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Original Research

Factors Associated With Walking in Older Medical Inpatients

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KEYWORDS
Accelerometry;
Aged;
Hospitalization;
Mobility limitation;
Rehabilitation;
Walking

Abstract *Objective:* To identify patient characteristics on admission and daily events during hospitalization that could influence older medical inpatients walking activity during hospitalization.
Design: A cohort study.
Setting: Acute hospitalized care.
Participants: Premorbidly mobile, nonsurgical, nonelective inpatients (50% women) aged ≥65 years (N=154), with an anticipated ≥3-day inpatient stay were recruited consecutively within 48 hours of hospital admission. Of the 227 patients screened, 69 did not meet study criteria and 4 refused.
Interventions: Not applicable.
Main Outcome Measures: Age, comorbidities (Cumulative Illness Rating Scale), cognitive status (6-item Cognitive Impairment Test), falls history and efficacy (Falls Efficacy Scale-International), physical performance (short physical performance battery), and medications were recorded within 2 days of admission. Walking activity (step count) was recorded for 7 days or until discharge. Daily events (procedures, falls, fear of falling, ordered bedrest, devices or treatments that hindered walking [eg, intravenous fluids, wall-mounted oxygen therapy], patient- and nurse-reported medial status, fatigue, sleep quality, physiotherapy, or occupational therapy intervention) were measured on concurrent weekdays. Their associations with daily (log) step count were estimated using linear mixed-effects models, adjusted for patient-characteristics measured at admission.
Results: Approximately half of the variability in step count was described at the within-patient level. Multivariable models suggested positive associations with Wednesdays (+25% in step count; 95% confidence interval, 4-53), admission physical performance (+15%, 8-22),

List of abbreviations: 95% CI, 95% confidence interval; FES-I, Falls Efficacy Scale-International; IQR, interquartile range; SPPB, short physical performance battery.

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improving medical status (+33%, 7-64), negative associations with devices or treatments that hinder walking (−29%, −9 to −44), and instructed bedrest (−69%, −55 to −79).

Conclusion: Day-to-day step count fluctuated, suggesting considerable scope for intervention. Devices or treatments that hinder walking should be reviewed daily and walking activity should become a clinical priority. Admission physical performance may identify vulnerable patients.

The link between older adults and functional decline during or after hospitalization is well established.[1–4] This acquired, transient period of vulnerability[3] can lead to a loss of independence, a higher risk of readmission, falls, and institutionalization.[1]

Hospital clinicians tend to focus treatment on the presenting complaint, without prioritizing hospital events that may contribute to functional decline. However, there is now more focus on reducing these potentially contributing events, such as poor sleep, fasting for examinations, and low mobility.[3,5]

Reduced mobility, one such factor, is modifiable. Self-report,[6] direct observation,[7,8] and accelerometry[9–13] studies report that older medical inpatients walk very little during hospitalization. It has been reported that 35% of ambulatory patients do not walk further than their room,[6] that only 27% walked in the hallways,[8] that 88% of time is spent in the room,[7] with only 1-2 hours spent standing or walking.[10,14] Ambulatory patients take 625-740 steps daily,[12,13] with a maximum recording of 847 steps on the last day of hospitalization.[11] Approximately 600 steps equate to twelve minutes of walking in older slower walkers.[15] It is suggested that 900 steps or more is required to prevent functional decline.[16] However, the evidence indicates that inpatients are below this threshold.

Walking in hospital results in better outcomes; for example, walking outside the room daily was linked with a 1.5-day shorter hospital stay, even when adjusted for age, physical functional and cognitive status, and illness severity.[17] Similarly, an increase of 200 steps from the first to second hospital day was linked with 2 days' shorter hospital stay.[12] Patients who walked more had a significantly shorter hospital stay; a 50% higher step count was associated with a 6% shorter hospital stay, even when adjusted for potential confounders.[13] Conversely, failure to walk outside the room has been linked with a 4 times risk of functional decline.[6]

Walking during hospitalization is important; however, older patients report they are not encouraged to walk,[18] walking around open areas independently is not promoted,[19] and they receive conflicting information from staff.[18,20] Concerns about self-injury, weakness, pain, and fatigue limit their confidence in walking.[20] Nurses reported that mobility is often overlooked[21] and list lack of assistive devices, medical devices or treatments that hampered walking (eg, intravenous lines, wall-mounted oxygen therapy), and fear of falling[16,20,22] as barriers.[20] Walking is not a clearly identified quality indicator[16] and often only begins at discharge preparation.[23] Using a previously validated accelerometer[a] in older medical inpatients,[24] we found that older inpatients walking a median of 600 steps daily and that people who walked more had a significantly shorter hospital stay.[13] However, we remained unclear about factors that limited patient's walking. Therefore, by reexploring the data, the aim of this second analysis was to identify potential factors that may explain inpatients' walking activity. Unlike previously conducted qualitative studies, this quantitative study set out to measure the magnitude of the effect. Therefore, we aimed to measure the effect of time-invariant and time-varying factors on walking (average daily step count) during hospitalization.

Methods

Using the STROBE guidelines, this article reports on a secondary analysis of a previously reported cohort study conducted from July 2014 to January 2015 in a 350-bedded general teaching hospital.[13] Ethical approval was granted by the local research ethics committee (ECM 3 [ss], July 5, 2013).

Patient selection and setting

Participants were recruitment in a 350-bedded teaching hospital. All wards admitted older medical inpatients, including 1 small geriatric ward. Rehabilitation and general staffing levels were comparable across all wards. Irrespective of ward allocation, premorbidly mobile, nonelective, nonsurgical inpatients aged 65 and older, admitted from and planned for discharge home (rather than for institutional care), with an anticipated hospital stay ≥3 days were recruited. Exclusion criteria were inpatients >48 hours prior to screening; unable to follow simple commands in English; or requiring acute psychiatric, active end-of-life or critical care; ordered bedrest or contraindications to walking (eg, hip fracture or high ventricular rate atrial fibrillation); or poor ankle skin condition (precluding attachment of the accelerometer).

Outcome measure

The association between walking activity (average daily step count) and (1) patient presentation on admission (comorbidities, cognitive status, frailty, falls history and falls efficacy, physical performance, quality of life) and (2) daily recorded dynamic factors potentially influencing walking (patient and nurse-reported mobility, pain, fear of falling, walking assistance required, ordered bedrest, fatigue, sleep quality, devices or treatments that hampered walking) were measured.

Walking activity

Walking activity was measured with a triaxial accelerometer (accurate in slow walkers[25,26] and in older medical inpatients[24]) attached above the wearer's dominant malleolus (unless skin fragility requires it to be worn on the opposite ankle).

As per the manufacturer's instructions, the sensitivity of the accelerometer was adjusted for each participant before it was attached, based on the participants' height, gait pattern, and gait cycle (supplemental appendix S1, available online only at http://www.archives-pmr.org/).

Step count was saved in periods of 15 seconds (time interval or epoch), which has good accuracy in older inpatients.[13] The accelerometer was attached with a disposable elastic strap, and the skin was checked daily for irritation and adjusted as required. Step count was summarized as the average daily step count for analysis and downloaded at the conclusion of the patient's participation in the study to the study computer.

Patients presentation on admission (time invariant measures)

Comorbidities

Comorbidities were measured using the Cumulative Illness Rating Scale.[27] This validated tool for geriatric patients measures the severity of impairment for 14 organ systems, with a possible score ranging from 0 to 56, a higher score reflecting a greater impairment in several systems.

Cognitive status

Cognitive status was tested using the 6-item Cognitive Impairment Test,[28] which is quick to administer and has similar diagnostic accuracy to the Mini-Mental State Examination.[29]

Frailty

Frailty was measured using the SHARE FI, a validated and simple frailty instrument based on the Survey of Health, Ageing and Retirement Survey in Europe.[30] Five SHARE variables approximating Fried's frailty definition[31] are used: fatigue, loss of appetite, grip strength, functional difficulties, and physical activity. Four of the 5 domains are self-reported and grip strength is objectively measured. Possible scores range between -2.515 and 6.505, and SHARE-FI gender-specific calculators, freely available on the web, determine the patient's frailty category (frail, prefrail, or robust).[30] Grip strength was measured using a hydraulic hand dynamometer[b] and completed in sitting with the elbow flexed at 90 degrees and kept close to the chest wall. The stronger of 2 attempts was recorded.

Falls history and falls efficacy

The number of patient-recalled falls over the previous 6 months was recorded. Fear of falling was measured using the Falls Efficacy Scale-International (FES-I), a self-reported tool with high internal validity and reliability.[32] The questions aim to determine how concerned older adults are about falling while performing typical community-dwelling tasks or activities on a scale of 1 (not concerned at all) to 4 (very concerned). The patients were asked to report before the onset of their current illness, when they felt well at home. A score above 19 points (out of a possible 64 points) indicates a moderate to high concern about falling.[33] If the patient was unable to complete the report, their next of kin was interviewed. Although next of kin have been found to overestimate patients' fear of falling, the information that they provide is consistent and valuable.[34]

Quality of life

Quality of life was measured using the EuroQol 5 Domain 5 Level Scale[35] and covers mobility, self-care, activity, pain or discomfort and anxiety or depression domains, and a visual analog scale to measure self-reported health status (from 0 to 100). The next of kin completed this questionnaire if the patients were unable to. Evidence exists suggesting that proxy reports are generally poorer than self-reports.[36] However, other studies have found little or no difference between self and proxy reports in older adults,[37] patients with traumatic brain injury and Parkinson disease[38]; therefore, with low participant numbers, the decision to include proxy reports was made.

Physical performance

Physical performance was measured using the short physical performance battery (SPPB).[39] The SPPB is a validated composite tool and includes balance, walking speed, and chair-stand tests. Each section is scored between 0 and 4, the lower scores indicating poorer performance (total score 0-12). Balance was measured with the patient's feet together, in semitandem and in tandem stance. Self-selected walking speed was measured over 2.44 m. Finally, time taken to stand up 5 times quickly with arms folded is measured.

Dynamic factors (recorded daily) (time-varying measures)

Daily factors potentially associated with walking were measured dichotomously (present or absent) as reported by the patient or nursing staff. The questions related to the previous 24 hours and explored the following: patient and nurse-reported mobility, pain, fear of falling, walking assistance required, ordered bedrest, fatigue, sleep quality, and devices or treatments that hindered walking (see supplemental appendix S1).

Procedure

After informed consent, baseline data were recorded from patient notes including demographics, home setup, smoking and alcohol consumption, comorbidities, and medications on

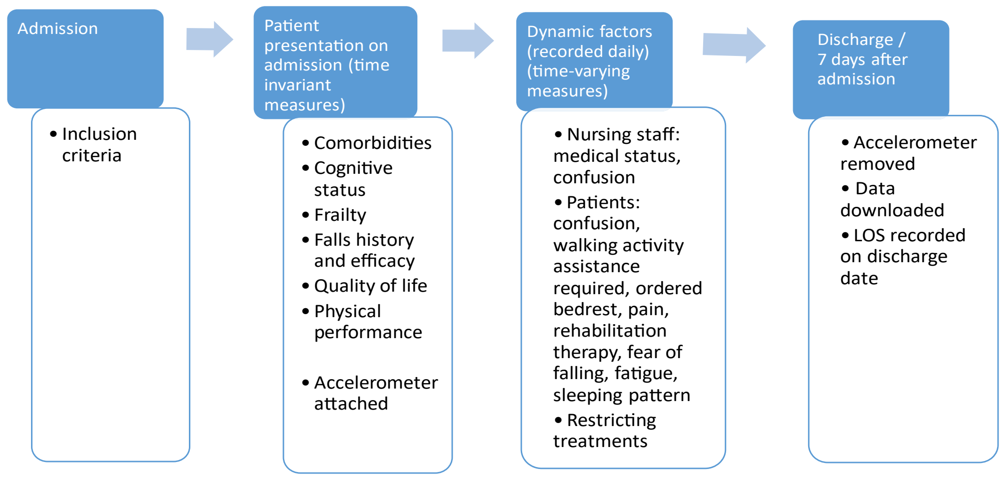

Fig 1 Flow diagram of study. Abbreviation: LOS, length of stay.

admission. Step count was measured using the accelerometer, usually attached mid to late morning. The accelerometer began recording immediately, leaving most patients with between 10 and 13 hours of recorded walking in the first day.

Patients were visited every weekday until discharge or for the first 7 weekdays of hospitalization. Skin condition at the accelerometer site was checked and the nurses and patients were asked the specified questions (see supplemental appendix S1). Patients were not visited at weekends, but continued to wear the accelerometer (fig 1).

On day of discharge or after the first 7 days, the accelerometer was removed and the data were downloaded using the software provided. Length of stay was recorded from the electronic hospital information system.

Table 1 Baseline descriptors and potential barriers to walking with their crude effect on walking

Variable	Mean ± SD	25th, 50th, 75th Quantiles	Effect*
Age (y)	77.5±7.4	71, 78, 83	0.97 (0.94-1)
Height (cm)	169±8	163, 170, 175	0.99 (0.96-1.01)
Weight (kg)	72.9±18.2	58, 70, 84.2	1 (0.99-1.01)
Number of medications	6.6±3.7	4, 7, 8.5	1.03 (0.97-1.09)
CIRS-G	7±2.8	5, 7, 9	1.05 (0.98-1.13)
SPPB	4±3.4	1, 4, 7	1.18 (1.12-1.25)†
Variable		**n (%)**	**Effect***
Women (vs men)		73 (49.7)	1.13 (0.75-1.69)
Medical status			
Stable		261 (49.3)	-
Critical		6 (1.1)	2.39 (1.01-5.67)†
Deteriorating		35 (6.6)	0.72 (0.48-1.09)
Improving		186 (35.2)	1.95 (1.58-2.42)†
At baseline		41 (7.8)	1.65 (1.14-2.38)†
Any therapy on the day prior		157 (29.7)	0.83 (0.65-1.07)
Assigned bedrest		42 (7.9)	0.25 (0.17-0.37)†
Restricting treatments		127 (24)	0.58 (0.44-0.76)†
Fear of falling		145 (27.4)	0.48 (0.36-0.65)†
Fell the previous day		14 (2.6)	0.66 (0.35-1.23)
Pain		156 (29.5)	0.71 (0.54-0.94)†
Tired		287 (54.3)	0.73 (0.58-0.91)†
Needs assistance to walk		153 (28.9)	0.86 (0.66-1.12)
Needs an aid to walk		220 (41.6)	1.07 (0.81-1.41)
Confusion (SqiD)		94 (17.8)	0.55 (0.39-0.8)†
Agitated		9 (1.7)	0.98 (0.43-2.23)

Abbreviations: CIRS-G, Cumulative Illness Rating Scale-Geriatric; SqiD, single question in delirium.
* Effect size was estimated using linear mixed-effects models with log (step count) as the dependent variable.
† Statistically significant scores ($P<.05$).

Table 2 Step-count trajectories for patients over recorded days

Variable	Dependent Variable: Log (Step Count)			
	Empty	+ Day Effect	+ Assessment on Admission	+ Potential Time Varying Influences (Reported Daily)
	(1)	(2)	(3)	(4)
Wednesday		1.25 (1.02, 1.52)*	1.24 (1.02, 1.51)*	1.26 (1.04, 1.53)*
First day		0.44 (0.37, 0.52)*	0.44 (0.37, 0.52)*	0.51 (0.42, 0.62)*
Age (y)			1.00 (0.98, 1.03)	1.00 (0.98, 1.02)
Women (vs men)			1.01 (0.63, 1.61)	0.95 (0.62, 1.46)
Height (cm)			0.98 (0.95, 1.01)	0.98 (0.96, 1.01)
Weight (kg)			1.00 (0.99, 1.02)	1.00 (1.00, 1.01)
Total medications			1.02 (0.96, 1.07)	1.02 (0.97, 1.07)
CIRS-G			1.03 (0.95, 1.10)	1.02 (0.95, 1.08)
SPPB at baseline			1.19 (1.12, 1.27)	1.15 (1.08, 1.22)
Medically critical				1.79 (0.81, 3.94)
Medically deteriorating				0.74 (0.50, 1.08)
Medically improving				1.33 (1.07, 1.64)
Medically at baseline				0.81 (0.56, 1.17)
Any therapy the day prior				0.85 (0.68, 1.07)
Assigned bedrest				0.31 (0.21, 0.45)
Fear of falling				0.88 (0.65, 1.18)
Falls				1.13 (0.65, 1.97)
Pain				0.85 (0.66, 1.10)
Restricting treatments				0.71 (0.56, 0.91)
Tired				0.92 (0.75, 1.12)
Needs assistance				0.84 (0.63, 1.11)
Needs an aid				1.08 (0.82, 1.44)
SqiD				1.05 (0.76, 1.46)
Agitated				1.58 (0.76, 3.32)
Constant	387.73 (315.77, 476.00)	474.67 (383.07, 588.35)	174.80 (96.18, 317.36)	279.80 (154.36, 504.32)
Observations	529	529	529	529
Log likelihood	−877.57	−837.34	−817.8	−780.83
Akaike inf. crit.	1761.13	1684.68	1659.59	1615.66
Bayesian inf. crit.	1773.95	1706.03	1710.85	1730.97

Abbreviations: CIRS-G, Cumulative Illness Rating Scale-Geriatric; SqiD, single question in delirium.
* $P < .05$.

Statistical methods

Categorical variables were described by count and proportion. Normally distributed continuous variables were reported as mean ± SD, 25th, 50th, and 75th quartiles, and range.

The relations between log-transformed daily step count and the daily recorded factors associated with walking were estimated with linear mixed-effects regression models. We estimated 4 models in total. Each included a random effect for patient to account for the clustered or longitudinal nature of the data. The first was an empty model with no covariates, used to evaluate the within and between-patient variability in daily step counts. In the second model, based on preliminary analyses of the data, we added indicator variables for when the observations occurred on the first day of observation, or on a Wednesday (when a peak in step count had been detected). In the third model, we added measurements taken on admission. In the final model, we added the daily dynamic factors. All models used a complete case sample, and model assumptions were explored using standard methods.

Fixed effects estimates from the mixed models are presented as ratios of geometric means (95% confidence interval [95% CI]). The *P* values are for 2-sided tests of the null hypothesis of no association ($\beta=0$). All analyses were conducted using R version 3.4.0.[c]

Results

Of the 2154 medical patients aged ≥65 years admitted during the study period, resources only permitted 227 to be screened, an average of 2 patients daily. Patients were screened in order of admission each recruitment day. Of these, 69 did not meet study criteria, 4 refused, and 154

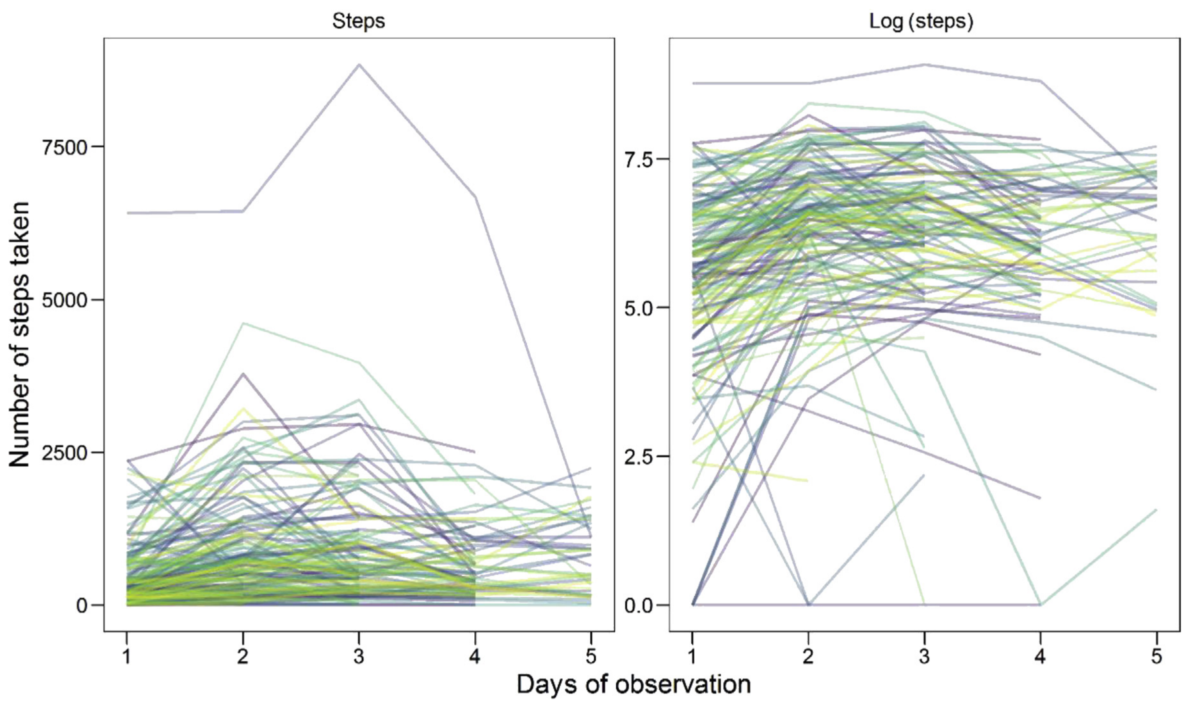

Fig 2 Step-count trajectories for patients over recorded days.

(mean age ± SD [y], 77.5±7.4; 50% women) consented. Most patients were recruited on Tuesday (n=44), the least on Monday (n=23), and all other days were similar (n=29). Seven patients had missing data, leaving 147 patients in our analytical sample.

Patient presentation on admission

Participants had many comorbidities (Cumulative Illness Rating Scale-Geriatric, 6.9±2.8) and prescribed medications (6.6±3.7). Most were categorized as frail (98 [64%]). Physical performance was typically low (SPPB, 4.0±3.4) and fear of falling was high (FES-I, 32.6±14.4). Seventy-three patients (50%) were independently mobile, 43 (29%) were walking-aid users, 24 (16%) required assistance, and 7 (5%) were unable to walk (although premorbidly mobile). Patients' median length of stay was 7 nights (interquartile range, 4-10). Other data are presented in table 1.

Dynamic factors (recorded daily)

Dynamic factors were assessed on average 4.1 weekdays per patient; 22 patients were observed for fewer than 3 weekdays. A total of 529 observations were recorded (table 2). Most patients (347 [84.5%]) were medically *stable* or *improving*; 14 (2.6%) reported a fall, while 145 (27%) reported fear of falling. Complaints of pain (156 [30%]) and fatigue (287 [54%]) were common. Many needed an aid (220 [42%]) or assistance (153 [29%]) to walk. More patients needed assistance to walk during hospitalization than on admission, mostly because of connected devices or treatments that hindered walking or occasionally, with a deterioration in walking ability.

Walking patterns

The accelerometer was tolerated well, with no complaints of irritation or pain. The patient-level step-count trajectories are displayed in fig 2. The crude within-patient estimated variance was 1.23, which was 53% of the total variance, and this variance remained consistent across the 4 models (estimates not shown).

Step count on the first day was 56% lower than other days (95% CI, 0.37-0.52) (see table 2), as expected. Preliminary analysis found that step count was 25% higher on Wednesdays (95% CI, 1.02-1.52) (see table 2).

Factors associated with daily step count

The SPPB was the only measurement on admission strongly associated with walking, with a 1-unit increase in SPPB associated with a 15% increase in step count (95% CI, 1.08-1.22) (see table 1). Many dynamic factors including deteriorating medical status, assigned bedrest, devices or treatments that hampered walking, fear of falling, pain, fatigue, and confusion were associated with less walking. However, in the fully adjusted models, only *improving* medical status (1.33; 95% CI, 0.95-1.10), assigned bedrest (0.31; 95% CI, 0.21-0.45), and devices or treatments that hampered walking (0.71; 95% CI, 0.56-0.91) remained significant. Needing assistance and fear of falling were still associated with reduced step count (15% reduction), but the 95% CIs included a null effect. Assigned bedrest and devices or treatments that hampered walking appeared to be predominant barriers and occurred frequently (151 total patient days). However, in a post hoc analysis with these patient days removed, we found broadly similar results for the other dynamic factors (supplemental table S1, available online only at http://www.archives-pmr.org/).

Discussion

Our analysis showed 3 main findings. First, walking varied greatly, with most variability (53%) occurring within patients and with no detectable increase over time. Second, admission on physical performance was the only independent predictor of walking. Third, devices or treatments that hindered walking (and bedrest) were frequently present and had a considerable effect on walking, while *medically improving* patients were more active.

Physical performance on admission was the only predictor of walking activity and has been suggested previously[40] as a useful screening tool. The SPPB is a quick assessment and could be used to identify patients needing support and assistance with a structured intervention.

Within-patient walking variability remains largely unexplained and suggests that walking may be a haphazard activity. Half of the patients did not need assistance to walk; however, they remained inactive. Previous evidence has shown that patients are not encouraged to walk nor that walking independently in the hospital is promoted.[18,19] The variability in walking emphasizes an opportunity for interventions to promote walking and the need for daily vigilance. Contrary to previous reports,[20] pain and fatigue did not appear to determine walking activity. Similarly, the need for assistive devices, previously reported as a barrier,[20] while associated with less walking, was not significant. However, devices or treatments that hampered walking (which have been previously reported as a barrier[20]) were common and limited walking by 30%. The strong effect of these devices or treatments suggests simple measures like removing completed intravenous tubing promptly, pausing slow infusions for periods, wheeled intravenous poles pushed by the patients themselves, and access to small oxygen canisters may considerably affect walking.

The reason for heightened activity on Wednesday is unclear. Resources limited recruitment on Mondays, with most patients recruited on Tuesday. The patients' awareness of the recording may have encouraged more walking (indeed, many patients reported this anecdotally). Irrespective of the day, patients walked most on the second day of recording (median 681 [interquartile range, 298-1191]). From then on, step count was haphazard and remained lower (see fig 2). To note, the accelerometer used did not provide visual step-count feedback, which has shown to increase walking in orthopedic, stroke, and geriatric hospitalized patients.[41–43] This could have further augmented or maintained this encouragement. Another possible explanation may be heightened hospital activity midweek. An ethnographic study, including patient interviews and observation, may better explain factors including complex patient-environment interactions, such as hospital- or illness-related anxiety, or interactions with others.

Study limitations

This exploratory study had some limitations. The dichotomously measured dynamic factors may have weakened their effect on the highly variable walking activity. Using the Barthel Index may have helped describe the cohort. Resources did not allow full recruitment of patients on Monday or step-count data collection for the full duration of the hospital stay. The results are limited to older medical inpatients; they may not be generalizable to other cohorts such as neurologic or surgical patients. The percentage of proxy reports of the FES-I and EuroQol 5 Domain 5 Level Scale was not recorded, limiting evaluation from these findings. Results from 6-CIT showed that 58 participants (38%) scored less than 6 of 28 points, indicating cognitive impairment,[28] and the author (R.M.C.) anecdotally recalls that proxy reports were mostly used for these patients. And finally, data on the weekend dynamic factors would considerably strengthen the finding of this study, because it is well known that hospital activity can differ greatly from weekday services.

Conclusions

The within-patient walking variability suggests that walking tends to be a haphazard activity, with scope to improve walking activity with defined interventions. Patients with poor physical performance at baseline may need targeted encouragement, support and referral to rehabilitative services. Patients should be encouraged to walk daily. Devices or treatments that hindered walking had a strong effect on walking activity, and thus, should be reviewed regularly with this in mind.

Suppliers

a. Modus Stepwatch; Modus Health LLC.
b. Jamar hand dynamometer; Sammons Preston.
c. R version 3.4.0; R Foundation for Statistical Computing.

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