Loss of Independence in Activities of Daily Living in Older Adults Hospitalized with Medical Illnesses: Increased Vulnerability with Age

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OBJECTIVES: To describe the changes in activities of daily living (ADL) function occurring before and after hospital admission in older people hospitalized with medical illness and to assess the effect of age on loss of ADL function.

DESIGN: Prospective observational study.

SETTING: The general medical service of two hospitals.

PARTICIPANTS: Two thousand two hundred ninety-three patients aged 70 and older (mean age 80, 64% women, 24% nonwhite).

MEASUREMENTS: At the time of hospital admission, patients or their surrogates were interviewed about their independence in five ADLs (bathing, dressing, eating, transferring, and toileting) 2 weeks before admission (baseline) and at admission. Subjects were interviewed about ADL function at discharge. Outcome measures included functional decline between baseline and discharge and functional changes between baseline and admission and between admission and discharge.

RESULTS: Thirty-five percent of patients declined in ADL function between baseline and discharge. This included the 23% of patients who declined between baseline and admission and failed to recover to baseline function between admission and discharge and the 12% of patients who did not decline between baseline and admission but declined between hospital admission and discharge. Twenty percent of patients declined between baseline and admission but recovered to baseline function between admission and discharge. The frequency of ADL decline between baseline and discharge varied markedly with age (23%, 28%, 38%, 50%, and 63% in patients aged 70–74, 75–79, 80–84, 85–89, and ≥90, respectively, $P < .001$). After adjustment for potential confounders, age was not associated with ADL decline before hospitalization (odds ratio (OR) for patients aged ≥90 compared with patients aged 70–74 = 1.26, 95% confidence interval (CI) = 0.88–1.82). In contrast, age was associated with the failure to recover ADL function during hospitalization in patients who declined before admission (OR for patients aged ≥90 compared with patients aged 70–74 = 2.09, 95% CI = 1.20–3.65) and with new losses of ADL function during hospitalization in patients who did not decline before admission (OR for patients aged ≥90 compared with patients aged 70–74 = 3.43, 95% CI = 1.92–6.12).

CONCLUSION: Many hospitalized older people are discharged with ADL function that is worse than their baseline function. The oldest patients are at particularly high risk of poor functional outcomes because they are less likely to recover ADL function lost before admission and more likely to develop new functional deficits during hospitalization **J Am Geriatr Soc 51:451–458, 2003.**

Key words: hospitalization; activities of daily living; frail elderly; geriatric assessment; health status

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A principle goal of the care of older patients is maintaining the ability to perform basic self-care activities such as bathing, dressing, using a toilet, transferring out of a bed or chair, and eating without assistance.[1,2] These activities, known as activities of daily living (ADLs), are fundamental to maintaining older people's independence and quality of life. Loss of independence in these activities is strongly associated with institutionalization, caregiver burden, higher resource use, and death.[3–6]

Acute illnesses requiring hospitalization often precipitate loss of ADL function in older people in spite of treatment of the acute illness.[7–15] However, despite the importance of functional loss around the time of hospitalization in older people, only a few studies have described functional changes in hospitalized older people. Most prior studies of functional change in hospitalized older people have focused entirely on rates of functional decline between a preadmission baseline and discharge or between admission and discharge.[11,12,14,15] Because these studies do not separately describe functional changes occurring before and after admission, they do not provide a complete understanding of the functional trajectories of hospitalized older people. Functional decline in hospitalized older people may occur frequently before admission, and some of these patients may be able to recover during their hospitalization. In a study of 71 patients in one hospital, Hirsch et al. provided evidence supporting a view that functional change in hospitalized older people is a complex dynamic process that may include decline before admission and recovery or decline in the hospital.[13]

There is also limited information about the effect of increasing age on the pattern and frequency of functional changes in hospitalized older people. Although prior work suggests that older patients are more likely to be discharged with worse-than-baseline ADL function,[11,12,14] the relationship between age and ADL changes in hospitalized older people has not been comprehensively described. In particular, no study has examined the relationship between age and functional changes before and during hospitalization, and no study has had a large enough sample size to examine functional changes in nonagenarians

To better understand the dynamic nature of functional changes in older people hospitalized with medical illnesses, especially in the oldest old, this study analyzed functional changes in older people on the inpatient medical services of two hospitals. The first goal was to better understand the extent to which functional changes occurring before and after hospital admission influence functional outcomes at discharge. Before hospital admission, patients can remain stable in function or decline in function because of their acute illness. After hospital admission, patients who were stable before admission can remain stable or decline, whereas patients who declined before admission can recover, not recover, or decline further. Understanding the extent to which each of these changes affects functional outcomes at discharge could help clarify the potential importance of hospital processes in influencing these outcomes. Changes occurring before the hospitalization are primarily the result of the acute illness and cannot be prevented or exacerbated by care provided in the hospital. In contrast, functional changes occurring after admission reflect the interaction of illness with hospital care and treatments and may be amenable to changes in the processes of hospital care. The second goal was to describe the effect of increasing age on these functional changes. It is hypothesized that, after adjustment for other measures of illness severity, age will have only a modest effect on functional outcomes. This hypothesis is consistent with research on the relationship between age and hospital mortality.[16,17]

METHODS

Patients

Patients were drawn from two randomized controlled studies of an intervention to improve functional outcomes in older (≥70) hospitalized medical patients.[18,19] The studies were conducted between 1993 and 1997 at University Hospitals of Cleveland, a tertiary care hospital, and Akron City Hospital, a community teaching hospital in Ohio. Both studies enrolled nonelective admissions to the general medical services. Patients admitted electively, with expected length of stay of 2 days or less, or admitted to the intensive care unit were excluded. Because functional changes were similar for the intervention and control groups in both hospitals, intervention and control patients were combined for these analyses.[16,17]

Of the 3,163 patients enrolled at the two hospitals, 402 were not eligible for these analyses because they died before hospital discharge (n = 116) or because they were dependent in all ADLs 2 weeks before hospital admission (n = 286). Patients dependent in all ADLs before hospitalization were excluded because it was not possible to measure additional declines in ADL function.

Of the 2,761 eligible patients, 468 were excluded from this study because they or a surrogate respondent could not be interviewed on hospital admission (n = 301) or at the time of hospital discharge (n = 167), resulting in an analytical sample of 2,293 patients.

Data Collection

Patients or surrogate respondents were interviewed at the time of hospital admission and hospital discharge. Surrogates were interviewed when the patient failed a cognitive screen (defined as ≥5 errors on the Short Portable Mental Status Questionnaire),[20] was unable to communicate, or was too ill to be interviewed at the time of hospital admission. Surrogates were defined as the primary caregiver, as identified in the nursing admission note. The same respondent was interviewed at admission and discharge; 24% of respondents were surrogates.

At the time of hospital admission, the respondent was asked to report whether the patient could perform each of five ADLs independently (defined as not needing the assistance of another person).[21] For example, for bathing subjects were asked, "On the day you were admitted to the hospital, did you need help washing or bathing yourself?" The other ADLs were dressing, transferring from a bed to a chair, using the toilet, and eating. The respondent was also asked to report whether the patient could perform each ADL independently 2 weeks before hospital admission. This was referred to as baseline function. This time point is often selected in studies of hospitalized older people because it is distant enough to generally reflect the

patient's functional status before the onset of the acute illness episode that necessitated hospitalization but recent enough that respondents should be able to recall reliably the patient's functional status.[22,23] Evidence supporting the validity of these retrospective reports has previously been reported.[23] At the time of hospital discharge, each respondent was again asked to report whether the patient could perform each ADL independently.

Also at the time of hospital admission, respondents were asked to report on the patient's ability to perform seven instrumental activities of daily living (IADLs) independently 2 weeks before hospitalization[24] and provide demographic information such as living situation and ethnicity.

Data gathered from medical records included the reason for admission, comorbid diagnoses included in the Charlson comorbidity index,[25] components of the acute physiology score (APS)[26] at the time of admission, and the serum albumin level at the time of admission.

Analyses: Description of Functional Trajectories

For each time point (baseline, admission, and discharge), a global ADL score was created and defined as the number of ADLs in which the patient was independent. Patients were classified into one of five functional trajectories depending on whether they declined between baseline and discharge, whether or not they decline between baseline and admission, and whether they declined, were stable, or improved between admission and discharge. Functional decline between baseline and discharge was defined as being independent in fewer ADLs at discharge than at baseline. The first two trajectories included patients who did not decline between baseline and discharge. The first trajectory included patients who had stable function throughout their course (no decline between baseline and admission and no decline between admission and discharge). The second trajectory included patients who declined between baseline and admission but recovered to their baseline function by the time of discharge. The next three trajectories included patients who declined in ADL function between baseline and discharge. The third trajectory included patients who did not decline between baseline and admission but declined between admission and discharge. The fourth trajectory included patients who declined between baseline and admission and did not recover to baseline function by the time of hospital discharge. The fifth trajectory included patients who declined between baseline and admission and declined further between admission and discharge.

Analyses: Relationship Between Age and Functional Change

The first analysis assessed the relationship between age and decline in global ADL function between baseline and discharge. Additional analyses assessed the effect of age on functional changes occurring between baseline and admission and between admission and discharge. The analysis of functional changes occurring between baseline and admission included all subjects. The analysis of functional changes occurring between admission and discharge was stratified depending upon whether the patient declined in ADL function between baseline and admission. For patients who declined between baseline and admission, the relationship between age and the failure to recover to baseline function between admission and discharge was measured. For patients who did not decline between baseline and admission, the relationship between age and new declines in ADL function between admission and discharge was assessed.

For each of these analyses, age was divided into five different categories and chi-square tests were used for linear trend to test the relationship between age and functional change. To assess the effect of confounders, logistic regression was used to measure the association between age and ADL change after adjusting for sex, ethnicity, number of independent IADLs at baseline, number of independent ADLs at baseline, Charlson comorbidity score, chart diagnosis of dementia, APS score, serum albumin, and whether interviews were obtained with a surrogate. Results were almost identical when adjusted for length of stay.

RESULTS

Characteristics of Subjects

The mean age of the patients was 79.5, 64% were women, and 24% were African American (Table 1). At baseline, 2 weeks before admission, 67% were independent in all ADLs and 45% were independent in all IADLs. Older patients had greater levels of illness severity and functional dependence before and at admission. For example, patients aged 90 and older were more likely than patients aged 70–75 to have a diagnosis of dementia (25% vs 6%, $P < .001$), have an acute physiology score of six or more points (36% vs 28%, $P < .01$), be dependent in at least one ADL 2 weeks before admission (56% vs 24%, $P < .001$), and be dependent in more IADLs 2 weeks before admission (3.9 vs 2.3, $P < .001$).

Functional Course of Patients Before and During Hospitalization

The ADL function of 65% of the 2,293 patients did not decline between baseline and discharge (Figure 1). This included the 45% of patients with stable function throughout their course (no decline before or during hospitalization) and the 20% of patients who declined between baseline and admission but recovered to their baseline level of function between admission and discharge. Thirty-five percent of patients declined in ADL function between baseline and discharge (independent in fewer ADLs at discharge than baseline). This included the 12% of patients who did not decline between baseline and admission but declined between admission and discharge, the 18% of patients who declined between baseline and admission and failed to recover to their baseline function between admission and discharge, and the 5% of patients who declined between baseline and admission and experienced additional decline between admission and discharge.

Thus, most patients (55%) had unstable ADL function consisting of decline in ADL function before admission that persisted or progressed during hospitalization (23%), a transient decline before admission with recovery during hospitalization (20%), or new-onset decline during hospitalization (12%). In about half of the 35% (17%) of patients discharged with worse than baseline ADL function, at least some of the ADL decline was attributable to ADL declines occurring after admission, but of the 43% of

patients who declined between baseline and admission, nearly half (20%) recovered to their baseline level of function between admission and discharge.

Figure 2 presents the functional trajectories for each individual ADL in patients who were independent in a particular ADL at baseline. For individual ADLs, rates of loss of independence between baseline and admission ranged from 14% (toileting) to 30% (transferring). For each ADL, about half of patients who lost independence between baseline and admission recovered by discharge.

Table 1. Characteristics of Subjects (N = 2,293)

Characteristic	Percent
Age*	
70–74	27.9
75–79	27.5
80–84	21.8
85–89	13.6
≥90	9.3
Female	63.6
Living alone	35.2
Admitted from nursing home	4.9
Nonwhite	23.6
Reason for admission	
Neurological	15.2
Cardiovascular	13.5
Infectious	12.7
Pulmonary	23.1
Gastrointestinal	19.7
Metabolic	7.0
Other	8.8
Serum albumin on admission	
0–2.9	13.1
3.0–3.4	23.7
3.5–3.9	29.5
≥4	33.7
Acute physiology score on admission	
0–2	32.3
3–5	37.1
≥6	30.8
Charlson comorbidity score	
0	19.8
1–2	47.0
3–4	22.1
≥5	11.1
Dementia diagnosis	11.0
Number of independent activities of daily living 2 weeks before admission	
5	66.9
4	13.1
3	7.4
2	6.8
1	5.8
Number of independent instrumental activities of daily living 2 weeks before admission	
7	44.7
4–6	30.0
0–3	25.3

Note: Mean length of stay was 6.3 days.
* Mean age = 79.5.

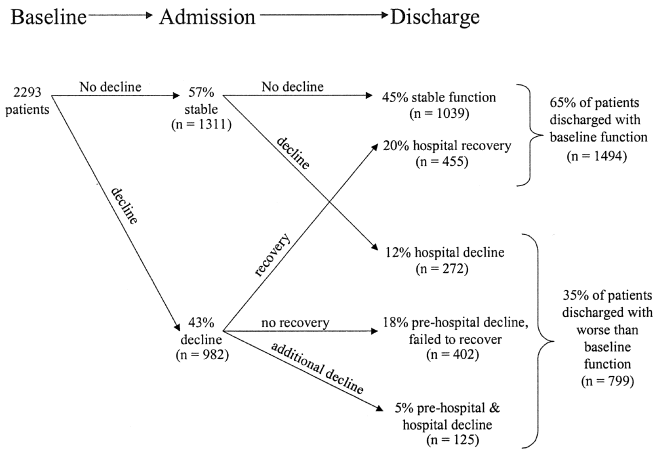

Figure 1. Functional transitions of patients between baseline (2 weeks before admission), hospital admission, and discharge. The left portion of the figure depicts the functional course of patients between these three time points. Decline refers to loss of activities of daily living (ADL) function, defined as a lower ADL independence score. The recovery refers to return of ADL independence score to the baseline level. Right side of figure depicts the end result of these functional transitions.

For each ADL, 10% to 15% of patients who were independent at admission became dependent by discharge.

Relationship Between Age and Changes in ADL Function—Bivariate Analysis

Older age was strongly associated with functional deterioration between baseline and discharge (Table 2). Less than one-quarter (23%) of patients aged 70 to 74 declined in

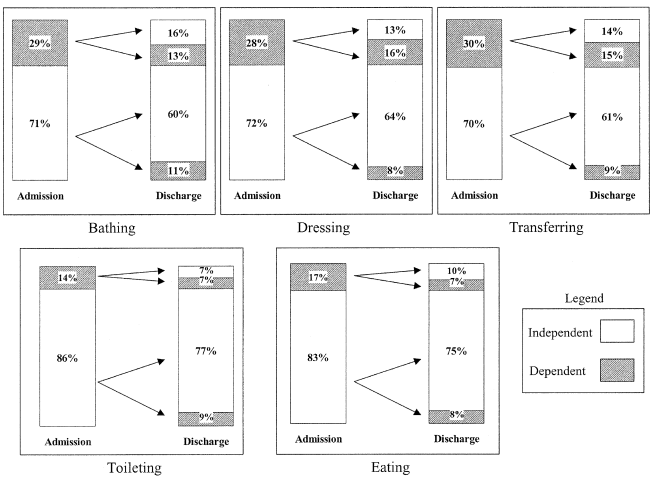

Figure 2. Functional changes between before and during hospitalization for individual activities of daily living (ADL). For each ADL, analyses are limited to patients who were independent at baseline (2 weeks before admission). The bar labeled Admission depicts the proportion of patients who became dependent (gray) by admission and the proportion remaining independent at admission (white). For both groups, the proportions that were independent (white) and dependent (gray) at discharge are depicted.

Table 2. Relationship Between Age and Functional Decline: Bivariate Results

Outcome	Age 70–74	75–79	80–84	85–89	≥90	*P*-value
	%					
Decline between 2 weeks before admission and discharge (N = 2,293)	23	28	38	50	63	<.001
Decline before hospitalization (N = 2,293)	35	42	42	49	59	<.001
Decline during hospitalization in patients who did not decline before hospitalization (n = 1,311)	13	16	23	36	44	<.001
Failure to recover during hospitalization in patients who declined before hospitalization (n = 982)	41	45	57	65	76	<.001

ADL function between baseline and discharge, whereas over half (63%) of patients aged 90 and older declined. For each component of functional change (decline between baseline and admission, decline between admission and discharge in patients with no decline between baseline and admission, and failure to recover between admission and discharge in patients who declined between baseline and admission), adverse changes were more common in older patients. However, the risk associated with increasing age was smaller for prehospitalization decline than for new decline in the hospital or failure to recover in the hospital.

Relationship Between Age and Declines in Global ADL Function—Multivariate Analysis

After adjusting for baseline ADL and IADL function, illness severity, comorbidity, and other confounders, older patients remained at higher risk of declining in ADL function between baseline and hospital discharge (Table 3), but there was a differential effect of age on functional decline before and during hospitalization. After adjustment for these confounders, especially lower baseline functional status in the oldest patients, the association between age and functional decline between baseline and admission was no longer significant. Nevertheless, even after adjustment for these confounders, of patients who did not decline between baseline and admission, older patients were more likely to experience new declines in ADL function between admission and discharge. Similarly, of patients who declined before hospitalization, older patients were more likely to fail to recover to their baseline level of function between admission and discharge.

DISCUSSION

These results demonstrate that ADL function is unstable in more than half of older patients hospitalized for medical illnesses. By the time of discharge, more than one-third (35%) of patients had worse ADL function than their preillness baseline. This rate of functional decline had a striking relationship with age, with rates exceeding 50% in patients aged 85 and older. Functional changes occurring after admission to the hospital were crucial determinants of discharge outcomes. In about half of patients dis-

Table 3. Relationship Between Age and Functional Decline: Multivariate Results

Outcome	Age 70–74	75–79	80–84	85–89	≥90	*P*-value for trend
	Odds Ratio* (95% Confidence Interval)					
Decline between 2 weeks before admission and discharge (N = 2,293)	1.0	1.21 (0.92–1.60)	1.52 (1.14–2.03)	2.23 (1.60–3.09)	2.67 (1.81–3.92)	<.001
Decline before hospitalization (N = 2,293)	1.0	1.23 (0.97–1.57)	1.02 (0.79–1.33)	1.14 (0.84–1.55)	1.26 (0.88–1.82)	.39
Decline during hospitalization in patients who did not decline before hospitalization (n = 1,311)	1.0	1.31 (0.86–2.00)	1.75 (1.14–2.69)	2.89 (1.78–4.69)	3.43 (1.92–6.12)	<.001
Failure to recover during hospitalization in patients who declined before hospitalization (n = 982)	1.0	0.98 (0.66–1.45)	1.37 (0.90–2.09)	1.72 (1.06–2.77)	2.09 (1.20–3.65)	<.001

*Adjusted for gender, ethnicity, number of independent instrumental activities of daily living at baseline, number of independent activities of daily living at baseline, Charlson comorbidity score, chart diagnosis of dementia, acute physiology score, serum albumin, and whether interviews were obtained with a surrogate.

charged with worse-than-baseline functional status, some or all the functional decline occurred after hospital admission, but almost half of patients who declined before hospitalization recovered to their baseline level of function before discharge. Older age had a particularly deleterious effect on functional changes during the hospitalization. Although adjustment for baseline function explained the association between age and functional loss before hospitalization, age was strongly associated with functional loss and failure to recover during hospitalization.

This study is the most-comprehensive report to date of changes in functional status before and during hospitalization in older patients hospitalized with medical illnesses. Strengths of this study include a large cohort at two hospitals, validated measures of functional status, the ability to distinguish between functional changes occurring before and after hospital admission, and a large number of patients in the oldest age categories. The results extend previous studies demonstrating that hospitalized older people are frequently discharged with worse-than-baseline functional status.[11–15] It was demonstrated that functional loss often occurs before admission and that functional changes after admission are key determinants of functional outcomes at discharge. In contrast to past studies and geriatrics literature that have emphasized hospital-associated functional deterioration,[8,9,11,12,14] these results demonstrate that functional recovery is also common after hospital admission. Age-related variability in functional recovery accounts for much of the overall variability in rates of functional decline at discharge. In addition, although other studies have demonstrated that age is associated with functional decline between baseline and discharge, this is the first study large enough to determine the rates of functional loss in the oldest old, which were striking. More importantly, the authors have extended prior findings by demonstrating that age-associated functional changes are greater after hospital admission than before.

Many metrics of hospital quality would have classified all the patients in this study as having had good outcomes because they survived to hospital discharge.[27] However, it is likely that many of the patients who were discharged with worse-than-baseline ADL function would not be satisfied with their outcomes. The functional changes that were observed would likely affect other important outcomes such as mortality, nursing home placement, healthcare costs, and caregiver strain.[3–6,28] Clinicians considering postdischarge care needs should be aware that many patients will be less able to perform basic self-care activities at the time of hospital discharge than they were before their acute illness.

These results also suggest that physiological and functional markers of illness often follow markedly different trajectories. Although physiological markers in these patients were not tracked, prior data suggest that physiological markers such as vital signs and laboratory measures generally improve and often normalize between hospital admission and discharge.[29] In contrast, functional measures often fail to improve and frequently worsen in older adults during hospitalization.

The results of this study suggest that an older patient's functional trajectory may be a useful vital sign worthy of close attention by hospital clinicians. Assessing a patient's functional trajectory by inquiring about baseline and admission function may be particularly valuable. A patient's baseline function may serve as a useful benchmark and goal for discharge outcomes. For patients who have lost ADL function before admission, rehabilitation could be a goal of inpatient care. For patients who have acquired ADL disability from admission to discharge, efforts to prevent disability could be implemented. Research assessing the predictors of functional recovery, the relationship between hospital processes of care and recovery, and the effectiveness of rehabilitative interventions would enhance such efforts. When assessing functional change, in addition to considering whether a patient needs help with an ADL, it may be useful to consider lesser degrees of ADL loss such as increases in difficulty as well as other functional measures such as mobility.[30]

The need for preventive and rehabilitative interventions is particularly important in the oldest old. More than half of patients aged 85 and older had worse ADL function at the time of discharge than at their preillness baseline. The relationship between older age and functional change differs before and after hospitalization. After adjusting for baseline risk factors, the likelihood of functional loss before hospitalization in patients aged 70 and older is not associated with age. However, age is a strong independent risk factor for failing to recover and new loss of ADL function during hospitalization. The finding that age is a strong independent risk factor for functional change during hospitalization stands in contrast to prior work demonstrating that age is only a minimal independent risk factor for mortality in hospitalized older people.[16,17]

These results do not explain why older age is strongly and independently associated with adverse functional changes after admission but not before admission. It is possible that processes occurring during hospitalization may be differentially harmful to the oldest patients. Processes that may contribute to adverse outcomes include inadequate nutrition, excessive bedrest, polypharmacy, and sleep deprivation.[2,8,9] It is also possible that physicians are less aggressive in pursuing therapies that may prevent functional decline or restore function in the oldest patients. The plausibility of such a hypothesis is supported by other data demonstrating a lower intensity of care in hospitalized older people, even after adjustment for patient preferences.[16,17,31] This may in part occur because physicians underestimate the benefits and overestimate the harms of some treatments in the oldest old.[32] However, in the case of functional decline, the more fundamental problem may simply be recognition of functional impairment in hospitalized older people. For example, a recent study demonstrated that physicians often fail to document functional impairment in hospitalized older people.[33]

Several methodological issues should be considered when interpreting these results. First, the measures of ADL function are based on the reports of patients and surrogates. It is possible that results might have been different for performance-based measures. Nevertheless, there is evidence of the validity of patient and surrogate reports of ADL function.[34–36] In addition, these reports are strongly associated with other outcomes such as mortality, nursing home placement, and resource use.[28,36] Nevertheless, in some patients, the unique circumstances of hospitalization

may have made the interpretation of some of the ADL items complex. For example, patients who needed help dressing because they were tethered to an intravenous pole may have varied in whether they identified themselves as independent or dependent. Also, it is possible that the use of proxy respondents introduced biases into the results and that, in some cases, proxies may not have been able to optimally observe the extent to which patients performed various ADLs in the hospital. The use of proxy respondents increased with age, and it is possible that this explains some of the association between age and adverse functional changes after hospitalization. However, this is unlikely, because the multivariate analyses adjusted for whether a proxy respondent was used. Third, reports of preillness baseline function were based on retrospective reports. Although these reports may be subject to more inaccuracy than concurrent reports of ADL function, there is reported evidence demonstrating the validity of retrospective reports of ADL function.[23] Fourth, the study was limited to two sites in Ohio, and the generalizability to other sites needs to be established. Finally, although many potential confounders such as the presence of dementia and other comorbidities, baseline functional status, and acute illness severity were adjusted in the analyses, other potential confounders such as the severity of cognitive impairment, nutritional status, and the degree of social support could not be adjusted.

These results also pose a number of questions for further study. For example, although there has been much speculation as to the causes of hospital-associated functional decline, there is a need for studies to clearly establish the etiology of this problem. Furthermore, work is needed to determine whether hospital-acquired disability can be prevented. Although some studies have provided evidence that multicomponent interventions can prevent hospital-acquired disability, the results of these studies have been inconsistent and the effect sizes of positive studies often modest and of short duration.[10,18,37] Finally, although evidence was presented that failure to recover function lost before hospitalization may be as important a contributor to disability as hospital-acquired functional loss, further study is needed to determine whether new ADL disability acquired before hospital admission can be reversed through rehabilitation and other interventions.

In summary, this study found that functional changes are common before and during hospitalization in older people. Many patients' function at the time of discharge is worse than their baseline ADL function. The risk of decline in ADL function increases markedly with age. Higher rates of functional decline and lower rates of functional improvement after admission primarily explain the association between age and poor functional outcomes after hospitalization. This investigation highlights the need for clinicians to closely monitor the functional status of hospitalized older people, especially in the oldest patients.

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