire sample experienced at least one fall during their stay, and 86% of all patients were taking

at least one medication associated with increased fall risk (benzodiazepines, antidepressants, hypnotics, or diuretics),^{21,22} including 98% of patients who had cardiac surgery.

Use of standardized balance measures

Standardized balance measures were performed for 73% of all patients; we found significant differences between groups in the proportion of patients who received a standardized measure ($p < 0.001$). The stroke group had the highest proportion (100%), followed by the complex MSK group (78%), the amputation group (70%), and the deconditioned group (60%). Patients in the cardiac surgery group were least likely to receive a standardized measure (54%). There were also significant differences in the number of standardized measures used across groups ($p < 0.001$): the stroke and amputation groups received the most standardized balance measures, at 1.2 (SD 0.4) and 1.2 (SD 0.9) per patient respectively, while the cardiac surgery group received the fewest, at 0.6 (SD 0.5) per patient.

Four standardized balance measures were administered (see Table 3). The timed up-and-go (TUG) test was the most commonly used overall (48%), followed by the Berg Balance Scale (BBS) (36%), the Single Leg Stance (SLS) test (5%), and Functional Reach (FR) (0.4%). The TUG and BBS were administered in all groups, while the SLS and FR were used only in the amputation group. The TUG was the most frequently used measure in the cardiac, amputation, and MSK groups ($p < 0.001$), while the BBS was used most with the stroke and deconditioned groups ($p < 0.001$).

Table 3 Use of Standardized Balance Measures

Measure	No. (%) of clinical diagnoses						χ^2	<i>p</i> -value
	Entire sample (<i>n</i> = 250)	Stroke (<i>n</i> = 50)	Complex MSK (<i>n</i> = 50)	Amputation (<i>n</i> = 50)	Deconditioned (<i>n</i> = 50)	Cardiac surgery (<i>n</i> = 50)		
TUG	121 (48)	8 (16)	39 (78)	29 (58)	20 (40)	29 (58)	41.9	<0.001
BBS	89 (36)	50 (100)	0 (0)	15 (30)	21 (42)	15 (30)	138.8	<0.001
SLS	13 (5)	0 (0)	0 (0)	13 (26)	0 (0)	13 (26)	54.8	<0.001
FR	1 (0.4)	0 (0)	0 (0)	1 (2)	0 (0)	0 (0)	4.0	0.40

TUG = timed up-and-go test; BBS = Berg Balance Scale; SLS = Single Leg Stance; FR = Functional Reach.

Table 4 Use of Other Physiotherapy (PT) Assessments Related to Balance

Other PT assessment	No. (%) of clinical diagnoses						χ^2	<i>p</i> -value
	Entire sample (<i>n</i> = 250)	Stroke (<i>n</i> = 50)	Complex MSK (<i>n</i> = 50)	Amputation (<i>n</i> = 50)	Deconditioned (<i>n</i> = 50)	Cardiac surgery (<i>n</i> = 50)		
Gait observation	246 (98)	50 (100)	50 (100)	47 (94)	49 (98)	50 (100)	8.6	0.07
Transfers assessment	246 (98)	50 (100)	50 (100)	50 (100)	50 (100)	46 (92)	16.3	0.003
Distance walked	233 (93)	46 (92)	50 (100)	38 (76)	49 (98)	50 (100)	32.6	<0.001
AROM	212 (85)	15 (30)	50 (100)	50 (100)	49 (98)	48 (96)	146.0	<0.001
Stairs assessment	195 (78)	39 (78)	46 (92)	29 (58)	32 (64)	49 (98)	34.7	<0.001
Strength	191 (76)	10 (20)	47 (94)	50 (100)	49 (98)	35 (70)	126.3	<0.001
2MWT	177 (71)	27 (54)	43 (86)	23 (46)	37 (74)	47 (94)	43.2	<0.001
Light touch	161 (64)	44 (88)	6 (12)	47 (94)	17 (34)	47 (94)	136.6	<0.001
Swelling	161 (64)	0 (0)	48 (96)	48 (96)	16 (32)	49 (98)	181.5	<0.001
PROM	158 (158)	43 (86)	43 (86)	42 (84)	26 (52)	4 (8)	99.9	<0.001
Activity tolerance	138 (55)	13 (26)	20 (40)	44 (88)	13 (26)	48 (96)	94.6	<0.001
Postural alignment	97 (39)	48 (96)	0 (0)	43 (86)	6 (12)	0 (0)	194.3	<0.001
Leg length assessment	89 (36)	0 (0)	39 (78)	42 (84)	8 (16)	0 (0)	153.9	<0.001
Pain/temperature	80 (32)	23 (46)	3 (6)	47 (94)	7 (14)	0 (0)	147.3	<0.001
Proprioception	80 (32)	34 (68)	1 (2)	44 (88)	1 (2)	0 (0)	173.1	<0.001
CMSA	50 (20)	49 (98)	0 (0)	0 (0)	0 (0)	1 (2)	237.7	<0.001
Coordination	44 (18)	42 (84)	0 (0)	0 (0)	2 (4)	0 (0)	190.4	<0.001
Vision testing	43 (17)	43 (86)	0 (0)	0 (0)	0 (0)	0 (0)	207.7	<0.001
Internal perturbations	5 (2)	5 (10)	0 (0)	0 (0)	0 (0)	0 (0)	20.4	0.009
External perturbations	4 (2)	4 (8)	0 (0)	0 (0)	0 (0)	0 (0)	16.3	0.003
Vestibular assessment	4 (2)	0 (0)	0 (0)	0 (0)	4 (8)	0 (0)	16.4	0.003
6MWT	2 (1)	1 (2)	1 (2)	0 (0)	0 (0)	0 (0)	3.0	0.55
DTR	2 (1)	0 (0)	0 (0)	0 (0)	1 (2)	1 (2)	3.0	0.55
Kinesthesia	2 (1)	0 (0)	0 (0)	2 (4)	0 (0)	0 (0)	8.1	0.09
Other	105 (42)	49 (98)	2 (4)	38 (76)	1 (2)	15 (30)	153.5	<0.001

AROM = active range of motion; 2MWT = 2-Minute Walk Test; PROM = passive range of motion; CMSA = Chedoke-McMaster Stroke Assessment scale; 6MWT = 6-Minute Walk Test; DTR = Deep Tendon Reflex testing.

Use of other PT assessments related to balance

All the charts we reviewed included at least one other PT assessment related to balance. Of these, the most commonly used were gait observation and transfer assessment (both 98%), distance walked (93%), and active range of motion (AROM, 85%) (see Table 4). Other PT assessments were performed with considerable variations in frequency across groups; for example, vision testing was performed only in the stroke group (86%), and the

vestibular system was assessed in only four patients, all in the deconditioned group.

Components of balance assessed with standardized measures

Biomechanical constraints, anticipatory movement strategies, orientation in space, and control of dynamics were evaluated with standardized measures in more than 70% of patients (see Table 5); static stability was evaluated in 40% of patients, and sensory strategies in 36%. Neither reactive movement strategies nor cognitive processing

Table 5 Components of Balance Assessed with Standardized Measures

Component of balance	No. (%) of clinical diagnoses						χ^2	<i>p</i> -value
	Entire sample (<i>n</i> = 250)	Stroke (<i>n</i> = 50)	Complex MSK (<i>n</i> = 50)	Amputation (<i>n</i> = 50)	Deconditioned (<i>n</i> = 50)	Cardiac surgery (<i>n</i> = 50)		
Biomechanical constraints	181 (72)	50 (100)	39 (78)	35 (70)	30 (60)	27 (54)	32.3	<0.001
Orientation in space	176 (70)	50 (100)	39 (78)	30 (60)	30 (60)	27 (54)	34.1	<0.001
Individual sensory inputs	89 (36)	50 (100)	0 (0)	15 (30)	21 (42)	3 (6)	138.8	<0.001
Static stability	100 (40)	50 (100)	0 (0)	26 (52)	21 (42)	3 (6)	135.5	<0.001
Control of dynamics	175 (70)	50 (100)	39 (78)	29 (58)	30 (60)	27 (54)	34.9	<0.001
Anticipatory movement strategies	176 (70)	50 (100)	39 (78)	30 (60)	30 (60)	27 (54)	34.1	<0.001
Reactive movement strategies	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	N/A	N/A
Cognitive processing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	N/A	N/A

Table 6 Components of Balance Assessed with Other Physiotherapy Assessments

Component of balance	No. (%) of clinical diagnoses						χ^2	<i>p</i> -value
	Entire sample (<i>n</i> = 250)	Stroke (<i>n</i> = 50)	Complex MSK (<i>n</i> = 50)	Amputation (<i>n</i> = 50)	Deconditioned (<i>n</i> = 50)	Cardiac surgery (<i>n</i> = 50)		
Biomechanical constraints	250 (100)	50 (100)	50 (100)	50 (100)	50 (100)	50 (100)	N/A	N/A
Orientation in space	250 (100)	50 (100)	50 (100)	50 (100)	50 (100)	50 (100)	N/A	N/A
Individual sensory inputs	175 (70)	49 (98)	6 (12)	50 (100)	23 (46)	47 (94)	147.6	<0.001
Static stability	248 (99)	50 (100)	49 (98)	49 (98)	49 (98)	50 (100)	3.0	0.55
Control of dynamics	248 (99)	50 (100)	50 (100)	50 (100)	49 (98)	50 (100)	3.0	0.55
Anticipatory movement strategies	250 (100)	50 (100)	50 (100)	0 (0)	50 (100)	50 (100)	N/A	N/A
Reactive movement strategies	4 (2)	4 (8)	0 (0)	0 (0)	0 (0)	0 (0)	16.3	0.003
Cognitive processing	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	N/A	N/A

was assessed by any standardized balance measure in any of the diagnostic groups.

Components of balance assessed with other PT assessment measures

Biomechanical constraints, anticipatory movement strategies, orientation in space, control of dynamics, and static stability were assessed with other PT assessments in more than 99% of charts reviewed (see Table 6). Reactive movement strategies were assessed with other PT assessments in only 2% of charts, while cognitive processing was not evaluated in any diagnostic group.

DISCUSSION

Postural control is critical to the performance of functional movement and tasks; deficits in its components are key risk factors for falls in older people.²³ Our study found that standardized balance measures, recognized as an important element of evidence-based PT practice,²⁴ were used in a high proportion of patients at the study site (73%); the TUG and the BBS were the most commonly implemented of these measures. The earlier survey of Ontario PTs¹⁸ also found that the BBS and TUG were among the most commonly reported measures, in addition to the SLS test, which was used by 79% of respondents. We did not find such a high frequency of SLS in the

present study, however; this may be attributed to differences in practice setting, as less than 5% of the sample in the survey¹⁸ worked in in-patient rehabilitation. Many other functional assessments that are important for assessing readiness for discharge were conducted in the present sample that also captured elements of postural control.

We found many differences in the usage patterns of standardized and other PT assessments among clinical populations. The reasons for these differences are unclear, but could reflect theoretical factors, such as the appropriateness of a particular measure in a given population or a lack of psychometric validation, and practical/cultural factors, such as a measure's failure to be considered because it is not included in a standard assessment form for a particular clinical population. Indeed, all of the measures and tools most commonly used in our sample appeared on the study sites' standardized assessment forms for those populations. For example, the TUG was listed on the standard PT lower extremity assessment and discharge forms used for most diagnostic groups, while the BBS, most commonly used in the stroke group, was listed on the hospitals' assessment forms for this population. The development of institutional assessment forms warrants further study, as there

is little data describing their development and few models exist that critically analyze the evidence-based underpinnings of their content.²⁵ Moreover, there is still some debate as to what constitutes a balance measure. For example, although the TUG was originally described as a measure of balance,²⁶ use of a gait aid such as a rollator during the test significantly reduces its balance demands, and a recent content analysis on standardized balance measures did not include the TUG for consideration.²⁷ Individual clinicians need to understand how such performance variations can affect postural control demands, and they need to be aware of the need to perform additional assessments of balance in some cases. However, given the absence of a “gold standard” measurement tool for balance,²⁸ there is also a larger recognized need for consensus on the selection and use of standardized balance measures.²⁹

Using the systems framework for postural control as a guide revealed that certain components of postural control have been assessed more commonly than others, and these components often showed bimodal distributions between clinical groups. Biomechanical constraints, anticipatory movement strategies, orientation in space, control of dynamics, and static stability were assessed in virtually all patients. Assessment of individual sensory strategies, however, was highly related to clinical diagnosis: 100% of people with amputation and stroke, but only 12% of those with complex MSK conditions, were assessed for this component. Consistent with the previous survey of Ontario PTs,¹⁸ our study found that the two least assessed components of postural control were cognitive processing and reactive movement strategies. Both have been found to decrease with age,^{6,30} and a deficit in these components of postural control has been postulated as a possible cause for falls among older adults.³¹ However, the proportion of participants in the Ontario survey¹⁸ who self-reported regularly assessing cognitive contributions (55%) and reactive control (41%) was considerably higher than that documented in our chart review. These differences may indicate that informal observations associated with the balance measures related to cognitive processing abilities and reactive movement strategies were not recorded; it may also be that the cognitive demands associated with some standardized balance measures, such as the BBS, TUG, and FR, prevented some patients with severe cognitive limitations from being assessed.

Arguably, the most significant finding of our study is that there was no standardized balance measure, other PT assessment, or combination of the two that specifically evaluated all the components of balance outlined by the systems framework of postural control in any individual patient, largely because of the lack of assessment of cognitive processing and reactive movement strategies. While the lack of documented assessment of reactive control is concerning, for this is the component

of balance most directly linked to fall avoidance,³² none of the standardized measures used includes an assessment of reactive control. Therefore, the reason that this component was not routinely assessed or documented in our sample may be a lack of awareness of standardized methods (i.e., BESTest,³³ Fullerton Advanced Balance Scale,³⁴ Performance Oriented Mobility Assessment³⁵) that can measure this component in the clinical environment. In addition, the risk level of falls associated with tests of perturbations and the safety mechanisms required to mitigate the impact of an actual fall induced by the test may have deterred clinicians from assessing patients' reactive control. Finally, it is perhaps more likely that these components of balance were assessed informally. For example, cognitive processing is typically assessed by asking questions while walking with patients and assessing their orientation to their physical surroundings; if there were no detrimental effects on walking during the cognitive task,³⁰ the combination of seemingly insignificant results and a lack of formalized documentation protocol for this type of testing may lead the physiotherapist away from documenting the result. Similarly, it has been suggested that clinicians may be informally assessing reactive postural control through “internal perturbations” generated in the course of other assessments,³⁶ although without documentation of informal assessment or an explicit evaluation of reactive postural control, it is difficult to know the existence or the quality of such assessments.

Our findings related to balance assessment practices in people with cardiac surgery have important clinical significance. People who had undergone cardiac surgery received the smallest number of standardized balance measures (0.6 per patient), despite the fact that 98% of people in this group were taking at least one medication associated with increased fall risk^{21,22} and that 12% also experienced a fall during their inpatient stay, accounting for 18% of all falls in the sample. Because the cardiac group had a shorter LOS than other groups in the sample and because available therapy assessment and treatment time are limited, the traditional focus on function and mobility for medically stable discharge in the cardiac surgery population would likely take priority. However, our findings suggest that more research on fall prevention in the cardiac population is necessary in order to avoid overlooking the potentially deleterious effects of the medications prescribed after the surgical procedures on balance.

Our study has several limitations. Previous research has shown that individualized approaches to assessing postural control, which may vary among physiotherapists or rehabilitation facilities, do exist in clinical practice.¹¹ Our study looked at the assessment practices of one rehabilitation facility only, which limits our results to a finite number of clinicians practising within the same environment and using the same assessment

forms. Without a qualitative analysis of therapists' clinical reasoning processes exploring what components of postural control were considered, we are limited to reporting only that a complete postural control assessment was not documented. Furthermore, the fact that our research was conducted at a specialized urban rehabilitation hospital with academic affiliations may have affected the assessment of balance in clinical practice relative to other settings. As the time course of assessments was not tracked, we could not determine whether significant events such as falls were associated with differences in assessment practices. Future studies should evaluate both in-patient and community-based postural control assessments, compare other rehabilitation facilities to the present facility, and provide qualitative analyses of the complex clinical reasoning processes that physiotherapists consider with each clinical population or each individual patient. Future tracking of the timing of particular assessments will also contribute richer data to inform understanding of clinical reasoning processes.

Assessments performed by other health professionals—such as the occupational therapy neurological outpatient assessment form, which includes measures of vision, AROM/PROM, postural alignment, perturbations, strength, light touch, pain/temperature sensation, proprioception, and tone/coordination—may have evaluated important components of balance, but it is unclear whether this information was communicated to or considered by the therapist. This issue warrants further investigation, since accounting for undocumented communication between health care practitioners in relation to postural control is difficult.³⁷ Although we noted that the CMSA was documented on 20% of the charts we reviewed (primarily in the stroke group), there was no record of which component of the assessment was conducted or of the actual scores. The CMSA does include an evaluation of reactive control, so it is possible that some people may have received this assessment.

CONCLUSION

Performing a complete assessment of all components of postural control is crucial in addressing balance deficits associated with aging and clinical diagnoses. In this study, many components of balance were assessed in elderly patients receiving physiotherapy in in-patient rehabilitation, but no patient received a complete assessment of postural control. Our findings highlight the need for a comprehensive assessment to guide clinical decision making regarding fall prevention in older adults. Refining existing practices of balance assessment in older adults can improve the quality of care provided in rehabilitation facilities through a more inclusive assessment of all components related to balance. Future research should be conducted in other acute-care and rehabilitation hospital and community settings and may include other health care practitioners' assessments to

develop a more complete understanding of current balance assessment procedures.

KEY MESSAGES

What is already known on this topic

Falls are the leading cause of injury-related hospitalization for seniors in Canada. Studies have shown that balance is a modifiable risk factor for falls in older adults; balance is a complex multi-factorial system comprising various motor, sensory, and cognitive components. Proper assessment of all components of postural control can help to prevent fall-related injuries among older adults.

What this study adds

No patient received a complete balance assessment through the use of standardized or other physiotherapy assessment measures according to the systems theory of postural control; however, differences in the usage patterns of assessment exist between clinical populations. The assessment of cognitive processing and reactive control, important components of a comprehensive assessment of postural control, was particularly lacking in the clinical documentation.

REFERENCES

1. Tinetti ME, Speechley M, Ginter SF. Risk factors for falls among elderly persons living in the community. *N Engl J Med*. 1988;319(26):1701–7. <http://dx.doi.org/10.1056/NEJM198812293192604>. Medline:3205267
2. Scott V, Wagar L, Elliott S. Falls and related injuries among older Canadians: fall-related hospitalizations & intervention initiatives. Prepared on behalf of the Public Health Agency of Canada Division of Aging and Seniors. Victoria (BC): Victoria Scott Consulting; 2010.
3. Tinetti ME, Kumar C. The patient who falls: "It's always a trade-off". *JAMA*. 2010;303(3):258–66. <http://dx.doi.org/10.1001/jama.2009.2024>. Medline:20085954
4. Dillon CF, Gu Q, Hoffman HJ, et al. Vision, hearing, balance, and sensory impairments in Americans aged 70 years and older: United States, 1999–2006. *NCHS Data Brief* 31. Hyattsville, MD: National Center for Health Statistics; 2010.
5. Miller WC, Deathe AB, Speechley M, et al. The influence of falling, fear of falling, and balance confidence on prosthetic mobility and social activity among individuals with a lower extremity amputation. *Arch Phys Med Rehabil*. 2001;82(9):1238–44. <http://dx.doi.org/10.1053/apmr.2001.25079>. Medline:11552197
6. Goel K, Shen J, Wolter AD, et al. Prevalence of musculoskeletal and balance disorders in patients enrolled in phase II cardiac rehabilitation. *J Cardiopulm Rehabil Prev*. 2010;30(4):235–9. <http://dx.doi.org/10.1097/HCR.0b013e3181e17387>. Medline:20551829
7. O'Dell M, Noren T. Principles of surgical rehabilitation. In: Norton J, Barie P, Bollinger RR, et al, editors. *Surgery*. New York: Springer; 2008. p. 631–45. http://dx.doi.org/10.1007/978-0-387-68113-9_35.
8. Fernie GR, Holliday PJ. Postural sway in amputees and normal subjects. *J Bone Joint Surg Am*. 1978;60(7):895–8. Medline:701337
9. Hof AL, van Bockel RM, Schoppen T, et al. Control of lateral balance in walking. Experimental findings in normal subjects and above-knee amputees. *Gait Posture*. 2007;25(2):250–8. <http://dx.doi.org/10.1016/j.gaitpost.2006.04.013>. Medline:16740390
10. Miller WC, Deathe AB. A prospective study examining balance confidence among individuals with lower limb amputation. *Disabil Rehabil*. 2004;26(14-15):875–81. <http://dx.doi.org/10.1080/09638280410001708887>. Medline:15497916

11. McGinnis PQ, Hack LM, Nixon-Cave K, et al. Factors that influence the clinical decision making of physical therapists in choosing a balance assessment approach. *Phys Ther.* 2009;89(3):233–47. <http://dx.doi.org/10.2522/ptj.20080131>. Medline:19179463
12. Mancini M, Horak FB. The relevance of clinical balance assessment tools to differentiate balance deficits. *Eur J Phys Rehabil Med.* 2010;46(2):239–48. Medline:20485226
13. Horak FB, Wrisley DM, Frank J. The Balance Evaluation Systems Test (BESTest) to differentiate balance deficits. *Phys Ther.* 2009;89(5):484–98. <http://dx.doi.org/10.2522/ptj.20080071>. Medline:19329772
14. Horak FB. Postural orientation and equilibrium: what do we need to know about neural control of balance to prevent falls? *Age Ageing.* 2006;35(Suppl 2):ii7–11. <http://dx.doi.org/10.1093/ageing/afl077>. Medline:16926210
15. Shumway-Cook A, Woollacott MH. Motor control: translating research into clinical practice. 3rd ed. Philadelphia: Lippincott Williams and Wilkins; 2007.
16. Berg K. Balance and its measure in the elderly: a review. *Physiother Can.* 1989;41(5):240–6. <http://dx.doi.org/10.3138/ptc.41.5.240>.
17. Stokes EK, O'Neill D. Use of outcome measures in physiotherapy practice in Ireland from 1998 to 2003 and comparison to Canadian trends. *Physiother Can.* 2008;60(2):109–16. <http://dx.doi.org/10.3138/physio.60.2.109>. Medline:20145774
18. Sibley KM, Straus SE, Inness EL, et al. Balance assessment practices and use of standardized balance measures among Ontario physical therapists. *Phys Ther.* 2011;91(11):1583–91. <http://dx.doi.org/10.2522/ptj.20110063>. Medline:21868613
19. Davis DA, Mazmanian PE, Fordis M, et al. Accuracy of physician self-assessment compared with observed measures of competence: a systematic review. *JAMA.* 2006;296(9):1094–102. <http://dx.doi.org/10.1001/jama.296.9.1094>. Medline:16954489
20. Liddy C, Wiens M, Hogg W. Methods to achieve high interrater reliability in data collection from primary care medical records. *Ann Fam Med.* 2011;9(1):57–62. <http://dx.doi.org/10.1370/afm.1195>. Medline:21242562
21. Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: II. Cardiac and analgesic drugs. *J Am Geriatr Soc.* 1999;47(1):40–50. Medline:9920228
22. Leipzig RM, Cumming RG, Tinetti ME. Drugs and falls in older people: a systematic review and meta-analysis: I. Psychotropic drugs. *J Am Geriatr Soc.* 1999;47(1):30–9. Medline:9920227
23. Muir SW, Berg K, Chesworth B, et al. Use of the Berg Balance Scale for predicting multiple falls in community-dwelling elderly people: a prospective study. *Phys Ther.* 2008;88(4):449–59. <http://dx.doi.org/10.2522/ptj.20070251>. Medline:18218822
24. Sackett DL, Rosenberg WM, Gray JA, et al. Evidence based medicine: what it is and what it isn't. *BMJ.* 1996;312(7023):71–2. <http://dx.doi.org/10.1136/bmj.312.7023.71>. Medline:8555924
25. Crow JL, Harmeling BC. Development of a consensus and evidence-based standardised clinical assessment and record form for neurological inpatients: the Neuro Dataset. *Physiotherapy.* 2002;88(1):33–46. [http://dx.doi.org/10.1016/S0031-9406\(05\)60527-5](http://dx.doi.org/10.1016/S0031-9406(05)60527-5).
26. Mathias S, Nayak US, Isaacs B. Balance in elderly patients: the “get-up and go” test. *Arch Phys Med Rehabil.* 1986;67(6):387–9. Medline:3487300
27. Pardasany PK, Slavin MD, Wagenaar RC, et al. Conceptual limitations of balance measures for community-dwelling older adults. *Phys Ther.* 2013;93(10):1351–68. <http://dx.doi.org/10.2522/ptj.20130028>. Medline:23704036
28. Tyson SF, Connell LA. How to measure balance in clinical practice. A systematic review of the psychometrics and clinical utility of measures of balance activity for neurological conditions. *Clin Rehabil.* 2009;23(9):824–40. <http://dx.doi.org/10.1177/0269215509335018>. Medline:19656816
29. Howe TE, Skelton DA. Consensus on core outcome measures of function are needed to progress our knowledge of ‘best practice’ exercise components for older people. *Age Ageing.* 2011;40(5):532–3. <http://dx.doi.org/10.1093/ageing/afr082>. Medline:21791446
30. Huxhold O, Li SC, Schmiedek F, et al. Dual-tasking postural control: aging and the effects of cognitive demand in conjunction with focus of attention. *Brain Res Bull.* 2006;69(3):294–305. <http://dx.doi.org/10.1016/j.brainresbull.2006.01.002>. Medline:16564425
31. Pollock AS, Durward BR, Rowe PJ, et al. What is balance? *Clin Rehabil.* 2000;14(4):402–6. <http://dx.doi.org/10.1191/0269215500cr342oa>. Medline:10945424
32. Maki BE, McIlroy WE. Postural control in the older adult. *Clin Geriatr Med.* 1996;12(4):635–58. Medline:8890108
33. Horak FB, Wrisley DM, Frank J. The Balance Evaluation Systems Test (BESTest) to differentiate balance deficits. *Phys Ther.* 2009;89(5):484–98. <http://dx.doi.org/10.2522/ptj.20080071>. Medline:19329772
34. Rose DJ, Lucchese N, Wiersma LD. Development of a multidimensional balance scale for use with functionally independent older adults. *Arch Phys Med Rehabil.* 2006;87(11):1478–85. <http://dx.doi.org/10.1016/j.apmr.2006.07.263>. Medline:17084123
35. Tinetti ME. Performance-oriented assessment of mobility problems in elderly patients. *J Am Geriatr Soc.* 1986;34(2):119–26. Medline:3944402
36. Sibley KM, Inness EL, Straus SE, et al. Clinical assessment of reactive postural control among physiotherapists in Ontario, Canada. *Gait Posture.* 2013;38(4):1026–31. <http://dx.doi.org/10.1016/j.gaitpost.2013.05.016>. Medline:23810087
37. Griffin E, Martin M, Fitzgerald T, et al. Gait abnormalities in older people—comparison of inter-professional assessment. *Ir Med J.* 2005;98(6):169–70. Medline:16097506