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Pilot Study Examining the Association Between Ambulatory Activity and Falls Among Hospitalized Older Adults

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Abstract

Objective—To examine the ambulatory activity of older patients who had a documented fall during hospitalization for acute illness.

Design—A retrospective case control design was used in a pilot study of 10 patients 65 years and older who had a documented fall during their hospital stay (cases) and 25 matched controls who did not fall.

Setting—Acute care medical / surgical unit.

Participants—Men and women 65 years and older who wore a step activity monitor while hospitalized.

Interventions—N/A

Main Outcome Measures—Fall incidents during the hospital stay were documented by the nurse in a standardized patient safety event report in accordance with hospital policy. Number of steps per 24-hour interval, time spent walking, and total number of activity episodes were determined for cases and controls.

Results—On average, patients who fell took 480.3 (432.2) steps per hospital day, spent 53.8 (36.9) minutes walking, and engaged in 25.8 (16.9) episodes of activity. Mean daily steps, time spent walking, and number of activity episodes for patients who did not fall were 680.1 (876.0), 50.1 (58.6), and 21.6 (23.8), respectively. Logistic regression results indicated no association between the fall outcome and mean daily steps (OR=0.95, 95% CI=0.84–1.06).

Conclusions—Ambulatory activity among patients who fell varied widely. Mean daily steps, time spent walking, and number of episodes of activity were comparable to matched controls who did not fall. Patient falls were more likely to be associated with cognitive and hospital environmental factors than actual amount of walking.

Keywords

geriatrics; falls; hospitalization

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Medicare no longer reimburses hospitals for treatments relating to in-hospital falls.[1] As a result, there is concern that efforts to prevent fall-related injuries will have unintended consequences and come at the expense of other important outcomes.[2] For example, one consequence might be reduced patient mobility leading to hospital related functional decline. Objective information on the ambulatory activity of older patients who fall is lacking, however. Also lacking are data on how the activity of patients who fall compares to that of similar patients who do not fall. In this pilot study, we used accelerometer technology and a case-control design to examine the association between ambulatory activity and falls among older hospitalized patients. Total daily steps, time spent walking, and number of activity episodes were compared between patients who had a documented fall during their hospital stay (cases) and matched controls who did not fall.

METHODS

Setting and sample selection

A case-control design was used to study a cohort of 10 patients 65 years and older who had a documented fall during their hospitalization and 25 matched controls who did not fall. All patients were admitted to the Acute Care for Elders (ACE) unit at a university teaching hospital. A Step Activity Monitor (SAM) was placed around the patient's ankle on the day of admission and worn until discharge. This pilot was part of a larger study examining the ambulatory activity of hospitalized older adults.[3] The 10 patients who fell (cases) all had an inpatient fall report and wore a SAM for at least 3 days during hospitalization. The 25 (2 to 4 for each case) were matched on age, gender, reason for admission, illness severity, and mobility status prior to admission. The study received ethical approval from the University's Institutional Review Board.

Assessment of ambulation

The SAM is a pager sized, waterproof, dual-axis accelerometer worn around the ankle using a Velcro strap. It has been shown to be 98% accurate in a variety of clinical populations, including individuals with very slow or shuffling gait.[4] Stride counts (steps) were recorded in 1-minute intervals synchronized to a 24-hour clock resulting in a temporal series of 1,440 observations per day.

Independent measures

Number of steps per 24-hour (midnight to midnight) interval was the primary independent variable. Steps were defined as the number of stride counts recorded by the monitor multiplied by two. A mean daily steps parameter was calculated based on the number of complete 24-hour days the SAM was worn. Total minutes of ambulatory activity, defined as the number of 1-minute intervals recorded by the monitor with stride count >0, and number of activity episodes, defined as the number of 1-minute intervals the subject switched from inactivity (stride count=0) to activity (stride count >0) were also determined. Patient demographic and clinical information was obtained from the electronic medical record.

Outcome measure

Falls (yes vs. no) were determined by inpatient fall report documentation. Fall incidents during the hospital stay were documented by the nurse in a standardized patient safety event report in accordance with hospital policy. A fall was defined as a patient unintentionally descending to the floor.

Data Analysis

Descriptive statistics were reported as percentages for categorical measures and means (standard deviations [SD] or interquartile ranges) for continuous measures. Differences between groups were assessed with Fisher's Exact and Mann-Whitney U tests for categorical and continuous measures, respectively. Testing was 2-sided using an alpha 0.05. The pattern of total daily steps for patients who fell across hospitalization days was graphed for visual analysis. Conditional logistic regression was used to calculate the odds ratio (95% confidence intervals [CI] per 100 step intervals) as a measure of association between fall outcome (0=no fall, 1=fall) and mean daily steps. The first model included mean daily steps only. The second model added statistically significant variables from the bivariate analyses. Conditional logistic regression is appropriate when studying matched pairs. Cohen's d statistic was also calculated as a measure of effect size between cases and controls for each of the 3 ambulatory activity parameters: mean daily steps, time spent walking, and episodes of activity. All analyses were performed using SAS version 9.2 (SAS Institute, Inc., Cary, NC).

RESULTS

The mean age of the sample was 76.3 (SD=6.7) years; a majority were female (60.0%). Cardio-pulmonary conditions (48.6%) were the most common reasons for admission. Average length of hospital stay was 6.5 days (SD=3.5).

Characteristics of cases and controls are shown separately in Table 1. Only delirium (p=0.02) and length of hospital stay (p <0.001) demonstrated statistically significant differences between cases and controls. Cases had a higher incidence of delirium and, on average, longer lengths of stay.

Mean daily steps for the entire sample was 623.0 (interquartile range 63.5–843.0). Table 1 also shows ambulatory activity parameters for cases and controls. There was no association by mean daily steps (p=0.87), time spent walking (p=0.18), or number of activity episodes (p=0.16).

Figure 1 shows the pattern of total daily steps for patients who fell. The day the fall occurred is labeled with an “F”. There were no clear patterns of ambulation across hospitalization days. All patient falls occurred in evening or night time between the hours of 4:00 pm and 8:00 am; 60% of falls occurred during bathroom-related circumstances.

As a sensitivity analysis we also compared number of steps in the 24 hours prior to the fall for cases to that of controls matched to a comparable day in their hospital stay. On average, cases took 512 steps (SD=684.7) on the day prior to the fall and controls 524.5 steps (SD=804.3) (*p*=1.00).

Results of conditional logistic regression indicated no association between the fall outcome and mean daily steps (OR=0.95, 95% CI=0.84–1.06). The odds ratio was similar (OR=0.88, 95% CI=0.71–1.11) after controlling for differences in statistically significant variables (Delirium and Length of Stay).

Cohen's *d* was 0.29 for mean daily steps; 0.08 for time spent walking; and 0.20 for episodes of activity. A Cohen's d effect size of 0.2 to 0.3 could be considered a “small” effect.[5]

DISCUSSION

The purpose of this pilot study was to examine ambulatory activity in a cohort of acutely ill older patients who had a documented fall (cases) during their hospital stay and matched

controls that did not fall. Cases and controls were matched on age, sex, mobility status prior to admission, reason for admission, and illness severity. Ambulatory activity varied widely within both groups. Patients who fell did not significantly differ from controls by number of mean daily steps, minutes of ambulatory activity, or number of activity episodes. Presence of delirium was the only patient factor that significantly differentiated cases and controls.

Recent Medicare policy changes intended to realign hospital financial incentives with quality of care will naturally increase efforts to reduce patient falls. Careful consideration is warranted, however, if a consequence of these efforts is the perception that the safest patient is one who stays in bed. Inactivity in acutely ill older adults can initiate a myriad of pathophysiological events that facilitate rapid losses of muscle mass and physical function.[5] Amount of ambulation varied widely in our study, but overall was profoundly low - approximately 1/10th levels observed for older adults living in the community.[6]

Patients who did and did not fall walked very little, but what walking they did occurred in frequent short bouts. Similar findings have been observed in previous studies that did not have the benefit of actual step counts.[7] This suggest strategies aimed at increasing patient activity and reducing falls might consider approaches that include more *scheduled* walking programs and toileting.[89]

Confusion or delirium was the only patient factor strongly associated 203 with the fall outcome. Previous research has linked impaired cognition and falls.[11] Our findings provide further evidence it may also be a risk factor for low mobility. Sub-group analysis showed patients with delirium ambulated less, on average, than those without delirium (mean daily steps: 354.3±470.3 vs. 730.5±851.0, respectively). Efforts to provide safe walking practices for older cognitively impaired patients and prevent acute delirium[12] may provide high return on investment by reducing both falls and low mobility.

Study Limitations

A primary limitation of this pilot study was its small sample size and subsequent lack of statistical power. We would have been able to detect a large effect size of 1.0 or above with power of 0.8 based on a paired-t test at 0.05 two-sided significance level. This translates to about a 600 step difference between cases and controls. Power-related lack of statistical significance notwithstanding, the observed effect likely has little clinical significance in this context. Prior to the day of the fall, the mean difference of approximately 100 steps per day between the 2 groups could be eliminated with a single episode of 2–3 minutes of continuous slow walking per day.[13]

The important message appears to be that in-hospital walking behaviors are similar for patients who do and do not fall, and alone, may be a poor predictor of falls. Any efforts to reduce fall related injuries in-hospital will likely require multi-component initiatives that address modifiable risk factors for all patients[10] -- and take into consideration potential impacts on already low levels of mobility in this population.

CONCLUSIONS

The ambulatory activity among patients who fell and matched controls that did not fall was very similar. Patient falls were more likely to be associated with cognitive and hospital environmental factors than actual amount of walking. Issues surrounding the prevention of fall related injury in older patients are complex. Findings from this pilot study suggest that limiting patient mobility as a general approach to reducing falls may be too simplistic.

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Dr. Fisher had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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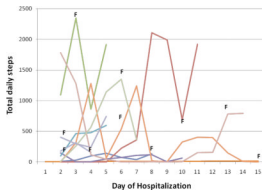

Figure 1.
Pattern of Total Daily Steps for Patient who Fell (cases) during Hospitalization
"F" indicates the day that the fall occurred.

Table 1

Demographic and Clinical Characteristics of Cases and Controls.

Characteristic	Cases N = 10	Controls N = 25	p-value
Age, mean (SD)	77.8 (7.8)	75.7 (6.3)	0.50
Female	60.0%	60.0%	0.10
Body Mass Index, mean (SD)	25.4 (5.1)	28.3 (6.9)	0.32
Mobility Prior to Admit			1.00
Independent	40.0%	48.0%	
Cane or Walker	50.0%	44.0%	
Dependent[a]	10.0%	8.0%	
Confusion / Delirium	60.0%	16.0%	0.02
Restricted[c]	50.0%	20.0%	0.11
Frequent Need to Toilet Medications[d]	60.0%	60.0%	1.00
Toileting			0.70
Independent	55.6%	66.7%	
With assist	33.3%	29.2%	
Dependent	11.1%	4.2%	
Physician Activity Orders[e]			0.74
As tolerated	50.0%	56.0%	
Ambulate with assist	20.0%	8.0%	
Bed rest[f]	30.0%	36.0%	
Reason for Admission			1.00
Cardiopulmonary	50.0%	48.0%	
Gastrointestinal	20.0%	20.0%	
Endocrine/Metabolic	10.0%	16.0%	
Neurological	10.0%	8.0%	
Other	10.0%	8.0%	
Charlson Comorbidity Index, mean (SD)	3.3 (1.8)	2.5 (1.8)	0.25
Illness Severity[g]			1.00
minor or moderate	30.0%	28.0%	
major or extreme	70.0%	72.0%	
Length of Stay in days, mean (SD)	9.4 (3.95)	5.2 (2.48)	<0.01
Daily Steps[h], mean (SD)	480.3 (432.2)	680.1 (876.0)	0.87
Daily Minutes of Activity[i], mean (SD)	53.8 (36.9)	50.1 (58.6)	0.18
Daily Activity Episodes[j], mean (SD)	25.8 (16.9)	21.6 (23.8)	0.16

[a] Requiring significant help from another.

[c] Mobility restricted by tubing or monitoring equipment during the nurse's admission assessment.

[d] Antihypertensives, diuretics, or laxatives.

[e] Activity orders at hospital admission only.

[f] Bed rest orders for all cases and controls were revoked within 48 hours of admission.

[g] The Center for Medicare and Medicaid Services All Patient Refined-Diagnosis Related Group (APR-DRG) severity of illness classification: a modification of the traditional DRG that adds 4 classes of illness severity: 1=minor, 2=moderate, 3=major, and 4=extreme.

[h] Based on the number of complete 24 hour days the SAM was worn.

[i] Total minutes of ambulatory activity, defined as the number of 1-minute intervals recorded by the monitor with stride count greater than 0.

[j] Total episodes of activity, defined as the number of 1-minute intervals the subject switched from inactivity (stride count = 0) to activity (stride count >0).