Assessing Gait Speed in Acutely Ill Older Patients Admitted to an Acute Care for Elders Hospital Unit

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Background: Assessment of mobility in geriatric hospital units relies primarily on subjective observation or patient self-reports. We objectively examined the gait speed of hospitalized older patients.

Methods: Prospective study of 322 patients 65 years or older admitted from the community to a geriatric hospital unit between March 2008 and October 2009. Associations of gait speed (in meters per second) and activities of daily living with length of stay and home discharge were examined in multivariable logistic and generalized linear regression models.

Results: In total, 206 of 322 patients completed the gait speed walk, with a mean gait speed of 0.53 m/s. A strong association was found between faster gait speed and shorter length of stay. Patients unable to complete the walk and patients having gait speeds of less than 0.40 m/s had significantly longer lengths of stay by 1.9 and 1.4 days, respectively, compared with patients having gait speeds of at least 0.60 m/s. Similarly, patients unable to complete the walk (odds ratio, 0.03; 95% CI, 0.003-0.21) and patients having gait speeds of less than 0.40 m/s (odds ratio, 0.07; 95% CI, 0.001-0.63) had significantly decreased odds of home discharge compared with patients having gait speeds of at least 0.60 m/s. Activities of daily living were less robust than gait speed in discriminating the risk of length of stay or home discharge.

Conclusions: Gait speed is a clinically relevant indicator of functional status and is associated with important geriatric health outcomes, including length of stay and home discharge. Gait speed could be used to complement information obtained by self-reported activities of daily living.

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GAIT SPEED EXCEEDING 1.0 m/s is an important indicator for community living and participation, reflecting the ability to perform activities of daily living (ADL).[1,2] In contrast, gait speed of less than 0.6 m/s is considered abnormally slow and is associated with declines in functional independence.[3] Using data from 9 large cohort studies that included persons 65 years or older living in the community, Studenski et al[4] reported in 2011 that those with gait speeds of about 0.8 m/s had the median life expectancy for the total population studied, with faster gait speeds associated with longer life expectancy and slower gait speeds associated with shorter life expectancy.

See Invited Commentary at end of article

Based on evidence from community samples, gait speed has been recommended as a potentially important clinical indicator of health and predictor of health outcomes.[5] Evaluation of gait speed at the time of hospital admission could provide useful information to the physician in determining patient care needs, length of stay, discharge planning, and prognosis after discharge. Assessing gait speed at the time of hospital admission may also be of considerable value in identifying high-risk patients who would benefit from early intervention targeted toward preserving or improving functional independence. Recent data indicate that many older patients lose some mobility when hospitalized and often fail to regain the lost function after discharge.[6-8]

Patient mobility is typically evaluated by nurse observation or by patient self-reports.[9,10] However, as Simonsick et al[11] have argued, a major limitation of self-reported measures of mobility is that they were not designed to capture the entire range of function in older adults. Often, the focus is on inability to perform tasks, need for assistance, or difficulty in performing discrete activities, such as stair-

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Table 1. Demographic and Clinical Characteristics of the Patients

Patient Characteristics	Value (n = 322)
Age, y, No. (%)	
65-74	155 (48.1)
75-84	125 (38.8)
≥85	42 (13.0)
Female sex, No. (%)	205 (63.7)
Race/ethnicity, No. (%)	
Non-Hispanic white	228 (70.8)
Non-Hispanic black	55 (17.1)
Hispanic	39 (12.1)
Married, No. (%)	147 (45.7)
Education ≥high school, No. (%)	246 (76.4)
ADL disability, No. (%)	
0	175 (54.3)
1-2	47 (14.6)
3-4	50 (15.5)
≥5	50 (15.5)
Length of stay, mean (SD), d	4.1 (3.8)
Charlson Comorbidity Index, mean (SD)	2.7 (2.1)
BMI, mean (SD)	28.1 (7.3)

Abbreviations: ADL, activities of daily living; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared).

climbing or walking short distances. Despite the increasing attention given to mobility in hospitalized older patients, investigations remain limited. The primary objective of this study was to objectively assess the gait speeds of patients admitted from a community environment to an acute care for elders (ACE) hospital unit. A secondary objective was to assess the strength of association for gait speed and ADL in predicting length of hospital stay and discharge setting.

METHODS

STUDY POPULATION

The study population was drawn from adults 65 years or older admitted to a 20-bed ACE hospital unit at the University of Texas Medical Branch teaching hospital between March 2008 and October 2009. Patients were excluded if at the time of hospital admission, they were disorientated to person, place, or time per nursing assessment (18.4%), were admitted for observation or terminal illness (14.0%), or were transferred from nursing home, intensive care unit, or day surgery settings (14.8%). Patients were also excluded if they did not have a primary admitting diagnosis of cardiopulmonary disease or respiratory or gastrointestinal problems (18.7%). In a study of characteristics among 16 ACE hospital units, Jayadevappa et al[12] reported that respiratory infections and cardiopulmonary and gastrointestinal problems accounted for 87% of all admissions. Of 565 eligible patients, 97 refused participation, 82 could not be interviewed within 24 hours of hospitalization, and 64 were tethered to monitoring equipment or tubing. Patients who were excluded from the study did not differ significantly from patients who were included in terms of age, sex, or race/ethnicity.

Of 322 patients included in the study, 206 (64.0%) completed the gait speed walk, and 116 (36.0%) did not. The use of personal assistive devices was allowed (n=57). This study received approval from the university's institutional review board, and all participants provided written informed consent.

DATA COLLECTION

Data were collected within 24 hours of admission to the ACE hospital unit. Trained clinical interviewers completed an electronic medical record review and administered a face-to-face questionnaire to each enrolled patient. Data gathered from the electronic medical records were comorbid diagnoses included in the Charlson Comorbidity Index and body mass index (calculated as weight in kilograms divided by height in meters squared). Data gathered from the questionnaire included age, sex, race/ethnicity (non-Hispanic white, non-Hispanic black, or Hispanic), years of education, marital status (married or unmarried), and 7 self-reported ADLs (bathing, dressing, walking, transferring, eating, toileting, and grooming). Patients were considered to have an ADL disability if they needed help or were unable to complete the particular ADL task. The ADL were used as continuous variables (range, 0-7) and as categorical variables (0, 1-2, 3-4, or ≥5), with higher scores indicating more disability. A licensed physical therapist assessed gait speed. From a standing start, patients were asked to walk 8 ft at their usual pace, and time to completion was recorded to the nearest tenth of a second; this value was divided by the distance to obtain the mean gait speed (in meters per second) and was converted to 4-m gait speed values according to a formula established by Guralnik et al.[13] The adjusted 4-m gait speed (unable to complete or <0.40, 0.40-0.59, or ≥0.60 m/s) was used as continuous and categorical measures. Length of stay was calculated as the number of days from admission to discharge from the ACE hospital unit. Discharge destination was dichotomized as home discharge or other (eg, skilled nursing facility or nursing home).

STATISTICAL ANALYSIS

Means (SDs) were reported for continuous measures and percentages for categorical measures. To compare the ability to predict odds of discharge destination, we fit multivariable logistic regression models to evaluate the separate and combined associations of gait speed and ADL disability with odds of home discharge. Multivariable generalized linear regression models with a log-linked normal distribution were fit to compare and predict length of stay separately and in combination for gait speed and ADL disability. Linear contrasts in logistic and generalized linear regression models were used to assess trends of associations of gait speed and ADL disability with length of stay and home discharge. The area under the curve (C statistic) from logistic regression models was used as a measure of predictive accuracy for the 2 outcomes of length of stay and home discharge. To calculate C statistics for length of stay, we dichotomized it as less than 4 vs 4 or more days and as less than 5 vs 5 or more days. For all models, testing was 2-sided, and $P<.05$ was considered significant. We checked the data for outliers, multicolinearity, and heteroscedasticity. We also conducted Hosmer-Lemeshow goodness-of-fit tests to ensure that all logistic regression models fit well. All analyses were performed using commercially available software (SAS statistical software, version 9.2; SAS Institute, Inc).

RESULTS

The mean (SD) age at admission was 76.1 (6.9) years, 63.7% of participants were women, 70.8% were of non-Hispanic white race/ethnicity, 45.7% were married, and 76.4% had a high school education or more (**Table 1**). On average, patients had a mean (SD) of 2.7 (2.1) comorbid conditions and were overweight (mean [SD] body mass index, 28.1 [7.3]). A large percentage of patients (45.6%) reported at least 1 ADL disability.

Completion of the gait speed walk was not significantly associated with age, sex, education, marital status, race/ethnicity, or Charlson Comorbidity Index. The mean (SD) gait speed for patients who completed the gait speed walk was 0.53 (0.25) m/s. One hundred sixteen patients attempted and were unable to complete the walk, 69 walked at speeds of less than 0.40 m/s (mean [SD], 0.28 [0.08] m/s), 65 walked at speeds between 0.40 and 0.59 m/s (0.50 [0.06] m/s), and 72 walked at speeds of at least 0.60 m/s (0.80 [0.19] m/s) (**Table 2**). There was a significant decline in gait speed by age group ($P < .001$). For patients aged 65 to 74 years, the mean (SD) gait speed was 0.60 (0.25) m/s; for those aged 75 to 84 years, 0.47 (0.23) m/s; and for those 85 years or older, 0.40 (0.16) m/s. Adjusting for age, the mean (SD) gait speeds were faster in men (0.53 [0.24] m/s) than in women (0.46 [0.23] m/s) ($P = .08$). The mean (SD) gait speeds were significantly slower in patients who used an assistive device (0.36 [0.16] m/s) than in patients who did not (0.61 [0.24] m/s) ($P < .001$). Adjusting for age and sex, the mean (SD) gait speeds were significantly faster among 54.3% of patients who had no ADL disability (0.58 [0.25] m/s) than among those who had at least 1 ADL disability (0.39 [0.19] m/s) ($P < .001$).

Table 2 gives unadjusted associations of gait speed with length of stay and home discharge. The mean (SD) length of stay was 4.1 (3.9) days (range, 1-29 days). Patients unable to complete the walk had the longest length of stay, and those with gait speeds of at least 0.60 m/s had the shortest length of stay. As summarized in the table, although most patients were discharged home, there was a strong association of faster gait speeds with increased likelihood of home discharge, ranging from 66.4% among patients unable to complete the walk to 98.6% among patients with gait speed of at least 0.60 m/s.

Table 3 summarizes the results of separate and combined multivariable generalized linear regression models for gait speed and ADL disability models predicting length of stay. For all models, we first adjusted for age and sex and then added measures of education, marital status, Charlson Comorbidity Index, and body mass index. For the 4 levels of gait speed, an association was observed between faster gait speeds and decreased length of stay. In the fully adjusted model, patients unable to complete the walk and patients having gait speeds of less than 0.40 m/s had significantly longer length of stay by about 1.9 and 1.4 days, respectively, compared with patients having gait speeds of at least 0.60 m/s. Other variables significantly associated with shorter length of stay in the fully adjusted model included older age and being married.

For the 4 levels of ADL disability (0, 1-2, 3-4, or ≥5) ($P = .21$), the linear trend of association with length of stay was not as strong or as discriminating as that for gait speed ($P = .09$). In the age- and sex-adjusted model, patients having 3 to 4 ADL disabilities and at least 5 ADL disabilities had longer length of stay by 1.60 (95% CI, −0.15 to 3.60) days and 1.46 (−0.01 to 3.50) days, respectively, compared with those having no ADL disability, but the results failed to reach significance (Table 3). In the fully adjusted model, patients having 3 to 4 ADL disabilities had significantly longer length of stay by 1.79 (95% CI, 0.41-3.70) days. Although the association between increasing gait speed and shorter length of stay remained in the combined model, neither gait speed nor ADL disability reached statistical significance in predicting length of stay.

Table 2. Length of Stay and Home Discharge by Gait Speed Category

Gait Speed	No. of Patients	Length of Stay, Mean (SD), d	Home Discharge, %
Unable to complete gait speed test	116	4.8 (4.7)	66.4
Gait speed, m/s			
<0.40	69	4.1 (3.9)	82.6
0.40-0.59	65	3.6 (3.2)	92.3
≥0.60	72	3.1 (2.6)	98.6
Overall	**322**	4.1 (3.9)	82.5

To further evaluate the association of length of stay with gait speed and ADL disability, we used areas under the curve (C statistics) in logistic regression models. We dichotomized length of stay in 2 ways, as less than 4 vs 4 or more days and as less than 5 vs 5 or more days. In the fully adjusted logistic regression models using the former cut point, the C statistic for gait speed (0.64; 95% CI, 0.56-0.70) was similar to that for ADL disability (0.63; 0.56-0.69). In the fully adjusted combined gait speed and ADL disability model, the C statistic was 0.65 (0.58-0.70). Findings were similar using the other cut point.

Table 4 summarizes the results of separate and combined multivariable logistic regression models for gait speed and ADL disability predicting home discharge. In the age- and sex-adjusted model for gait speed, patients unable to complete the walk (odds ratio [OR], 0.03; 95% CI, 0.04-0.22) and those with gait speeds of less than 0.40 m/s (0.08; 0.04-0.59) had significantly reduced odds of home discharge. This strong relationship remained in the fully adjusted model. In the age- and sex-adjusted model and the fully adjusted model for ADL disability, patients reporting at least 3 ADL disabilities were significantly less likely to be discharged home compared with those reporting no ADL disability. In the combined gait speed and ADL disability model, patients unable to complete the walk (OR, 0.05; 95% CI, 0.01-0.46), those with gait speeds of less than 0.40 m/s (0.10; 95% CI, 0.01-0.86), and those with at least 5 ADL disabilities (0.25; 0.10-0.63) had significantly decreased odds of home discharge. C statistics for the separate gait speed (0.84; 95% CI, 0.79-0.89) and ADL disability (C statistic, 0.81; 95% CI, 0.78-0.89) models showed that both models strongly predicted home discharge. In the combined gait speed and ADL disability model, the C statistic was 0.86 (95% CI, 0.81-0.91). Results also showed significant linear trends of association of faster gait speed ($P = .008$) and less ADL disability ($P = .01$) with home discharge.

Table 3. Multivariable Generalized Linear Regression Models Predicting Length of Stay by Gait Speed and ADL Disability

Predictor	Odds Ratio (95% CI) for Increased Length of Stay, d		
	Gait Speed Model	ADL Disability Model	Combined Gait Speed and ADL Model
Adjustment for Age and Sex			
Gait speed[a]			
Unable to complete gait speed test	1.92 (0.33 to 4.21)	. . .	1.61 (−0.15 to 4.31)
<0.40 m/s	1.40 (0.19 to 3.82)	. . .	1.28 (−0.39 to 3.85)
0.40-0.59 m/s	0.24 (−1.06 to 2.32)	. . .	0.22 (−1.15 to 2.40)
ADL disability[b]			
1-2	. . .	0.22 (−1.11 to 2.23)	−0.24 (−1.52 to 1.69)
3-4	. . .	1.60 (−0.15 to 3.60)	0.65 (−0.75 to 2.67)
≥5	. . .	1.46 (−0.01 to 3.50)	0.44 (−0.97 to 2.52)
Additional Adjustment[c]			
Gait speed[a]			
Unable to complete gait speed test	1.82 (0.38 to 3.92)	. . .	1.55 (0.00 to 3.92)
<0.40 m/s	1.48 (0.02 to 3.71)	. . .	1.35 (−0.16 to 3.68)
0.40-0.59 m/s	0.25 (−0.91 to 2.12)	. . .	0.24 (−0.98 to 2.21)
ADL disability[b]			
1-2	. . .	0.46 (−0.79 to 2.33)	0.02 (−1.14 to 1.77)
3-4	. . .	1.79 (0.41 to 3.70)	0.88 (−0.38 to 2.66)
≥5	. . .	1.11 (−0.12 to 2.83)	0.20 (−0.93 to 1.85)

Abbreviations: ADL, activities of daily living; ellipsis, not applicable.
[a]Compared with those having gait speed of at least 0.60 m/s.
[b]Compared with those having no ADL disability.
[c]Age, sex, race/ethnicity, marital status, education, Charlson Comorbidity Index, and body mass index.

Table 4. Multivariable Logistic Regression Models Predicting Home Discharge by Gait Speed and ADL Disability

Predictor	Odds Ratio (95% CI) of Home Discharge		
	Gait Speed Model	ADL Disability Model	Combined Gait Speed and ADL Disability Model
Adjustment for Age and Sex			
Gait speed[a]			
Unable to complete gait speed test	0.03 (0.04-0.22)	. . .	0.06 (0.01-0.50)
<0.40 m/s	0.08 (0.04-0.59)	. . .	0.10 (0.01-0.78)
0.40-0.59 m/s	0.19 (0.02-1.68)	. . .	0.22 (0.10-1.96)
ADL disability[b]			
1-2	. . .	0.67 (0.24-1.85)	1.02 (0.35-2.99)
3-4	. . .	0.25 (0.11-0.59)	0.52 (0.22-1.39)
≥5	. . .	0.10 (0.04-0.21)	0.22 (0.10-0.54)
Additional Adjustment[c]			
Gait speed[a]			
Unable to complete gait speed test	0.03 (0.003-0.21)	. . .	0.05 (0.01-0.46)
<0.40 m/s	0.07 (0.01-0.63)	. . .	0.10 (0.01-0.86)
0.40-0.59 m/s	0.24 (0.03-2.26)	. . .	0.29 (0.03-2.79)
ADL disability[b]			
1-2	. . .	0.64 (0.21-1.91)	0.96 (0.31-2.99)
3-4	. . .	0.23 (0.09-0.55)	0.52 (0.19-1.39)
≥5	. . .	0.10 (0.04-0.24)	0.25 (0.10-0.63)

Abbreviations: ADL, activities of daily living; ellipsis, not applicable.
[a]Compared with those having gait speed of at least 0.60 m/s.
[b]Compared with those having no ADL disability.
[c]Age, sex, race/ethnicity, marital status, education, Charlson Comorbidity Index, and body mass index.

COMMENT

This study collected information on gait speed among older adults admitted to an ACE hospital unit and compared the prognostic value of gait speed with ADL disability on 2 important geriatric health outcomes, length of stay and home discharge. We found that a simple, objective, and reliable performance test can be performed among hospitalized older patients, that this test of gait speed was not overly burdensome, and that no adverse events were reported. More than one-third of our sample was unable to complete the short walk, and of those who completed the walk, most walked at speeds considered abnormally slow (ie, <0.60 m/s). However, most older patients were discharged home. In multivariable models, a strong association was found between faster gait speeds and shorter length of stay and increased odds of home discharge. Our findings further indicate that gait speeds of less than 0.40 m/s in hospitalized older patients may be a clinically important marker of poorer functional health and slower recovery of physical health. Compared with gait speed, the relationship between ADL disability and length of stay was less discriminating, with no clear trend of association. In separate multivariable models, ADL disability was as good as gait speed in predicting discharge setting.

Testing of gait speed has been proposed as part of a standard clinical geriatric evaluation.[14] Adding a measure of gait speed to the standard medical assessment has several advantages. First, as a performance measure, gait speed could complement information on self-reported ADL. In the clinical setting, gait speed may have particular value in identifying older patients at risk of poor health outcomes, especially in those who report little or no ADL disability. In the present study, more than half of the patients reported no ADL disability but had abnormally slow gait speed (mean gait speed, 0.58 m/s). Second, because gait speed is highly reproducible and sensitive to change, this measure may be better able than ADL disability to detect small changes in physical health status over discrete points of time. Third, because gait speed reflects both the positive and negative aspects of physical and functional health, it could serve as a vital sign much the same way that blood pressure and pressure ulcers are assessed and tracked over time. Evaluating gait speed during hospitalization with successive daily measurement could prove critical in preventing the functional declines that often occur as a result of hospitalization. Between 30% and 60% of older patients lose or report limitations in their functional abilities when hospitalized.[7,15,16] Most important, declines often begin around the time of hospital admission and can progress rapidly,[7] often despite successful treatment of the condition precipitating the admission.[10,17] Research further shows that older patients who experience a decline in walking ability are at higher risk of death, rehospitalization, and nursing home placement, as well as further declines in functional ability after discharge.[14,18] Fourth, gait speed could prove useful in intervention studies and clinical trials. However, it is unknown what type of older patient is most likely to benefit from targeted in-hospital interventions aimed at promoting ambulation and increasing gait speed or whether there is an optimal level or threshold of gait speed needed to protect against physical and functional losses when hospitalized.

To increase its clinical usefulness, more work is needed to determine clinically meaningful cut points or thresholds of gait speed that convey important levels of limitation or elevated risk of adverse outcome in hospitalized older patients. We found that gait speed of at least 0.40 m/s may be a clinically important threshold needed to minimize the effects of hospitalization and promote recovery. Compared with commonly advocated cut points among older community samples, much lower thresholds or ranges of normal and abnormal gait speeds may need to be identified and used in hospitalized older patients. Equally important for the usefulness of gait speed in clinical settings is the need to develop criteria for clinically meaningful change. This would be vital for physicians to assess patient risk and recovery from an adverse health event, in which statistically significant change among groups of patients may not convey important clinical changes in gait speed among these older patients. It would be of value to examine patterns or trajectories of meaningful change in gait speed during and after hospitalization relative to subsequent independence and ability to perform basic ADL.

Strengths of this study include a large sample of older patients, the longitudinal study design, face-to-face interviews, and the use of electronic medical records. An additional strength was the use of an objective performance measure of walking ability, which we converted from an 8-ft to a 4-m gait speed measure to better allow for comparisons across studies. Limitations of this study include the use of a single ACE hospital unit and the fact that the results may not be generalizable to older patients in other health care settings. However, our sample comprised the 3 largest racial/ethnic groups in the United States and included common admitting diagnoses to geriatric hospital units.[12] Nonetheless, it would be important to replicate these findings in a multisite study because regional differences may exist. In addition, we excluded patients with cognitive difficulties. Because a large percentage of hospitalized patients may be classified as having mild to moderate cognitive impairments, further work with this patient group is warranted to validate the feasibility of performing gait speed tests among individuals with cognitive impairment.

The objectives of this study were to demonstrate that a simple objective performance test of gait speed could be safely assessed in a hospital and that this test could potentially provide meaningful information to the health care team about the health of the patient. Although performance measures like gait speed are rarely the focus of geriatric medical care, they may be critical determinants of quality of life, independence, and immediate and long-term prognosis.

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INVITED COMMENTARY

Gait Speed in Hospitalized Older People

Ostir et al[1] provide compelling evidence that simple performance measures of function, like gait speed, are powerful indicators of important health care outcomes, even in acutely ill older persons. Much of the prior work on performance measures was based in community-dwelling older populations, in which the assumption that performance measures were reliable in medically stable people was central to assumptions about predictive ability. Ostir et al show that performance measures in acutely ill, medically unstable older adults retain their ability to provide important clinical information.

Building on an ever-expanding evidence base, it is unequivocally clear that to understand and manage the health care needs, prognoses, and outcomes of older adults, we must incorporate indicators of function.[2,3] Because most older adults have multiple interacting health conditions, it is simply insufficient to base services on only disease-specific guidelines and outcomes.[4]

In this era of high health care costs and financial constraints, we continue to struggle with the challenges of health care reform, especially in large government programs like Medicare and Medicaid. We are appropriately obligated to evaluate the effectiveness and efficiency of our services. On the basis of what we have learned from Ostir et al and other investigators, it is clear that the evidence base we need to evaluate services for older people, whether derived from clinical trials or health care system data, must account for function, including mobility. Thus, the continued failure to incorporate measures of function into clinical trials or into health information systems represents a serious barrier to informing and improving health care for older people.

Functional status can be assessed using self-report, professional report, performance measures, or all 3 of these. While the first priority for practice and research with older people must be to incorporate functional status in any form, we should carefully consider the added value of performance measures of mobility. Mobility is a key component of disability. Performance measures of mobility are safe, very brief and reliable, and as suggested in the recent article of Ostir et al, may provide a unique perspective that is, at minimum, complementary and, at times, superior to reported function. Gait speed has been shown to predict multiple important outcomes, including hospitalization, disability, survival, and nursing home placement.[5] More recently, gait speed, used as the sole indicator of frailty, predicted risk of functional decline with hospitalization.[6] Gait speed also seems to provide important and unique prognostic information in other clinical situations, such as in predicting outcomes of cardiac surgery.[7]

Yes, there is a need for further work and more evidence. While Ostir et al demonstrate important effects, many issues of generalizability and clinical application remain. Will gait speed retain its predictive ability in older people hospitalized for conditions other than cardiopulmonary or digestive disorders, or in persons with cognitive impairment or depression? What is the role of social support as a modifier of mobility? Will repeated measures of gait speed help detect the common and serious problem of functional decline and mobility loss dur-