Factors that differentiate level of ambulation in hospitalised older adults

SIR—The adverse effects of low mobility in older hospitalised persons are well documented [1, 2]. The amount of time patients are limited to a bed or chair is an independent predictor of functional decline even after controlling for illness severity [3]. Ambulation is a potentially simple intervention to reduce low mobility in-hospital. A number of factors, however, can interact to influence how much a patient actually walks. Identifying factors associated with varied levels of ambulation would help clinicians identify older patients at risk for low levels of mobility. Although, previous studies have investigated perceived barriers to ambulation during hospitalisation from the perspectives of older patients and their primary nurses and physicians [4], no study has examined relevant factors using direct measures of ambulatory activity such as step counts.

We recently demonstrated that accelerometer technology can be used to collect continuous information on patient mobility in hospitalised older persons [5]. For this study, our objective was to identify subgroups of patients with shared clinical profiles who differed with respect to mean daily ambulation.

Methods

A cohort of patients 65 years and older admitted to an Acute Care for Elders (ACE) unit at a university teaching hospital was studied. A Step Activity Monitor (SAM) was worn by all patients from admission to discharge. Data were collected over a 5-month period in 2009; eligible patients included those 65 years or older of either gender. Patients were excluded for active bilateral lower leg infection, severe lower leg oedema, bilateral lower extremity amputations, terminal illness (i.e. admitted on a hospital contract) or severe agitation. Only patients with at least two complete 24-h days in-hospital were included in the analysis. The final sample included 198 patients. The study received approval from the University Institutional Review Board.

Assessment of ambulation

The SAM is a pager-sized accelerometer worn around the ankle using a Velcro strap [6–9]. It provides no feedback to the wearer and is impervious to tampering. Total daily steps were determined for each patient and defined as the number of stride counts recorded by the monitor per 24-h (midnight-to-midnight) day multiplied by two.

Outcome

A mean daily steps metric was calculated for each patient based on the number of complete 24-h days the SAM was worn.

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Independent measures
Information on patient demographic and clinical measures was obtained from the electronic medical record (see Table 1).

Statistical analysis
Descriptive summaries were tabulated for all patient characteristic variables. Multiple linear regression was used to determine the strengths of association between patient characteristics (demographic and clinical measures) and mean daily steps when controlling for other-related variables. Variables not demonstrating a statistically significant association with mean daily steps were removed via a backwards elimination step to achieve the most parsimonious model.

Classification and regression tree (CART) analysis was then used to evaluate more completely the association between the mean daily steps and the significant predictors identified in the parsimonious model. CART analysis creates a hierarchical order of potentially complex interactions among the predictor variables. These interactions are evaluated recursively instead of simultaneously as in linear regression. Recursive partitioning identifies homogeneous subgroups of patients with shared clinical profiles having the largest difference in the outcome metric (mean daily steps). This process results in a classification rule and is represented as a tree. These decision trees are simple to...
interpret, are frequently found in clinical settings and can be used at bedside [10]. Alpha was set to 0.05. SPSS version 14 (SPSS, Inc., Chicago, IL, USA) was used for all statistical analysis.

Results

Patient and clinical characteristics are presented in Table 1. Mean age was 76.9 (SD, 7.8) years. Mean length of stay was 6.2 (SD, 2.9) days. Mean daily steps for the sample was 585.0 (SD, 738.0). The median value was 332 steps per day. The Table also shows parameter estimates, standard errors and significance values for all independent variables entered into the regression model as well as separately for the parsimonious model containing only significant factors. Ethnicity, prior mobility status, diagnostic category and illness severity were significantly associated with the mean daily steps outcome.

The results of the CART analysis are shown in the Figure 1. As expected, prior mobility status was the strongest determinant differentiating patients based on their mean daily steps during hospitalisation. Among patients who reported being mobility independent 2 weeks prior to hospitalisation, diagnostic category was the most important factor. Patients with neurologic or orthopaedic/musculoskeletal conditions walked significantly less than those with all other medical diagnoses. Among those patients with a medical diagnosis, non-white patients walked significantly less than white patients. Lastly, among white patients who were hospitalised for a non-orthopaedic or neurologic condition, and previously mobility independent, illness severity was the strongest determinant. Overall, the four predictors in the CART model explained approximately 21% of the variance in mean steps per day within the entire data set.

Discussion

The purpose of this study was to identify important factors that influenced level of ambulation among older patients using accelerometer-based technology. Using two analytic approaches, we identified homogeneous subgroups of older patients based on their mean daily step counts. In hierarchical order, prior mobility status, diagnostic category, ethnicity and illness severity were the strongest determinants differentiating this sample of older patients based on their mean daily steps.

The use of a cane or walker prior to admission was strongly associated with a reduced overall level of ambulation. Prior use of a cane or walker has been previously
associated with adverse outcomes in this population [11, 12]. Qualitative research has shown the lack of ambulatory devices for use in the hospital and need for assistance with ambulation are perceived to be barriers to mobility by nursing staff, potentially lessening the likelihood that these patients will walk during their hospital stay [3]. Patients with a history of prior assistive device use may require increased attention from the health care team in regard to mobility status and may benefit from more intensive in-hospital and post-hospital rehabilitative therapy.

The reason for admission categorised patients, who were independent ambulators prior to admission, into two distinct subgroups with respect to mean daily steps. Understandably, orthopaedic/musculoskeletal and neurologic conditions were associated with the lowest ambulation levels. Either can have a direct effect on walking ability, and the low levels of ambulation we observed provide face validity for use of the SAM in this setting. Mobilisation has been shown to improve outcomes after hip fracture surgery and is also an important component of neurologic rehabilitation [13, 14]. Ambulation protocols, however, do not exist for patients with acute medical diagnoses (i.e. conditions other than orthopaedic or neurologic).

The different medical diagnoses (cardio-pulmonary, infectious etc.) represented a shared clinical profile and separate subgroup in the current study. These similar levels of ambulation suggest that interventions and programmes designed to reduce low mobility among the broad category of ‘older adults admitted for acute medical illness’ are possible and potentially important components of patient care.

Ethnic minorities with acute medical illnesses ambulated significantly less than white patients with like diagnoses. Older ethnic minorities living in the community have been shown to have lower overall levels of functioning than white older adults [15]. Non-white older patients also have lower rates of functional recovery after an acute hospitalisation [16]. Similar to our findings regarding prior assistive device use, older ethnic minority status may be a risk factor for low mobility during hospitalisation—as any pre-morbid mobility deficits are amplified while hospitalised.

Illness severity was a differentiating factor among a specific patient subgroup, i.e. whites with an acute medical illness who were mobility independent prior to hospitalisation. Previous research has shown the amount of time older patients with acute medical illnesses were confined to bed or chair predicts decline in ADLs, new institutionalisation and death even after controlling for illness severity [3]. Our findings suggest illness severity may be the predominant factor in regard to level of ambulation primarily among those patients without pre-morbid impairments or disease that directly affects walking.

Our study has limitations. First, there are many possible factors associated with an acute hospital stay that could influence walking behaviour. For example, we did not assess patient perceptions and attitudes. A recent study has found that 97% of geriatric patients report symptoms related to their condition influence how much they walked in hospital [4]. Second, CART analysis is a data-driven statistical technique [17]. Nevertheless, it provided a practical format for describing and understanding the relationships between factors relevant to acute hospitalisation and mean step activity. This approach has also been used in many clinical settings to classify patient risk and develop clinical guidelines [18–21].

In conclusion, accelerometer technology allowed the collection of objective information on ambulatory activity during hospitalisation which was then used to classify patient risk for low mobility. Hospital ambulation varied significantly according to identifiable patient and clinical characteristics. This knowledge could inform interventions and programmes designed to reduce low mobility in at risk older patients and aid in the development of clinical guidelines for ambulation in-hospital.

**Key points**

- Older patient ambulation varied significantly according to identifiable and clinically relevant characteristics.
- Ethnic minorities and patients with a history of prior assistive device use may require increased attention from the health-care team in regard to mobility status.
- Efforts to reduce low mobility among the broad category of older adults hospitalised for an acute medical illness are potentially important components of patient care.

**Conflicts of interest**

None declared.

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Relationship between sedentary behaviour, physical activity, muscle quality and body composition in healthy older adults

SIR—Sedentary behaviour (SB), defined as time spent sitting or lying, has been shown to be a major modifiable risk factor for chronic disease, disability and frailty [1] independently physical activity levels (PA) [2, 3]. Time spent sitting or lying affects muscle physiology [4], is thought to accelerate sarcopenia [5], and to be a determinant driver of the obesity epidemic [6]. These two effects of SB: obesity and low muscle strength appear to potentiate each other to increase risk of disablement and frailty in older adults [7].