Walking Speed Threshold for Classifying Walking Independence in Hospitalized Older Adults

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Background. Walking speed norms and several risk thresholds for poor health outcomes have been published for community-dwelling older adults. It is unclear whether these values apply to hospitalized older adults.

Objective. The purpose of this study was to determine the in-hospital walking speed threshold that best differentiates walking-independent from walking-dependent older adults.

Design. This was a cross-sectional study.

Methods. This study recruited a convenience sample of 174 ambulatory adults aged 65 years and older who had been admitted to a medical-surgical unit of a university hospital. The participants' mean (SD) age was 75 (7) years. Fifty-nine percent were women, 66% were white, and more than 40% were hospitalized for cardiovascular problems. Usual-pace walking speed was assessed over 2.4 m. Walking independence was assessed through self-report. Several methods were used to determine the threshold speed that best differentiated walking-independent patients from walking-dependent patients. Approaches included a receiver operating characteristic (ROC) curve, sensitivity and specificity, and frequency distributions.

Results. The participants' mean (SD) walking speed was 0.43 (0.23) m/s, and 62% reported walking independence. Nearly 75% of the patients walked more slowly than the lowest community-based risk threshold, yet 90% were discharged home. Overall, cut-point analyses suggested that 0.30 to 0.35 m/s may be a meaningful threshold for maintaining in-hospital walking independence. For simplicity of clinical application, 0.35 m/s was chosen as the optimal cut point for the sample. This threshold yielded a balance between sensitivity and specificity (71% for both).

Limitations. The limitations of this study were the small size of the convenience sample and the single health outcome measure.

Conclusions. Walking speeds of older adults who are acutely ill are substantially slower than established community-based norms and risk thresholds. The threshold identified, which was approximately 50% lower than the lowest published community-based risk threshold, may serve as an initial risk threshold or target value for maintaining in-hospital walking independence.
Walking speed is a commonly used clinical measure. Slow walking speed is associated with several adverse health outcomes, including poor general health, mobility disability, low physical and cognitive functioning, falls, hospitalization, loss of independence, and death. Studenski and colleagues stated that walking speed, a convenient physical performance measure, can serve as a “vital sign” for assessing health-related risks and needs of older adults in clinical settings.

Walking speed standards and risk thresholds for community-dwelling older adults are well established. “Normal” walking speeds for community-dwelling older adults who are healthy generally range from 0.90 to 1.30 m/s, whereas walking speeds ≤0.60 to 0.70 m/s are strong risk factors for poor health outcomes. Given the detrimental effects of acute illness and hospital-related inactivity on physical functioning, hospitalized older adults generally walk at speeds below these community-based benchmarks. Mean walking speeds of 0.50 and 0.23 m/s have been reported for older adults in hospital and geriatric rehabilitation settings, respectively. Thus, it is clear that the published norms and risk thresholds that have been established for older adults in the community are not practical (sensitive) for hospitalized older adults who are acutely ill. What is less clear, however, is whether there is other clinically relevant information within the truncated distribution of walking speeds among hospitalized older adults to justify collecting and interpreting those data.

The objective of this pilot study was to identify the walking speed threshold value that best differentiates walking-independent patients from walking-dependent patients in a sample of hospitalized adults aged 65 years and older. Preventing hospital-based functional declines and maintaining walking independence are critical to the long-term health and quality of life for older adults. Our study addressed the first step in this process: identifying relationships between modifiable risk factors and other health outcomes. In turn, this information may be useful for developing in-hospital therapy goals and suggesting postdischarge care decisions. Both the study design and clinical implications of the findings were shaped by the context of typical patient evaluation and management scenarios for hospital-based therapists.

**Method**

**Sample**

Data were collected from a convenience sample of older adults admitted to the Acute Care for Elders (ACE) unit in the University of Texas Medical Branch hospital in 2007. Patients were eligible for inclusion if they: (1) were aged 65 years or older, (2) were admitted on a weekday and consented to participate in the study within 24 hours of admission, (3) were deemed cognitively appropriate to provide self-reported health and functioning information via nurse screening using the Short Portable Mental Status Questionnaire, and (4) reported being able to walk across a small room 2 weeks prior to admission.

Over the study period, 403 patients were screened. Of the 403 patients screened, 261 met initial inclusion criteria and were eligible for the study. The remaining patients were excluded for a variety of reasons, including death, surgery, or transfer to another hospital before the completion of the study.

**The Bottom Line**

**What do we already know about this topic?**

Walking speed is an important health indicator in older adults. Critical thresholds for community-dwelling populations range from 0.6 to 0.7 m/s. Older adults who are acutely ill and hospitalized walk much slower than these previously published standards.

**What new information does this study offer?**

Useful information was found in the relatively compact distribution of walking speeds of older patients. Preliminary findings suggest that 0.35 m/s may serve as a risk threshold or target value for maintaining in-hospital walking independence.

**If you’re a patient, what might these findings mean for you?**

Physical therapists in the acute hospital setting often develop plans of care to help patients maintain or recover walking independence. Findings from this study may help your physical therapist set measurable, meaningful goals when developing a plan of care.
Walking Independence in Hospitalized Older Adults

Table 1. Patient Characteristics Overall and Stratified by Walking Speed Categories

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total</th>
<th>Dependent</th>
<th>Independent</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of patients</td>
<td>174</td>
<td>66</td>
<td>108</td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>75.27 (6.91)</td>
<td>76.47 (7.07)</td>
<td>74.54 (6.74)</td>
<td>.07</td>
</tr>
<tr>
<td>Women</td>
<td>58.6%</td>
<td>66.7%</td>
<td>53.7%</td>
<td>.09</td>
</tr>
<tr>
<td>Race</td>
<td></td>
<td></td>
<td></td>
<td>.49</td>
</tr>
<tr>
<td>White</td>
<td>65.5%</td>
<td>62.1%</td>
<td>67.6%</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>23.0%</td>
<td>22.7%</td>
<td>23.1%</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>11.5%</td>
<td>15.2%</td>
<td>9.3%</td>
<td></td>
</tr>
<tr>
<td>Body mass index (kg/m²)</td>
<td>28.06 (7.24)</td>
<td>29.79 (8.31)</td>
<td>27.00 (6.30)</td>
<td>.02</td>
</tr>
<tr>
<td>Admit diagnosis</td>
<td></td>
<td></td>
<td></td>
<td>.53</td>
</tr>
<tr>
<td>Cardiovascular problems</td>
<td>40.8%</td>
<td>34.8%</td>
<td>44.4%</td>
<td></td>
</tr>
<tr>
<td>Gastrointestinal problems</td>
<td>14.9%</td>
<td>15.2%</td>
<td>14.8%</td>
<td></td>
</tr>
<tr>
<td>Trauma</td>
<td>4.6%</td>
<td>7.6%</td>
<td>2.8%</td>
<td></td>
</tr>
<tr>
<td>Central nervous system problems</td>
<td>9.8%</td>
<td>10.6%</td>
<td>9.3%</td>
<td></td>
</tr>
<tr>
<td>Infections</td>
<td>13.2%</td>
<td>16.7%</td>
<td>11.1%</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>16.7%</td>
<td>15.2%</td>
<td>17.6%</td>
<td></td>
</tr>
<tr>
<td>Length of stay (d)</td>
<td>3.74 (2.66)</td>
<td>3.78 (2.91)</td>
<td>3.68 (2.23)</td>
<td>.82</td>
</tr>
<tr>
<td>Discharged home</td>
<td>90.2%</td>
<td>86.4%</td>
<td>92.6%</td>
<td>.18</td>
</tr>
<tr>
<td>Walking speed (m/s)</td>
<td>0.43 (0.23)</td>
<td>0.29 (0.14)</td>
<td>0.51 (0.23)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Walk quartile</td>
<td></td>
<td></td>
<td></td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Q1 (&lt;0.27 m/s)</td>
<td>24.7%</td>
<td>48.5%</td>
<td>10.2%</td>
<td></td>
</tr>
<tr>
<td>Q2 (0.27 to &lt;0.36 m/s)</td>
<td>24.7%</td>
<td>28.8%</td>
<td>22.2%</td>
<td></td>
</tr>
<tr>
<td>Q3 (0.36 to &lt;0.60 m/s)</td>
<td>24.1%</td>
<td>16.7%</td>
<td>28.7%</td>
<td></td>
</tr>
<tr>
<td>Q4 (≥0.60 m/s)</td>
<td>26.4%</td>
<td>6.1%</td>
<td>38.9%</td>
<td></td>
</tr>
</tbody>
</table>

*Values are mean (SD), unless denoted by %.

Criteria and were approached to participate, 24 were deemed by the physical therapist to be physically unable to perform the gait speed measure, 12 had excessive monitoring equipment or intravenous lines, and 51 declined to participate. The final sample included 174 patients, representing 67% of the eligible patient sample. Compared with the 174 patients included in the study, a greater percentage of the other 229 patients admitted to the ACE unit reported being walking-dependent. There were no significant differences between the groups in age, sex, race, diagnostic categories, body mass index (BMI), or discharge setting.

Protocol
Consenting patients provided background information and completed health and functioning questionnaires during 30- to 40-minute in-person interviews. Next, they performed a series of physical functional tests under the supervision of a licensed physical therapist. The functional assessments required 10 to 20 minutes to complete. All assessments were completed within 48 hours of admission. Lastly, study personnel reviewed the participants' medical charts. Variables relevant to this study are described below.

Measures

Independent variable. Walking speed was assessed over a flat, tiled 2.4-m (8-ft) course. Performances were timed with a stopwatch. Timing began with initial movement from a standing start, and each participant was instructed to walk at his or her usual pace. Time to complete the walk was recorded to the nearest hundredth of a second; this value was divided by the distance to obtain average speed (m/s). Each test was performed under close supervision of a licensed physical therapist; however, no physical assistance was provided for any test. Patients were allowed to use personal assistive devices (eg, canes, walkers).

Dependent variable. Walking independence was assessed via self-
report on the mobility question from an activities of daily living scale. Each patient was asked, “At the present time, do you need help from another person or special equipment or a device to walk across a small room?” Responses were coded as “do not need help” (independent) versus “need help or unable to do” (dependent).

Descriptive variables. Patient demographic characteristics (age, sex, and race/ethnicity) and health status information (BMI and admission diagnosis) were obtained from medical charts and in-person interviews.

Data Analysis
Descriptive summaries were tabulated and assessed for differences between patients who were walking-independent and walking-dependent with univariate statistics (independent t tests for numerical variables and chi-square tests for categorical variables). A receiver operating characteristic (ROC) curve was produced, and the area under the curve (AUC) was calculated to display the overall ability of walking speed to discriminate between walking-independent and walking-dependent patients across the entire distribution of walking speed values.

The AUC can range from 0.5 (no discrimination) to 1.0 (perfect discrimination). We used 2 different approaches to identify the cut-point (threshold) in walking speed values that best differentiated a positive test (walking-independent) from a negative test (walking-dependent). The “closest-to-0,1” approach identified the point on the ROC curve that was closest to perfect discrimination (ie, 0,1 on the figure axes). The Youden Index approach identified the point on the ROC curve that was furthest from chance discrimination (ie, largest vertical distance from the diagonal [no discrimination] line).

Next, we calculated test diagnostics (sensitivity, specificity, positive predictive value, and negative predictive value) for a series of cut-points, including the 2 identified through ROC curve analysis. We then plotted walking speed frequency distributions for both the walking-dependent and walking-independent groups to provide a comprehensive visual representation of the tradeoffs in test diagnostics at all possible walking speed cut-points.

Role of the Funding Source
This study was funded, in part, by grants from the National Institutes of Health: National Institute on Aging (R01-AG031178 and R01-AG024806), National Institute of Child Health and Human Development (R03-HD058216-01), and National Institute of Child Health and Human Development and National Institute of

### Table 2.
Classification Results for Select Walking Speed Cut-Points to Identify Walking Independence

<table>
<thead>
<tr>
<th>Walking Speed</th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
<th>Accuracy</th>
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</thead>
<tbody>
<tr>
<td>≥0.25 m/s</td>
<td>92.6%</td>
<td>43.9%</td>
<td>73.0%</td>
<td>78.4%</td>
<td>74.1%</td>
</tr>
<tr>
<td>≥0.30 m/s</td>
<td>84.3%</td>
<td>63.6%</td>
<td>79.1%</td>
<td>71.2%</td>
<td>76.4%</td>
</tr>
<tr>
<td>≥0.35 m/s</td>
<td>71.3%</td>
<td>71.2%</td>
<td>80.2%</td>
<td>60.3%</td>
<td>71.3%</td>
</tr>
<tr>
<td>≥0.40 m/s</td>
<td>62.0%</td>
<td>86.4%</td>
<td>88.2%</td>
<td>58.2%</td>
<td>71.3%</td>
</tr>
</tbody>
</table>

*PPV=positive predictive value, NPV=negative predictive value.*
Neurological Disorders and Stroke (K12-HD055929).

**Results**

Patient characteristics and walking speed values for the entire sample are displayed in Table 1. The table also provides the results for the univariate comparisons between the walking-dependent and walking-independent groups on all study variables. A majority (62%) of the participants self-reported as walking-independent. Only BMI and walking speed demonstrated statistically significant differences ($P<.05$) between the 2 groups; the walking-independent group had a lower mean BMI and a faster mean walking speed than the walking-dependent group.

The ROC curve is shown in Figure 1. The AUC was 0.81, which suggests moderate accuracy for walking speed to classify patients into walking ability categories. The 2 methods used to identify walking speed cut-points yielded slightly different values (0.29 and 0.36 m/s). Test diagnostics for select cut-points are displayed in Table 2. For this study, *sensitivity* was defined as the percentage of walking-independent patients with walking speeds at or above the threshold, *specificity* was defined as the percentage of walking-dependent patients with walking speeds below the threshold, *positive predictive value* was defined as the percentage of patients with walking speeds at or above the threshold who also were walking independent, and *negative predictive value* was defined as the percentage of patients with walking speeds below the threshold who also were walking-dependent. Figure 2 shows walking speed frequency distributions for the 2 groups. Together, Table 2 and Figure 2 demonstrate the trade-offs in classification rates across different walking speed cut-points and suggest that a threshold of approximately 0.35 m/s maximizes the balance between sensitivity and specificity.

**Discussion**

Walking speeds of older adults who are acutely ill are substantially slower than established community-based norms. The mean walking speed from our sample of hospitalized older adults (0.43 m/s) was much slower than published values from older adults in the community. Nearly three quarters of hospitalized older adults in the current study walked more slowly than the lowest community-based risk threshold (0.60 m/s). Our findings are comparable to those of a previous study of more than 1,300 hospitalized veterans; their mean age was 74 years and mean walking speed was 0.50 m/s.

Other authors have commented on the potential importance of walking speed assessments for hospitalized older adults who are acutely ill. Walking speed in older clinical populations may be a useful measure for detecting patients at risk of declining physical activity and for identifying those who will need and use more health care services over time. The current findings support this premise. Despite the truncated distribution from our sample, variations in walking speed still were associated with another important health outcome: walking independence.

The area under the ROC curve indicated that walking speed performed moderately well overall as a test to classify patients by walking disability status. Cut-point analyses, including ROC curve assessments, sensitivity and specificity values, and frequency distributions, suggested that a walking speed around 0.30 to 0.35 m/s may be a meaningful threshold for maintaining in-hospital walking independence. For simplicity of application, we reasoned that 0.35 m/s was the optimal cut-point for the current sample based on the agreement between the test diagnostics (sensitivity and specificity in Tab. 2) and the frequency distribution patterns of the 2 groups (Fig. 2). We chose the cut-point that best balanced sensitivity and specificity. Thus, the current findings and implications are based on the assumption of equal importance in misclassifications for both the walking-independent and walking-dependent groups. Further study is needed to determine whether false positives (ie, classifying someone who...
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is walking-dependent as walking-independent), for example, are more detrimental than false negatives (ie, classifying someone who is walking-independent as walking-dependent), in which case it would be advantageous to shift the cut-point to the right (eg, 0.45 m/s).

Approximately 86% of walking-dependent patients in the current study were discharged home. Thus, many hospitalized older adults are likely being discharged to the community without the capacity to function independently or the confidence to participate fully outside the home. Gill et al15 drew attention to this point by concluding that illness- or injury-related hospitalizations or activity restrictions are common sources of disability in community-dwelling older adults. Brown and colleagues23 recently provided quantitative support for these assumptions by demonstrating that cognitively sound and previously walking-independent older adult veterans are extremely inactive during hospitalization. Accelerometer data showed that the median daily duration that this group spent walking or standing was 43 minutes (ie, half of the patients were in bed or sitting for more than 23 hours and 17 minutes per day over an average 5-day hospital stay). The current findings provide a guideline for identifying patients with greater risk of being walking-dependent and, correspondingly, a minimum speed that can potentially be used as a target threshold for maintaining walking independence in hospitalized older adults.

This pilot study has some limitations, as well as indications for further study. The small convenience sample may not be representative of typical hospitalized older adults in the United States. Our sample did include similar numbers of men and women and good representation for the 3 largest racial/ethnic groups; however, the current findings still need to be validated in other groups of hospitalized older adults before they can be generalized to the larger older adult patient population. We limited our analysis to walking disability status in a cross-sectional analysis, and walking independence was determined through self-report. Although self-reported functional status measures are valid tools for clinical research and are often independent predictors of other long-term health outcomes,24 future studies should examine the utility of the identified cut-point in differentiating other meaningful outcomes such as length of stay, community independence, and rehospitalization.

Conclusion

Existing walking speed standards and risk threshold values are not practical for hospitalized older adults who are acutely ill. There is useful information, however, within the compact distribution of walking speeds in this population. Our findings suggest that 0.35 m/s may serve as an initial risk threshold/target value for maintaining in-hospital walking independence. This value is approximately 50% lower than the lowest published risk threshold derived from community-dwelling older adults. Follow-up studies are needed to confirm the utility of this threshold in larger samples and to examine its value in classifying other health outcomes.

References

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