CLINICAL INVESTIGATION

Recovery of Activities of Daily Living in Older Adults After Hospitalization for Acute Medical Illness

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OBJECTIVES: To compare functional outcomes in the year after discharge for older adults discharged from the hospital after an acute medical illness with a new or additional disability in their basic self-care activities of daily living (ADL) (compared with preadmission baseline 2 weeks before admission) with those of older adults discharged with baseline ADL function and identify predictors of failure to recover to baseline function 1 year after discharge.

DESIGN: Observational.

SETTING: Tertiary care hospital, community teaching hospital.

PARTICIPANTS: Older (aged $\geq$70) patients nonelectively admitted to general medical services (1993–1998).

MEASUREMENTS: Number of ADL disabilities at preadmission baseline and 1, 3, 6, and 12 months after discharge. Outcomes were death, sustained decline in ADL function, and recovery to baseline ADL function at each time point.

RESULTS: By 12 months after discharge, of those discharged with new or additional ADL disability, 41.3% died, 28.6% were alive but had not recovered to baseline function, and 30.1% were at baseline function. Of those discharged at baseline function, 17.8% died, 15.2% were alive but with worse than baseline function, and 67% were at their baseline function ($P<.001$). Of those discharged with new or additional ADL disability, the presence or absence of recovery by 1 month was associated with long-term outcomes. Age, cardiovascular disease, dementia, cancer, low albumin, and greater number of dependencies in instrumental ADLs independently predicted failure to recover.

CONCLUSION: For older adults discharged with new or additional disability in ADL after hospitalization for medical illness, prognosis for functional recovery is poor. Rehabilitation interventions of longer duration and timing than current reimbursement allows, caregiver support, and palliative care should be evaluated. **J Am Geriatr Soc 56:2171–2179, 2008.**

Key words: hospitalization; functional decline; recovery

Hospitalization for acute medical illness frequently precipitates disability in activities of daily living (ADLs).[1–9] The loss of self-care abilities results in serious short-term consequences for patients and families, because patients dependent in ADLs cannot successfully live at home without the assistance of caregivers, but the long-term significance of new or additional disabilities in ADLs associated with acute medical illness is not known. Recovery from disability in community-dwelling older persons is common, with rates of recovery from episodes of disability as high as 80%.[10,11] In the short term, rates of recovery for people who have been hospitalized may be higher than for those whose disability develops more progressively without having been hospitalized, but hospitalization does not predict persistent recovery, and little is known about functional recovery for more than 1 to 3 months after hospital discharge.[4,9,12–15] High rates of mortality and nursing home placement after hospitalization suggest that functional outcomes may be poor.[13,16–18]

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An understanding of the rates, time course, and predictors of functional recovery for older adults hospitalized for medical illness is essential for planning for the care needs of these patients, optimizing preventive and rehabilitative strategies for these patients, and informing health policy. Furthermore, formal rehabilitative services are less commonly provided after hospitalization for medical illness than for illnesses such as stroke or some surgical procedures, and many of these services are of short duration and low intensity.[19–22] The objectives of this study were to describe long-term functional outcomes in the year after discharge for medical hospitalization in older adults discharged with a new or additional disability in their self-care ADLs, (compared with their preadmission baseline 2 weeks before admission), to compare these functional outcomes with the outcomes of older adults who were discharged with baseline self-care ADL function, and to identify predictors of failure to recover to baseline function 1 year after hospital discharge in older people with new or additional disabilities in self-care ADLs.

METHODS

Setting and Participants

Patients were drawn from two randomized controlled trials of an intervention to improve functional outcomes in older (aged ≥70) hospitalized medical patients conducted between 1993 and 1998 at University Hospitals of Cleveland, a tertiary care hospital, and Akron City Hospital, a community teaching hospital in Ohio.[23,24] Both enrolled patients who had nonelective admissions to general medical services. Patients who were admitted electively, who had an expected length of stay of less than 2 days, or who were admitted to the intensive care unit were excluded. The intervention and control groups were combined because the analysis focused on postdischarge trajectories, and the intervention was hospital-based and did not affect changes in self-care ADLs between discharge and 1 year[23] (Figure 1A).

Of 2,279 patients who were eligible for this analysis, 1,480 were discharged with similar or better functional status than at 2 weeks before admission, whereas 799 were discharged with worse functional status than at 2 weeks before admission, as indicated by a new or additional disability in at least one self-care ADL (Figure 1B).

The institutional review board of Case Western Reserve University approved this study.

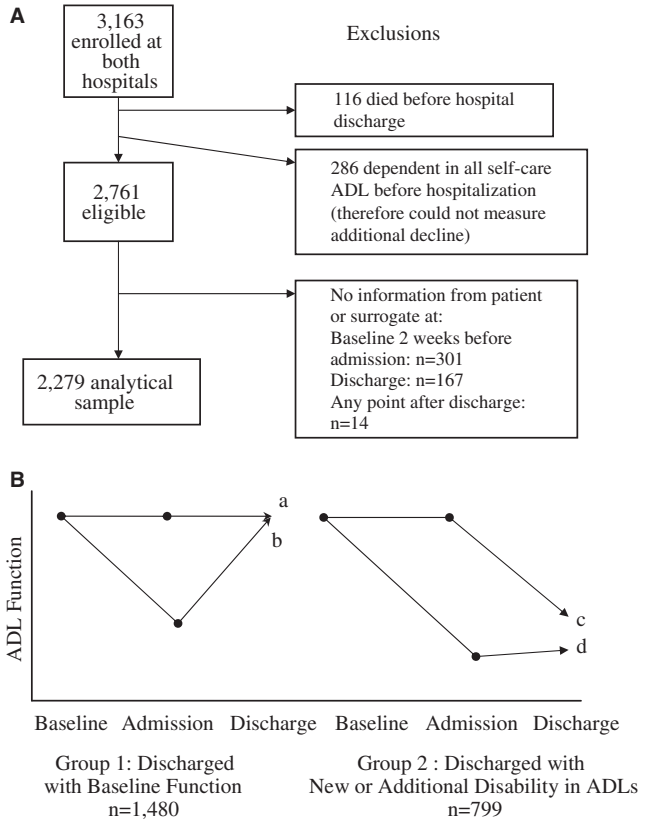

Figure 1. Derivation of the analytical sample and study definitions, (A) derivation of the analytic sample, (B) trajectories of function in self-care activities of daily living (ADLs): baseline through hospital discharge.
Group 1: Discharged with Baseline Self-Care ADLs Function.
Trajectory a: Patients who had stable function throughout their course with no decline in self-care ADLs function between baseline and admission and no decline between admission and discharge.
Trajectory b: Patients who declined in self-care ADLs function between baseline and hospital admission but recovered to baseline self-care ADLs function by the time of hospital discharge.
Group 2: Discharged with New or Additional Disability in self-care ADLs (decline in self-care ADLs function).
Trajectory c: Patients acquiring new or additional disability in self-care ADLs between baseline and admission who did not recover to baseline function by the time of hospital discharge.
Trajectory d: Patients who did not decline in self-care ADLs function between baseline and admission but acquired new or additional disability in self-care ADLs between admission and discharge.

Outcomes and Follow-Up

Data were collected in interviews with patients or surrogate respondents at the time of hospital admission and hospital discharge and in phone interviews 1, 3, 6, and 12 months after discharge. Surrogates, identified as the primary caregiver in the nursing admission note, were interviewed when patients were unable to communicate, were too ill, or failed a cognitive screen (defined as ≥5 errors on the Short Portable Mental Status Questionnaire) at the time of hospital admission.[25] In general, the same respondent was interviewed at admission, at discharge, and after discharge. Twenty-three percent of respondents were surrogates.

To determine whether the subject was independent or dependent in each of five self-care ADLs (bathing, dressing, eating, transferring from a bed to a chair, and using the toilet), subjects were asked whether they needed the help of another person to complete the self-care ADL (e.g., "On the day you were admitted to the hospital, did you need help washing or bathing yourself?") Each respondent was also asked whether the patient had been able to perform these self-care ADLs independently 2 weeks before admission, which defines baseline function in this study. This definition for baseline function was chosen, because it generally reflects function before the acute illness or exacerbation of chronic illness resulting in hospital admission but is recent enough that patient and surrogate recall of functional status is reliable. Prior work has demonstrated that these retro-

spective reports have predictive validity.[26] At the time of discharge, and at 1, 3, 6, and 12 months after discharge, respondents were again asked whether the patient could perform each self-care ADL independently at that time.

At the time of hospital admission, each respondent reported on demographic information on living situation, ethnicity, and education and the patient's ability to perform seven instrumental activities of daily living (IADLs) without another person's assistance 2 weeks before admission. Data gathered through medical record review included comorbid diagnosis information for the Charlson Comorbidity Index, chart diagnosis of dementia, information for the Acute Physiology Score[27] at the time of admission, and admission serum albumin level.

Definitions: Functional Trajectories Between Baseline and Hospital Discharge

For each time point (baseline, hospital admission, hospital discharge, 1-, 3-, 6-, and 12-month follow-up), a global self-care ADL score defined as the number of self-care ADLs that the patient could perform independently was calculated. Patients were classified into one of four functional trajectories based on changes in their functional status between their baseline and the time of hospital discharge (Figure 1B). The first two trajectories (Group 1) included patients whose self-care ADL function at discharge was at least as good as their baseline function (discharged with baseline function). The first trajectory within this group included patients who had stable function throughout their course (Group 1, Trajectory a: no decline between baseline and admission and no decline between admission and discharge). The second trajectory within this group included patients who declined between baseline and hospital admission but recovered to baseline self-care ADL function by the time of hospital discharge (Group 1, Trajectory b). The next group (Group 2) included patients who declined in self-care ADL function between baseline and discharge (i.e., were dependent in more self-care ADLs at the time of hospital discharge than at their preillness baseline) (discharged with new or additional self-care ADL disability (decline in self-care ADL function)). The first trajectory within this group included patients who declined in ADL function between baseline and admission who did not recover to baseline function by the time of hospital discharge (Group 2, Trajectory c). The second trajectory within this group included patients who did not decline between baseline and admission but declined between admission and discharge (Group 2, Trajectory d).

Data Analyses

Description of Functional Outcomes Following Hospitalization

At 1, 3, 6, and 12 months after hospitalization, patients in both groups were classified as having died, having worse than baseline self-care ADL function, and having recovered to baseline self-care ADL function, depending on whether they were independent in at least as many self-care ADLs as at baseline. Death was determined at each time point according to surrogate report or the National Death Index. Patients and surrogates who were could not be contacted were classified as missing at each time point; 5.8% were missing at 1 month, 7.9% at 3 months, 7.8% at 6 months, and 6.2% at 12 months. Differences in the proportions who died, who did not recover to baseline self-care ADL function, and who recovered to baseline self-care ADL function at each point in time were compared using chi-square tests. Then the effect of early functional recovery on patients discharged with worse-than-baseline functional status (n = 799) was examined. Outcomes at 3, 6, and 12 months of those with and without functional recovery at 1 month were compared using chi-square tests. (Excluding those with missing data at 1 month or who had died by 1 month resulted in a sample size of n = 651.) The timing of recovery was also determined for those who were at baseline function at 12 months after hospital discharge.

Predictors of 1-Year Outcome

Additional analyses addressed predictors of failure to recover at 3 and 12 months after discharge in subjects with new or additional disability in self-care ADLs at hospital discharge. First, chi-square tests were used to examine the relationship between predictor variables and failure to recover. Variables were chosen based on review of the literature and a priori hypotheses and included age, sex, ethnicity, educational level, living alone, number of independent self-care ADLs at baseline, number of independent IADLs at baseline, Acute Physiology Score, admission from a nursing home, serum albumin, and comorbid conditions included in the Charlson Comorbidity Index (cardiovascular disease (defined as history of myocardial infarction, coronary artery disease, peripheral vascular disease, or stroke), renal disease, diabetes mellitus, cancer, chronic obstructive pulmonary disease, dementia, and congestive heart failure). Cutpoints for variables were chosen based on prior work.[8] Logistic regression was used to identify independent predictors failing to recover by 1 year. This analysis was repeated to determine independent predictors of failing to recover in 1-year survivors. Only significant variables were retained in the final models. Established methodology was used to convert from odds ratios to risk ratios (RRs).[28]

RESULTS

The baseline characteristics of patients who were discharged with baseline function and those who had acquired at least one new disability in self-care ADLs since baseline are presented in Table 1.

Functional Outcomes in the Year After Hospital Discharge

At all time points (1, 3, 6, and 12 months after discharge), patients discharged with new or additional disability in self-care ADLs (n = 799) had considerably worse outcomes than patients who were discharged with their baseline function (n = 1,480) (Figure 2). Most (67%) patients who were discharged at their baseline functional status maintained their baseline level of self-care ADL function in the year after discharge. In contrast, functional outcomes were much poorer in those who were discharged with new or additional disability in self-care ADLs, with high rates of 1-year mortality (41.3%) and less than one-third recovering to their baseline level of function. There is also evidence of subsequent decline after recovery.

Table 1. Characteristics of Patients According to Function at Hospital Discharge

Characteristic	Discharged with New or Additional Disability in ADLs (n = 799)	Discharge with Baseline Function (n = 1,480)	*P*-Value
Age, mean ± SD	82.0 ± 7.3	78.2 ± 6.0	<.001
Length of stay, mean ± SD	8.2 ± 6.6	5.3 ± 3.6	<.001
Acute Physiology Score, mean ± SD	10.2 ± 3.9	9.1 ± 3.0	<.001
Ethnicity, %			
White	76.0	76.7	.15
Black	24.0	23.3	
Women, %	68.3	61.0	<.001
Lives alone, %	35.4	35.2	.94
Admitted from nursing home, %	7.8	3.4	<.001
Independent in all ADL at baseline, %	54.7	73.4	<.001
Number of independent IADLs at baseline (of 7), mean ± SD	4.0 ± 2.5	5.6 ± 2.1	<.001
Education <12 years, %	42.3	39.5	<.001
Cardiovascular disease, %*	42.4	35.9	.002
Cancer: solitary, %	6.6	6.1	.18
Metastatic cancer, %	5.2	4.0	
Congestive heart failure, %	31.0	26.9	.04
Dementia, %	18.9	7.3	<.001
Chronic obstructive pulmonary disease, %	18.0	23.7	.002
Diabetes mellitus, %	19.9	23.0	.08
Renal disease, %	4.8	4.0	.47
Albumin <3.5, %	43.3	33.4	<.001

*History of stroke, myocardial infarction, peripheral vascular disease, or coronary artery disease.

The following variables had some missing data (out of 2,279): instrumental activities of daily living (IADLs) (n = 8), education (n = 170), cancer (n = 22), congestive heart failure (n = 22), dementia (n = 24), chronic obstructive pulmonary disease (n = 22), diabetes mellitus (n = 22), Acute Physiology Score (n = 7).

ADL = activities of daily living; SD = standard deviation.

Of patients who were discharged with baseline function (n = 1,480, Group 1, Figure 1B), patients who had stable function throughout (Trajectory a) had slightly better outcomes than patients who declined between their preillness baseline and hospital admission but then recovered by hospital discharge (Trajectory b). At 12 months after discharge, 70% and 60% of patients in these two groups, respectively, were at baseline function ($P = .005$). For patients discharged with new or additional disability in self-care ADLs (n = 799, Group 2, Figure 1B), rates of recovery by 12 months were similar regardless of whether the patient declined before admission and then failed to recover by discharge (Trajectory c) cor was admitted with baseline function, but then declined after hospital admission (Trajectory d) (30% vs 31%).

To examine whether better baseline function predicted better functional outcomes, the analyses were repeated in subgroups based on whether subjects were independent in all five ADLs at baseline. The results confirmed that 1-year functional outcomes were poor in those with new ADL deficits at discharge regardless of baseline ADL function, although outcomes in those dependent at baseline were worse than in those independent at baseline (20% recovered to baseline ADL function at 1 year, 28% alive but not recovered, and 51% dead vs 36%, 27%, and 37%, respectively).

Timing of Functional Recovery

Of those who had a new or additional disability in self-care ADLs at hospital discharge, 30% recovered and were at their baseline level of functioning at 1 year; 62% of recovered by 1 month, with the remainder recovering over the next 11 months. Thus, most recovery, when it happens, occurs in the first month after hospitalization, although 38% of patients who recovered in the year after discharge did so after the first month after hospitalization. Twenty-two percent of recovery occurs between 1 and 3 months, with an additional 16% of patients recovering over the next 9 months.

Role of 1-Month Outcomes in Predicting Long-Term Outcomes

For patients discharged with a new or additional disability in self-care ADLs, the presence or absence of recovery by 1 month was associated with long-term outcomes. Of those who had recovered by 1 month after discharge, 56.2% remained at baseline function 1 year after discharge, 20.7% died, and 23.1% declined again in self-care ADL function (Figure 3). In contrast, of those who had not recovered by 1 month after hospital discharge, 17.1% recovered baseline function at 1 year after discharge, 44.4% died, and 38.4% were alive but not recovered ($P < .001$).

Predictors of Failure to Recover at 1 Year

Table 2 describes bivariate predictors of failure to recover in patients discharged with a new or additional disability in self-care ADLs.

In multivariate analysis, the independent predictors of failure to return to baseline function at 1 year after discharge (death or worse-than-baseline functional status) were cancer, cardiovascular disease, dementia, serum albumin less than 4 g/dL, age, and number of baseline IADL dependencies (Table 3) and were similar at 3 months after discharge, with the exception of cardiovascular disease becoming borderline significant. These relative risks are associated with high absolute risks, given the high outcome rate in the reference groups. Repeating this analysis excluding subjects who died by 1 year, the independent predictors of failure to return to baseline function at 1 year in those who survived (n = 469) included aged 90 and older (RR = 1.4, 95% confidence interval (CI) = 1.0–1.7), cardiovascular disease (RR = 1.4, 95% CI = 1.2–1.7), dementia (RR = 1.4, 95% CI = 1.0–1.7), and greater number of baseline IADL dependencies (>2 vs none, RR = 1.9, 95% CI = 1.6–2.3) but did not include cancer and albumin.

DISCUSSION

These results demonstrate that decline in self-care ADL function associated with hospitalization for medical ill-

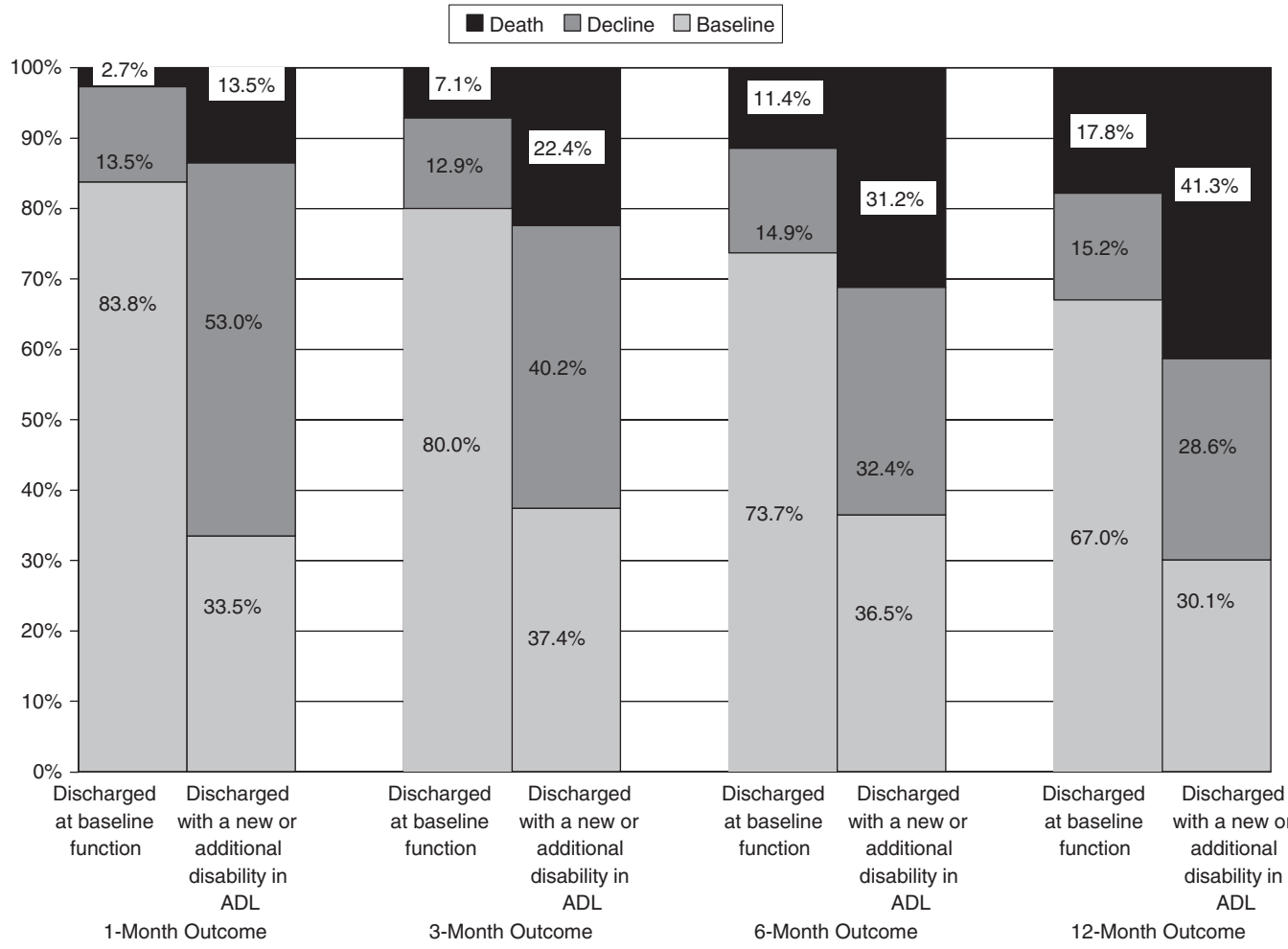

Figure 2. Course of self-care activity of daily living (ADL) outcomes and survival after hospitalization.
Discharged at baseline function: N = 1,480.
Discharged with new or additional disability in self-care ADLs: N = 799.
Baseline: At baseline level of self-care ADLs function.
Decline: With more self-care ADLs disabilities compared to baseline level of self-care ADLs function.

nesses is often a sentinel and highly morbid event for older adults. The prognosis for older adults discharged with new or additional disability in self-care ADLs is poor, with only 30% returning to their preadmission level of self-care ADL functioning by 1 year. Of those discharged with new or additional disability in self-care ADLs, functional recovery by 1 month is a predictor of 1-year outcomes, although in some cases, time to recovery was prolonged, with 38% of those who were at baseline function at 1 year requiring more than 1 month for recovery.

Long-term information on older adults' recovery of function after hospitalization is critically important, because large numbers of older adults are hospitalized annually for medical illnesses, and functional decline associated with hospitalization is common.[1–5,8,29] Previous reports have documented functional outcomes in hospitalized older adults up through 3 months.[4,8,9,13,14] This is one of the first reports to document that the long-term prognosis of hospital-associated new or additional disability in self-care ADLs is poor and substantially worse than that observed in community-dwelling older adults with disability arising from a broad range of causes.[10,18] These results suggest that the prognosis for hospital-associated disability in self-care ADLs is similar to that reported for other catastrophic conditions such as hip fracture and stroke.[30,31] The processes underlying these long-term outcomes are likely to be complex and highly dynamic.[10,32]

The results of the current study have important implications for hospital physicians and providers, because they suggest that hospitalized older adults may have dramatically higher care needs than before their incident hospitalization. New or additional disabilities in self-care ADL function acquired by the time of hospital discharge have important implications for patients' ability to live at home and for their needs for home care services. In addition, the demands on caregivers will markedly increase. Because recovery is sometimes prolonged, and some patients who initially recover subsequently decline, these results provide evidence that posthospitalization functional decline is a chronic, dynamic, long-term process that will probably necessitate acute and chronic services.

The timing, structure, duration, and intensity of rehabilitation in acute rehabilitation facilities, long-term care hospitals, skilled nursing facilities, outpatient sites, and

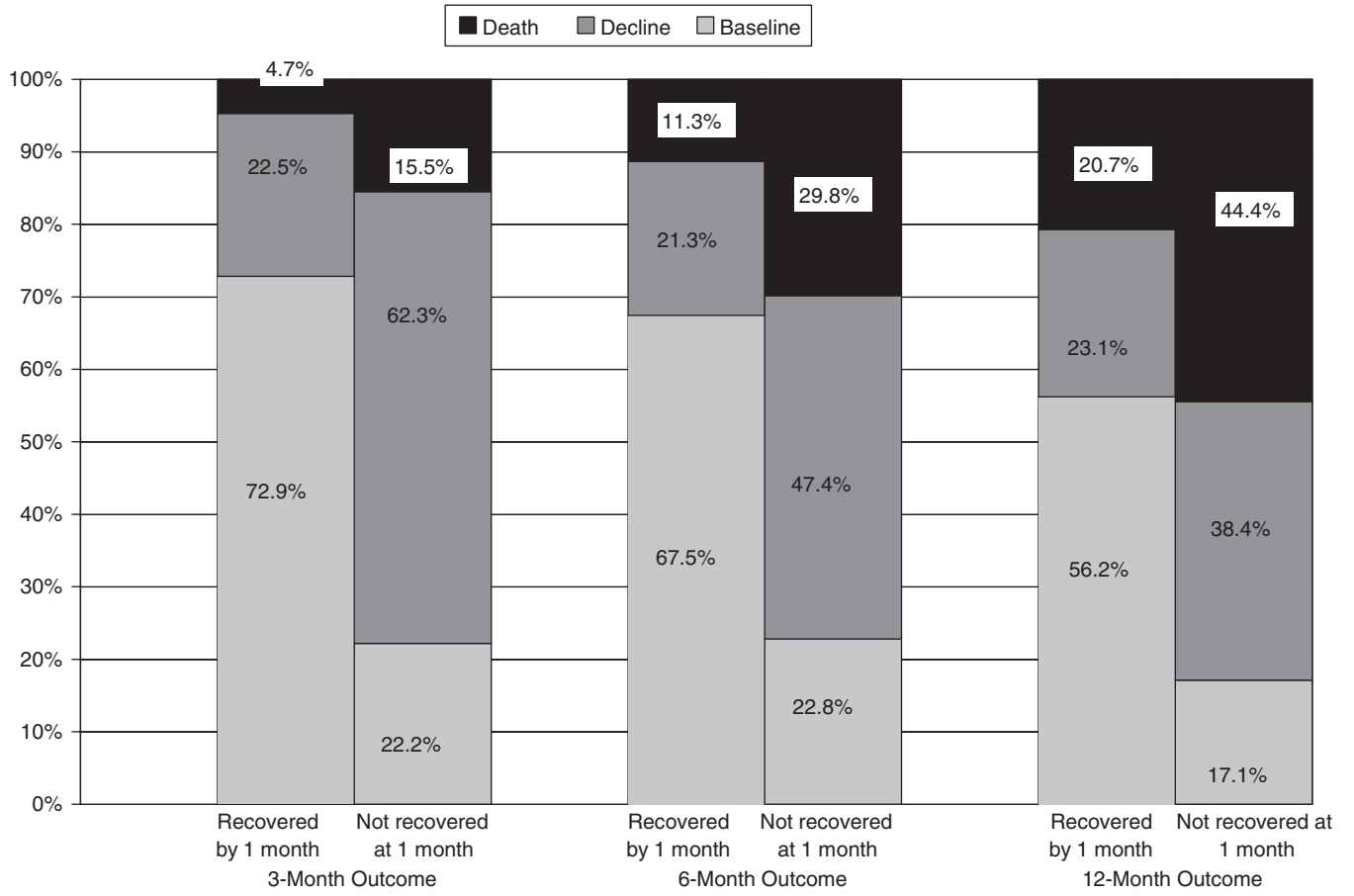

Figure 3. In those discharged with new or additional disability in self-care activities of daily living (ADLs), recovery to baseline level of self-care ADLs by 1 month after discharge (n = 651): Association with outcomes over 1 year.
N = 651 Of the original sample of those discharged with new or additional disability in self-care ADLs (N = 799), participants who were alive at discharge but who had died (n = 108) or who had missing data at 1 month (n = 40) were excluded.
Baseline: Recovery to baseline level of self-care ADLs function.
Decline: More self-care ADLs disabilities compared to baseline level of self-care ADLs function.

home health agencies may not be well suited to the needs of patients with hospital-associated functional decline, whose needs may be long term and chronic. During the 1990s, the prospective payment system and diagnosis related groups for acute hospitals and the postacute sector led to shorter hospital lengths of stay, with subsequent increases in postacute-care health utilization and costs.[19,20,33,34] Although the numbers of patients with medical illnesses receiving postacute physical, occupational, or speech services has increased in skilled nursing facilities, rehabilitation hospitals, and long-term care hospitals, the amount of rehabilitation received by patients has decreased in some settings and remains of short duration (<1 month).[19,20,35–37] Little is known about the functional consequences of these utilization changes to older medical patients or the best way to cost-effectively deliver high-quality care that maximizes functional outcomes.

Few older adults hospitalized with medical conditions receive acute inpatient rehabilitation.[3,38,39] The rates of patients with stroke, chronic obstructive pulmonary disease, pneumonia, congestive heart failure, and hip fracture receiving inpatient postacute rehabilitation services upon discharge ranged from 0.2% to 13% in 1996 to 1998, with the highest rates observed for stroke and hip fracture.[40] Stroke and hip fracture patients have better 1-year functional outcomes if they receive postacute care, with the best outcomes seen in those discharged to rehabilitation facilities.[34] The timing, duration, and intensity of therapy are related to functional gains.[41,42] Less is known about patients with functional decline associated with medical illnesses, but therapy intensity is related to gains in mobility, ADLs, and executive control in patients with cardiovascular and pulmonary conditions in skilled nursing facilities and increases the likelihood of being discharged to the community.[22,43] Current rehabilitative utilization patterns suggest that many medical patients with functional decline are not receiving the most-aggressive short-term interventions available. Possible explanations include inability to meet functional requirements or the requirement that 75% of admissions to inpatient rehabilitation facilities be for specific categorical diagnoses.[19,20,35–37] It is not known who with medical illness is most likely to benefit from acute rehabilitation or whether care through home care, skilled nursing facilities, or rehabilitation hospitals would be most likely to improve outcomes.[44,45] Average duration of rehabilitation in all of these postacute sites is short, given that 38% of older patients who recover in 1 year require more than 1 month to do so. Based on the results of the current study, aggressive rehabilitation may be indicated in the first

Table 2. Predictors of Failure to Recover to Baseline Activities of Daily Living Function at 1 Year in Patients Discharged with New or Additional Disability in Activities of Daily Living (ADLs): Bivariate Analysis (n = 799)

Characteristic	Not Recovered to Baseline ADL Function (%)	*P*-Value
Ethnicity		
White	71.1	.97
Black	71.0	
Sex		
Men	73.1	.40
Women	70.1	
Lives alone		
No	73.9	.02
Yes	65.8	
Education, years		
0–8	68	.83
9–11	76	
12	72	
13–15	65	
≥16	71	
ADLs at baseline		
Dependent	79.6	<.001
Independent	63.6	
Number of instrumental ADL dependencies at baseline		
0	46.7	<.001
1–2	69.1	
≥3	80.4	
Cancer		
None	69.0	.002
Solitary	84.0	
Metastatic	87.5	
Cardiovascular disease*		
No	66.5	.001
Yes	77.2	
Congestive heart failure		
No	68.0	.007
Yes	77.6	
Dementia		
No	67.5	<.001
Yes	85.6	
Chronic obstructive pulmonary disease		
No	71.7	
Yes	67.9	.37
Diabetes mellitus		
No	70.7	.71
Yes	72.2	
Renal disease		
No	70.6	.17
Yes	81.1	
Admitted from nursing home		
No	70.4	.15
Yes	79.3	
Age		
70–74	65.2	<.001
75–79	61.7	
80–84	73.2	
85–89	71.3	
≥90	85.9	
Acute Physiology Score		
5–7	67.3	.09
8–10	70.2	
>11	74.2	
Albumin		
<3	74.8	.005
3–3.4	74.0	
3.5–3.9	76.6	
>4	61.6	

*Defined as history of stroke, myocardial infarction, peripheral vascular disease, or coronary artery disease.

month, but because substantial functional change continues to occur in subsequent months, in many cases it may be important to target longer-term rehabilitation to increase recovery rates and maintain recovery when it occurs.[10] Restorative care for older persons receiving home care after acute illness and "prehabilitation" for frail older adults, who may have frequent hospitalizations, may be opportunities to maximize functional outcomes.[46,47]

Appropriate targeting of older patients for rehabilitation interventions is critical, and current aggressive rehabilitation strategies may be difficult in patients residing in nursing homes or with severe dementia. Although the results of the current study do not identify which patients are most likely to benefit from interventions, they suggest that older age, cardiovascular disease, dementia, cancer, lower albumin, and prior IADL disability predict failure to recover. It is important that future research also try to distinguish between patients who have the potential for reversibility and patients for whom this functional decline indicates that they are at the end of their lives. The high 1-year mortality rate in patients with hospital-associated functional decline should prompt consideration of palliative needs. For patients who are at the end of life, aggressive palliative interventions focused on symptom management and caregiver support may be more beneficial than interventions aimed at restoring function. It may often be appropriate to consider palliative care in tandem with rehabilitative efforts.

LIMITATIONS

Although measurements were taken at four time points over a 12-month period of observation, it is likely that there were additional functional transitions that occurred between observation points.[32,48] It was not the primary goal to describe all of the dynamic processes and transitions that occurred over the year after discharge. Second, it was not possible to consider all potential predictors of recovery, including lack of depressive symptoms, positive affect, and habitual physical activity, and objective measures of strength or physical capabilities.[15,49] Third, data were lacking on postacute utilization of rehabilitative services or recurrent hospitalizations, although rehabilitation, particularly prolonged, was not widely used for medical patients during the study period, even though use of rehabilitation in skilled nursing facilities has increased.[38] Although data on long-term outcomes of

Table 3. Independent Predictors of Failure to Return to Baseline Function at 1 Year After Discharge in Patients Discharged with New or Additional Disability in Activities of Daily Living (ADLs) (n = 799)

Variable	Not Returning to Baseline Function (Low to High Risks)	Risk Ratio (95% Confidence Interval)	
		Unadjusted	Adjusted
Cancer			
None (88%)	69%	Ref	Ref
Solitary (7%)	84%	1.22 (1.03–1.33)	1.25 (1.07–1.36)
Metastatic (5%)	88%	1.27 (1.06–1.37)	1.30 (1.12–1.39)
Cardiovascular disease*			
No (58%)	67%	Ref	Ref
Yes (42%)	77%	1.16 (1.07–1.23)	1.16 (1.06–1.25)
Dementia			
No (81%)	68%	Ref	Ref
Yes (19%)	86%	1.26 (1.15–1.34)	1.21 (1.07–1.30)
Albumin			
≥4.0 g/dL (30%)	62%	Ref	Ref
<4.0 g/dL (70%)	75%	1.22 (1.11–1.31)	1.23 (1.11–1.33)
Number of instrumental ADL dependencies at baseline			
0 (22%)	49%	Ref	Ref
1–2 (17%)	69%	1.45 (1.23–1.63)	1.50 (1.27–1.68)
>3 (61%)	80%	1.67 (1.54–1.77)	1.64 (1.49–1.76)
Age			
<90 (83%)	68%	Ref	Ref
≥90 (17%)	86%	1.26 (1.15–1.34)	1.22 (1.08–1.32)

*Defined as history of stroke, myocardial infarction, peripheral vascular disease, or coronary artery disease.
Adjusted for study site and intervention versus control arm. Neither of these variables was significant.

functional decline in the hospital in a large group of older adults presented here were collected beginning in the 1990s, there is no scientific basis to expect that the natural history of functional trajectories have changed. However, it is not known what the effect of shorter length of stays since the study period has had on functional outcomes of older patients. It is possible that, now, certain additional patients are not at their premorbid level of function before discharge. Fourth, there was not a large-enough sample size to examine recovery for specific admission diagnoses or recurrent hospitalizations. These older patients were all hospitalized nonelectively on general medicine units and, thus this analysis focuses on a subset of older adults who experience decline associated with hospitalization for acute illness other than the more commonly studied stroke and hip fracture.

CONCLUSION

Patients discharged with new or additional disability in self-care ADLs after medical illness are at high risk for poor outcomes and should be considered for intensive rehabilitative services during and after discharge from the hospital if this is congruent with the overall goals of care. Because outcomes in the first month seem to predict long-term outcomes, particularly aggressive interventions may be indicated in the first month, although because many patients may recover after 1 month, and many who recover by 1 month decline again, there may also be a need for sustained long-term interventions. Appropriate targeting is likely to be critical in interventions, and there is a clear role for palliative and caregiver services, perhaps provided in tandem with rehabilitation focused on maximizing recovery and adapting to new or additional disability. More research is needed to appropriately guide clinical practice and health policy for older adults hospitalized for acute medical illnesses who experience functional decline at hospital discharge.

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REFERENCES

1. Ferrucci L, Guralnik JM, Simonsick E et al. Progressive versus catastrophic disability: A longitudinal view of the disablement process. J Gerontol A Biol Sci Med Sci 1996;51A:M123–M130.
2. Gill TM, Williams CS, Tinetti ME. The combined effects of baseline vulnerability and acute hospital events on the development of functional dependence among community-living older persons. J Gerontol A Biol Sci Med Sci 1999; 54A:M377–M383.
3. Ferrucci L, Guralnik JM, Pahor M et al. Hospital diagnoses, Medicare charges, and nursing home admissions in the year when older persons become severely disabled. JAMA 1997;277:728–734.
4. Sager MA, Rudberg MA, Jalaluddin M et al. Hospital Admission Risk Profile (HARP): Identifying older patients at risk for functional decline following acute medical illness and hospitalization. J Am Geriatr Soc 1996;44:251–257.
5. Boyd CM, Xue QL, Guralnik JM et al. Hospitalization and development of dependence in activities of daily living in a cohort of disabled older women: The Women's Health and Aging Study I. J Gerontol A Biol Sci Med Sci 2005; 60A:888–893.
6. Boyd CM, Xue QL, Simpson CF et al. Frailty, hospitalization, and progression of disability in a cohort of disabled older women. Am J Med 2005;118:1225–1231.
7. Gill TM, Allore HG, Holford TR et al. Hospitalization, restricted activity, and the development of disability among older persons. JAMA 2004;292:2115–2124.
8. Covinsky KE, Palmer RM, Fortinsky RH et al. Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: Increased vulnerability with age. J Am Geriatr Soc 2003;51:451–458.
9. Sager MA, Franke T, Inouye SK et al. Functional outcomes of acute medical illness and hospitalization in older persons. Arch Intern Med 1996;156:645–652.
10. Hardy SE, Gill TM. Recovery from disability among community-dwelling older persons. JAMA 2004;291:1596–1602.
11. Gill TM, Robison JT, Tinetti ME. Predictors of recovery in activities of daily living among disabled older persons living in the community. J Gen Intern Med 1997;12:757–762.
12. Magaziner J, Simonsick EM, Kashner TM et al. Predictors of functional recovery one year following hospital discharge for hip fracture: A prospective study. J Gerontol 1990;45:M101–M107.
13. Rudberg MA, Sager MA, Zhang J. Risk factors for nursing home use after hospitalization for medical illness. J Gerontol A Biol Sci Med Sci 1996;51A: M189–M194.
14. Mahoney JE, Eisner J, Havighurst T et al. Problems of older adults living alone after hospitalization. J Gen Intern Med 2000;15:611–619.
15. Hardy SE, Gill TM. Factors associated with recovery of independence among newly disabled older persons. Arch Intern Med 2005;165:106–112.
16. Walter LC, Brand RJ, Counsell SR et al. Development and validation of a prognostic index for 1-year mortality in older adults after hospitalization. JAMA 2001;285:2987–2994.
17. Inouye SK, Peduzzi PN, Robison JT et al. Importance of functional measures in predicting mortality among older hospitalized patients. JAMA 1998;279: 1187–1193.
18. Johnson MF, Kramer AM, Lin MK et al. Outcomes of older persons receiving rehabilitation for medical and surgical conditions compared with hip fracture and stroke. J Am Geriatr Soc 2000;48:1389–1397.
19. McCall N, Korb J, Petersons A et al. Reforming Medicare payment: Early effects of the 1997 Balanced Budget Act on postacute care. Milbank Q 2003; 81:277–303, 172–273.
20. Murray PK, Love TE, Dawson NV et al. Rehabilitation services after the implementation of the nursing home prospective payment system: Differences related to patient and nursing home characteristics. Med Care 2005;43:1109–1115.
21. Shatto A. Comparing Medicare beneficiaries, by type of post-acute care received: 1999. Health Care Financ Rev 2002;24:137–142.
22. Jette DU, Warren RL, Wirtalla C. The relation between therapy intensity and outcomes of rehabilitation in skilled nursing facilities. Arch Phys Med Rehabil 2005;86:373–379.
23. Counsell SR, Holder CM, Liebenauer LL et al. Effects of a multicomponent intervention on functional outcomes and process of care in hospitalized older patients: A randomized controlled trial of Acute Care for Elders (ACE) in a community hospital. J Am Geriatr Soc 2000;48:1572–1581.
24. Covinsky KE, Eng C, Lui LY et al. The last 2 years of life: Functional trajectories of frail older people. J Am Geriatr Soc 2003;51:492–498.
25. Pfeiffer E. A short portable mental status questionnaire for the assessment of organic brain deficit in elderly patients. J Am Geriatr Soc 1975;23:433–441.
26. Covinsky KE, Palmer RM, Counsell SR et al. Functional status before hospitalization in acutely ill older adults: Validity and clinical importance of retrospective reports. J Am Geriatr Soc 2000;48:164–169.
27. Knaus WA, Draper EA, Wagner DP et al. APACHE II: A severity of disease classification system. Crit Care Med 1985;13:818–829.
28. Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. JAMA 1998;280:1690–1691.
29. Kozak LJ, DeFrances CJ, Hall MJ. National Hospital Discharge Survey: 2004 annual summary with detailed diagnosis and procedure data. Vital Health Stat 2006;162:1–209.
30. Magaziner J, Fredman L, Hawkes W et al. Changes in functional status attributable to hip fracture: A comparison of hip fracture patients to community-dwelling aged. Am J Epidemiol 2003;157:1023–1031.
31. Tilling K, Sterne JA, Rudd AG et al. A new method for predicting recovery after stroke. Stroke 2001;32:2867–2873.
32. Hardy SE, Dubin JA, Holford TR et al. Transitions between states of disability and independence among older persons. Am J Epidemiol 2005;161:575–584.
33. Ottenbacher KJ, Smith PM, Illig SB et al. Trends in length of stay, living setting, functional outcome, and mortality following medical rehabilitation. JAMA 2004;292:1687–1695.
34. Kane RL, Chen Q, Finch M et al. Functional outcomes of posthospital care for stroke and hip fracture patients under medicare. J Am Geriatr Soc 1998; 46:1525–1533.
35. Yip JY, Wilber KH, Myrtle RC. The impact of the 1997 Balanced Budget Amendment's prospective payment system on patient case mix and rehabilitation utilization in skilled nursing. Gerontologist 2002;42:653–660.
36. Wodchis WP, Fries BE, Pollack H. Payer incentives and physical rehabilitation therapy for nonelderly institutional long-term care residents: Evidence from Michigan and Ontario. Arch Phys Med Rehabil 2004;85:210–217.
37. Murtaugh CM, McCall N, Moore S et al. Trends in Medicare home health care use: 1997–2001. Health Aff (Millwood) 2003;22:146–156.
38. Gage B. Impact of the BBA on post-acute utilization. Health Care Financ Rev 1999;20:103–126.
39. Buechner JS, Donnelly EF. Utilization of inpatient rehabilitation services. Med Health R I 2001;84:412–413.
40. Kane RL, Lin WC, Blewett LA. Geographic variation in the use of post-acute care. Health Serv Res 2002;37:667–682.
41. Chen CC, Heinemann AW, Granger CV et al. Functional gains and therapy intensity during subacute rehabilitation: A study of 20 facilities. Arch Phys Med Rehabil 2002;83:1514–1523.
42. Penrod JD, Boockvar KS, Litke A et al. Physical therapy and mobility 2 and 6 months after hip fracture. J Am Geriatr Soc 2004;52:1114–1120.
43. Arling G, Williams AR, Kopp D. Therapy use and discharge outcomes for elderly nursing home residents. Gerontologist 2000;40:587–595.
44. Intrator O, Berg K. Benefits of home health care after inpatient rehabilitation for hip fracture: Health service use by Medicare beneficiaries, 1987–1992. Arch Phys Med Rehabil 1998;79:1195–1199.
45. Hadley J, Rabin D, Epstein A et al. Posthospitalization home health care use and changes in functional status in a Medicare population. Med Care 2000; 38:494–507.
46. Tinetti ME, Baker D, Gallo WT et al. Evaluation of restorative care vs usual care for older adults receiving an acute episode of home care. JAMA 2002; 287:2098–2105.
47. Gill TM, Baker DI, Gottschalk M et al. A prehabilitation program for physically frail community-living older persons. Arch Phys Med Rehabil 2003;84:394–404.
48. Guralnik JM, Ferrucci L. Underestimation of disability occurrence in epidemiological studies of older people: Is research on disability still alive? J Am Geriatr Soc 2002;50:1599–1601.
49. Ostir GV, Goodwin JS, Markides KS et al. Differential effects of premorbid physical and emotional health on recovery from acute events. J Am Geriatr Soc 2002;50:713–718.