Development and Validation of a Prognostic Index for 1-Year Mortality in Older Adults After Hospitalization

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Context For many elderly patients, an acute medical illness requiring hospitalization is followed by a progressive decline, resulting in high rates of mortality in this population during the year following discharge. However, few prognostic indices have focused on predicting posthospital mortality in older adults.

Objective To develop and validate a prognostic index for 1 year mortality of older adults after hospital discharge using information readily available at discharge.

Design Data analyses derived from 2 prospective studies with 1-year of follow-up, conducted in 1993 through 1997.

Setting and Patients We developed the prognostic index in 1495 patients aged at least 70 years who were discharged from a general medical service at a tertiary care hospital (mean age, 81 years; 67% female) and validated it in 1427 patients discharged from a separate community teaching hospital (mean age, 79 years; 61% female).

Main Outcome Measure Prediction of 1-year mortality using risk factors such as demographic characteristics, activities of daily living (ADL) dependency, comorbid conditions, length of hospital stay, and laboratory measurements.

Results In the derivation cohort, 6 independent risk factors for mortality were identified and weighted using logistic regression: male sex (1 point); number of dependent ADLs at discharge (1-4 ADLs, 2 points; all 5 ADLs, 5 points); congestive heart failure (2 points); cancer (solitary, 3 points; metastatic, 8 points); creatinine level higher than 3.0 mg/dL (265 μmol/L) (2 points); and low albumin level (3.0-3.4 g/dL, 1 point; <3.0 g/dL, 2 points). Several variables associated with 1-year mortality in bivariable analyses, such as age and dementia, were not independently associated with mortality after adjustment for functional status. We calculated risk scores for patients by adding the points of each independent risk factor present. In the derivation cohort, 1-year mortality was 13% in the lowest-risk group (0-1 point), 20% in the group with 2 or 3 points, 37% in the group with 4 to 6 points, and 68% in the highest-risk group (>6 points). In the validation cohort, 1-year mortality was 4% in the lowest-risk group, 19% in the group with 2 or 3 points, 34% in the group with 4 to 6 points, and 64% in the highest-risk group. The area under the receiver operating characteristic curve for the point system was 0.75 in the derivation cohort and 0.79 in the validation cohort.

Conclusions Our prognostic index, which used 6 risk factors known at discharge and a simple additive point system to stratify medical patients 70 years or older according to 1-year mortality after hospitalization, had good discrimination and calibration and generalized well in an independent sample of patients at a different site. These characteristics suggest that our index may be useful for clinical care and risk adjustment.

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PEOPLE AGED 65 YEARS OR OLDER make up about 13% of the US population, but they account for 37% of discharges from acute care hospitals.[1] For many elderly patients, an acute medical illness requiring hospitalization is followed by a progressive physical decline, resulting in high rates of mortality during the year following discharge.[2] Since hospitalization is frequently a major health transition for older adults, reassessing goals of care at this juncture is often necessary. Prognostic information can provide the basis for discussions about the goals of care and therapy.[3] However, few prognostic indices have focused on prediction of posthospital mortality in the elderly population.

A prognostic index that estimates long-term mortality in older adults following hospitalization may be useful to clinicians for many reasons. Such an index can provide objective prognostic estimates to supplement clinicians' intuition and judgment when counseling patients and their families about the meaning of health problems and utility of treatment options. Prognostic indices also can be useful in identifying groups at high risk for

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poor outcomes in whom targeted treatment interventions may be indicated[4] or for whom palliative care may be most appropriate.[5]

Also, prognostic indices are essential for comparing outcomes among different physicians, hospitals, or systems of care.[6] For example, indices that correct for baseline risk differences among patients are needed to draw fair inferences from observed mortality data about the quality of patient care provided by different health plans following hospitalization. Fair comparisons can stimulate improvements in quality of care, but such comparisons are not possible without accurate methods of risk adjustment.[7]

The few prognostic indices that stratify hospitalized general medical patients into risk groups for long-term mortality have a number of limitations. Some only apply to the critically ill,[8-10] or require complex calculations and data that would not be routinely available to clinicians. Only a few include functional status,[11-13] despite its association with mortality in older patients who are hospitalized.[14,15] Also, many indices have not been developed for ethnically diverse groups of patients or validated in independent samples, limiting their generalizability.[16]

To address these issues, we developed a prognostic index for 1-year mortality following hospital discharge in a large heterogeneous group of older adults with medical illnesses, in whom we measured multiple potential prognostic factors, including functional status. We then validated the index in an independent sample. Our goal was to provide an accurate and easy-to-use index that could stratify older adults into groups by their risk of mortality after hospital discharge.

METHODS

Participants

This study includes individuals enrolled in 2 randomized trials of an intervention to improve functional outcomes of hospitalized older adults. The trials were conducted at the University Hospitals of Cleveland (UHC), a tertiary care hospital, and the Akron City Hospital (ACH), a community teaching hospital in Ohio, between 1993 and 1997. Each trial enrolled patients who were aged 70 years or older and who were admitted to the general medical service. Patients admitted to intensive care units (ICUs) or subspecialty services or elective admissions were excluded, as were patients with lengths of stay fewer than 2 days. Study protocols randomly selected a subset of eligible patients to be representative of the general medical wards since it was not possible to enroll all eligible patients because of logistic constraints. Of a possible 11 475 eligible patients, 3163 were randomly selected for enrollment. The demographic, clinical, and functional characteristics of patients enrolled in the study were similar to those not enrolled.[17] After 1 year, there was no difference in mortality or functional status between the control and intervention groups, so they were combined for this analysis.

We used patients from the UHC to derive the prediction model and then used patients from the ACH to validate the model. The UHC trial enrolled 1632 patients and the ACH trial enrolled 1531 patients. The potential analytic cohorts for this study included the 1565 UHC patients and 1482 ACH patients who survived to hospital discharge. We excluded 70 patients (4%) in the UHC cohort because they were missing data on comorbid conditions or functional status, leaving 1495 patients, and 55 patients (4%) from the ACH cohort who were missing data on these risk factors, leaving 1427 patients.

Data Collection and Measurements

Predictors of Mortality. We obtained data from standardized interviews with patients and surrogates and from medical records. We interviewed surrogate respondents when the patient scored more than 5 errors on the 10-point Short Portable Mental Status Questionnaire[18] or was too ill to communicate at the time of admission (40%). We interviewed participants at both admission and discharge. The interviews included demographic characteristics and reports of independence in 5 activities of daily living (ADLs): bathing, dressing, using the toilet, transferring from bed to chair, and eating. We used a modified version of the Katz Index of ADLs[19] to assess independence in ADLs by asking the patient or surrogate at the time of discharge whether the patient needed help from another person to perform each activity. A patient who required personal assistance to perform a particular ADL was classified as dependent in that ADL. A patient who used an assistive device to perform an ADL but did not require help from another person was considered independent.

Information obtained from medical records by trained chart abstractors included laboratory values on admission comprising the APACHE (Acute Physiology and Chronic Health Evaluation) II score,[20] medical diagnoses comprising the Charlson comorbidity index,[21] reason for admission, length of hospital stay, and discharge destination. We used laboratory values from the time of admission, because in clinical practice they are routinely obtained at that time but not always at the time of discharge.

We grouped the risk factors that we hypothesized were associated with 1-year mortality into 4 broad categories: demographic variables, medical diagnoses, functional status, and laboratory values. Race was identified by the patient. Specific risk factors were chosen based on clinical relevance, previous studies of predictors of mortality, and prevalence greater than 10% in our sample.

Age was coded into 5-year intervals. Length of hospital stay was divided into 7 days or fewer or more than 7 days, based on the mean length of stay. Categorical variables, such as comorbid conditions, were coded as present or absent, except that cancer was coded as absent or solitary or metastatic solid tumor. Hematologic malignancies were coded as solitary cancer. Functional status was categorized as totally independent (independent in all ADLs), par-

tially dependent (dependent in 1-4 ADLs), or totally dependent (dependent in all ADLs). Analyses that used individual ADL items or total ADL scores produced models with virtually the same discrimination as our final model. Creatinine and albumin levels were also recoded into intervals based on clinically relevant cut points.[22,23]

Definition of Outcome. The outcome of interest was defined as death within 1 year after hospital discharge. We also used Kaplan-Meier curves to examine the performance of our prognostic index over time. We obtained information about vital status through follow-up interviews with participants and family members and a search of the National Death Index.[24] Deaths were classified based on matches of the National Death Index record with the subject according to name, sex, date of birth, and Social Security number. We achieved 100% follow-up for vital status.

Model Derivation. We measured the bivariable relationship between each risk factor and mortality in the derivation cohort using logistic regression models containing only the risk factor of interest. We then entered all risk factors associated with 1-year mortality (at $P<.20$) into a multivariable logistic regression model with backward elimination ($P<.05$ to retain) to select the final set of risk factors. The same multivariable model was chosen using forward selection ($P<.05$ to enter). After developing the final model, we assessed interactions between sex and age with other risk factors. None were significant at $P<.05$.

We describe the results of our predictive model in 2 ways. First, we estimated the predicted risk of death for each subject, based on the final logistic regression model, and divided the subjects into quartiles of risk. Second, we constructed a bedside risk scoring system in which we assigned points to each risk factor by dividing each β coefficient in the final model by the lowest β coefficient (male sex) and rounding to the nearest integer.[25] A risk score was assigned to each subject by adding up the points for each risk factor present. Subjects were then divided into approximate quartiles based on their risk scores.

The predictive accuracy of the logistic model and the point scoring system was determined by comparing predicted vs observed mortality in the ACH validation cohort (calibration), and by calculating the area under the receiver operating characteristic (ROC) curves (discrimination) in both the derivation and validation cohorts. Discrimination reflects the ability of the prognostic index to distinguish between patients at high and low risk of death and is often described in terms of the area under the ROC curve (ROC area), which is related to the relative probability that in all possible pairs of patients in which one patient lives and the other dies, a higher risk was assigned to the patient who died than to the one who lived.[26] We chose to validate our predictive model at a different site (ACH) than where it was developed (UHC) since this form of prospective validation not only tests the accuracy of the model but also tests its geographic and methodologic transportability.[16,27,28]

RESULTS

Characteristics of Participants

The mean (SD) age of patients in the UHC derivation cohort was 81 (7) years. Sixty-seven percent were women, 60% were white, and 30% were discharged to a nursing home or skilled nursing facility. Forty-one percent were independent in all ADLs at discharge, 32% were dependent in 1 to 4 ADLs, and 27% were dependent in all ADLs (TABLE 1). During 1-year follow-up, 492 patients (33%) died.

The mean (SD) age of patients in the ACH validation cohort was 79 (7) years. Sixty-one percent were women, 88% were white, and 14% were discharged to a nursing home or skilled nursing facility. Fifty percent were independent in all ADLs at discharge, 35% were dependent in 1 to 4 ADLs, and 15% were dependent in all ADLs (Table 1). During the year following hospital discharge, 398 patients (28%) died.

Bivariable Results

Risk factors associated with 1-year mortality in the bivariable analyses ($P<.20$) included age of 80 years or older, male sex, history of myocardial infarction, congestive heart failure, cerebrovascular disease, dementia, cancer, ADL function at discharge, length of hospital stay of more than 7 days, discharge to a nursing home or skilled nursing facility, creatinine level of 1.5 mg/dL (132.6 µmol/L) or more, and albumin level of less than 4.0 g/dL (TABLE 2).

Multivariable Results

Six of these 12 risk factors were independently associated with mortality in multivariable analysis (TABLE 3), including 1 demographic variable (male sex), 2 medical diagnoses (congestive heart failure and cancer), functional dependency in any ADL at discharge, and 2 laboratory values (creatinine level >3.0 mg/dL [265.2 µmol/L] and albumin level ≤3.4 g/dL). Many of the risk factors significantly associated with 1-year mortality in bivariable analyses were not independently associated with 1-year mortality after adjustment for discharge functional status. These included age, dementia, and discharge to a nursing home.

By quartiles of predicted risk, 1-year mortality ranged from 13% in the lowest-risk quartile to 63% in the highest-risk quartile in the derivation cohort and from 9% to 64% in the validation cohort (TABLE 4). There was good calibration of the model, with close agreement between observed and predicted mortality. The discrimination of the final model was better in the validation cohort (ROC area=0.80) than in the derivation cohort (ROC area=0.75). The model also retained good discrimination in the validation cohort within sex and age subgroups. The ROC area was 0.80 for women, 0.78 for men, 0.79 for patients aged 70 to 79 years, and 0.79 for patients aged 80 years or older.

Bedside Risk Scoring System

The points assigned to each of the final 6 risk factors in the bedside scoring system are listed in Table 3. A risk

score was calculated for each patient by adding the points of each risk factor that was present. For example, a 70 year-old man (1 point) admitted to a general medical service with functional dependency in 3 ADLs (2 points), an albumin level of 2.9 g/dL (2 points), and a normal creatinine level would have a risk score of 5 points. Derivation cohort risk scores ranged from 0 to 16 points (mean [SD], 4.0 [3]).

Patients were divided by risk scores into 4 risk groups of roughly equal size. In the UHC derivation cohort, mortality ranged from 13% in the lowest-risk group (0-1 point) to 68% in the high-risk group (>6 points). Within these groups, patients with 0 points had a mortality rate of 11% (22/197) while patients with more than 9 points had a mortality rate of 82% (55/67). Similar results were seen in the validation cohort, except that the low-risk group had only a 4% mortality (Table 4). The point system had better discrimination in the validation cohort (ROC area = 0.79) than the derivation cohort (ROC area = 0.75). Kaplan-Meier survival curves of the 4 risk groups in the validation cohort demonstrate that the groups have markedly different survival trajectories and that the mortality differences between risk groups are persistent over the 1 year of follow-up (FIGURE). In addition, the point system retained good discrimination in age and sex subgroup analyses (ROC area = 0.79 for women, 0.78 for men, 0.79 for patients aged 70-79 years, and 0.79 for patients aged 80 years or older).

Table 1. Characteristics of Patients in Derivation and Validation Cohorts

Characteristic	No. (%) Derivation (n = 1495)	No. (%) Validation (n = 1427)
Age, y		
70-74	386 (26)	393 (27)
75-79	370 (25)	399 (28)
80-84	328 (22)	321 (22)
85-89	225 (15)	180 (13)
≥90	186 (12)	134 (9)
Women	1004 (67)	869 (61)
Race		
White	894 (60)	1255 (88)
Black	601 (40)	172 (12)
Married	520 (35)	607 (43)
Activities of daily living (ADL) dependency at discharge		
Independent in all ADLs	604 (41)	709 (50)
Dependent in 1-4 ADLs	483 (32)	496 (35)
Dependent in all ADLs	408 (27)	222 (15)
Comorbid conditions		
Myocardial infarction	208 (14)	239 (17)
Congestive heart failure	400 (27)	410 (29)
Cerebrovascular disease	250 (17)	297 (21)
Dementia	271 (18)	235 (17)
Chronic obstructive pulmonary disease	256 (17)	350 (24)
Diabetes mellitus	265 (18)	300 (21)
Cancer	158 (11)	195 (24)
Length of hospital stay >7 d	458 (31)	329 (23)
Discharged to nursing home or skilled nursing facility	452 (30)	180 (14)
Chief reason for admission		
Neurologic problem	156 (10)	282 (20)
Cardiac problem	218 (15)	160 (11)
Fever or infection	199 (13)	200 (14)
Pulmonary problem	321 (21)	353 (25)
Gastrointestinal problem	299 (20)	240 (17)
Diabetes/metabolic problem	174 (12)	79 (5)
Other	128 (9)	113 (8)
Laboratory values on admission		
Creatinine, mg/dL*		
<1.5	893 (60)	1143 (80)
1.5-3.0	467 (31)	235 (16)
>3.0	135 (9)	49 (4)
Albumin, g/dL		
≥4.0	654 (44)	292 (20)
3.5-3.9	435 (29)	411 (29)
3.0-3.4	255 (17)	455 (32)
<3.0	151 (10)	269 (19)

*To convert to µmol/L, multiply by 88.4.

COMMENT

We have developed a prognostic index that can be used as a simple point scoring system at the bedside to stratify elderly medical patients into high-, intermediate-, and low-risk groups for mortality during the year following hospital discharge. This index includes risk factors from each of the 4 domains that we hypothesized were associated with 1-year mortality: demographic variables, medical diagnoses, functional status, and laboratory values. This finding is consistent with the clinical scenario that in many older adults the cause of death is multifactorial.[29] Our index emphasizes the importance of considering multiple domains when assessing prognosis in older patients and adds to our understanding of the complexity of mortality prediction in the elderly population.

Our study, by demonstrating the prognostic importance of ADL function, provides further evidence supporting routine assessment of functional status in hospitalized older adults. Consistent with other studies, we found that measures of functional status add important information about risk for

1-year mortality beyond that provided by medical diagnoses or physiologic measures.[13-15] This is probably because functional status reflects the severity and end result of many different illnesses and psychosocial factors. However, the importance of assessing functional status extends well beyond its value as a prognostic measure. Assessing ADL function of hospitalized older adults is essential for providing quality care after discharge. Without assessing ADL function, it is difficult to advise a patient about long-term care needs, assess the need for home care and other supportive services, or evaluate the needs of a patient's caregiver.[30,31] While physicians often fail to assess their patients' functional status,[32] the ADL questions we asked in this study took only a few minutes to administer. Also, the ease of reviewing functional information routinely obtained by other disciplines, such as nursing or physical therapy, should improve as more hospitals are developing systematic methods for measuring and recording functional status in older adults.[13]

Only 2 of the medical diagnoses from the Charlson comorbidity index (congestive heart failure and cancer) remained independently associated with mortality. Other illnesses, such as dementia and cerebrovascular disease, which were highly associated with mortality in bivariate analyses, no longer added to the prognostic estimate after adjustment for functional status. This suggests that decrements in functional status reflect the severity of dementia and cerebrovascular disease better than they reflect the severity of congestive heart failure or cancer.

Additional risk factors that remained associated with an increased risk for mortality after adjustment for comorbid illness and functional status included male sex and laboratory values for creatinine and albumin. Others have argued that the association between creatinine and mortality may be explained by the direct negative effects of renal dysfunction on multiple organ systems or may be reflective of generalized de-

Table 2. Bivariable Associations of Risk Factors and 1-Year Mortality in the Derivation Cohort

Risk Factor	No. (%) of Deaths	Odds Ratio (95% Confidence Interval)	*P* Value
Age, y			
70-74	102 (26)	1.0	
75-79	107 (29)	1.2 (0.8-1.6)	.44
80-84	117 (36)	1.5 (1.1-2.1)	.01
85-89	83 (37)	1.6 (1.1-2.3)	.01
≥90	83 (45)	2.2 (1.6-3.2)	<.001
Sex			
Women	312 (31)	1.0	
Men	180 (37)	1.3 (1.0-1.6)	.03
Race			
White	286 (32)	1.0	
Black	206 (35)	1.1 (0.9-1.4)	.32
Marital status			
Married	178 (34)	1.0	
Not married	314 (32)	0.9 (0.7-1.1)	.43
ADL dependency at discharge*			
Independent in all ADLs	112 (19)	1.0	
Dependent in 1-4 ADLs	158 (33)	2.1 (1.6-2.8)	<.001
Dependent in all ADLs	222 (54)	5.2 (4.0-7.0)	<.001
Comorbid conditions			
History of myocardial infarction			
Absent	410 (32)	1.0	
Present	82 (39)	1.4 (1.0-1.9)	.03
Congestive heart failure			
Absent	323 (29)	1.0	
Present	169 (42)	1.7 (1.4-2.2)	<.001
Cerebrovascular disease			
Absent	398 (32)	1.0	
Present	94 (38)	1.3 (1.0-1.7)	.08
Dementia			
Absent	364 (30)	1.0	
Present	128 (47)	2.1 (1.6-2.8)	<.001
Chronic obstructive pulmonary disease			
Absent	401 (32)	1.0	
Present	91 (36)	1.2 (0.9-1.5)	.32
Diabetes mellitus			
Absent	406 (33)	1.0	
Present	86 (32)	0.9 (0.7-1.3)	.86
Cancer			
Absent	401 (30)	1.0	
Solitary cancer	53 (48)	2.1 (1.4-3.2)	<.001
Metastatic cancer	38 (81)	9.9 (4.7-20.6)	<.001
Length of hospital stay, d			
1-7	303 (29)	1.0	
>7	189 (41)	1.7 (1.3-2.1)	<.001
Discharge destination			
Other	284 (27)	1.0	
Nursing home or skilled nursing facility	208 (46)	2.3 (1.8-2.9)	<.001
Laboratory values on admission			
Creatinine, mg/dL†			
<1.5	248 (28)	1.0	
1.5-3.0	178 (38)	1.6 (1.3-2.0)	<.001
>3.0	66 (49)	2.5 (1.7-3.6)	<.001
Albumin, g/dL			
≥4.0	165 (25)	1.0	
3.5-3.9	138 (32)	1.4 (1.1-1.8)	.02
3.0-3.4	106 (42)	2.1 (1.6-2.9)	<.001
<3.0	83 (55)	3.6 (2.5-5.2)	<.001

*ADL indicates activities of daily living.
†To convert to µmol/L, multiply by 88.4.

creased tissue perfusion.[33] Albumin also is a strong predictor of mortality in this and other studies probably because it is both a marker of malnutrition as well as general disease severity.[23] In contrast, age did not add to the predictive power of our index after we adjusted for comorbidity and functional status. This suggests that the association of older age with mortality may be explained by greater disease burden and functional impairment in older patients consistent with other studies.[12,34,35]

By combining functional status, comorbid illnesses, sex, and laboratory values, our index performed better in predicting 1-year mortality than other available prognostic indices that focus only on comorbid illnesses or physiologic measures. For example, the Charlson comorbidity index had a ROC curve area of 0.68 for 1-year mortality in the validation cohort, and APACHE II, a physiologic index developed for ICU patients, had a ROC area of 0.59.[15] Since mortality in older adults is often dependent on many factors, it makes sense that an index combining multiple domains of risk would have better discrimination than indices that consider only a single domain.

In comparison with other prognostic indices that consider multiple domains of risk,[8,11,13] our index is easier to use while maintaining prognostic accuracy. Our prognostic index, based on 6 risk factors and an additive point system, performed well in stratifying older adults into risk groups for 1-year mortality. Our index had good discrimination, with large differences in 1-year mortality between the low-risk and high-risk groups. Our index was successfully validated in an independent patient sample from a different site with no decrement in discrimination (ROC area=0.79) and only a mild decrease in calibration, demonstrating our index's generalizability to another location and patient group.[16]

Clinicians should use our index to supplement and lend confidence to their judgments about prognosis, rather than to replace their clinical judgment. Previous work suggests that clinicians' abilities to estimate prognoses are about equal to that of prognostic indices. However, combining prognostic indices and clinician estimates results in more accurate estimates than either alone.[8,11,36] Further, a recent survey of clinicians suggests that many clinicians do not fully consider prognosis in their clinical decision making and avoid discussing prognosis with patients because they lack confidence in their prognostic estimates.[37] This is despite evidence that most patients would like clinicians to discuss prognosis with them.[3,8] One use of objective prognostic indices may be to increase clinicians' confidence in their own prognostic estimates, enhancing their willingness to discuss prognosis with their patients.

Many patients may be concerned about their prognosis when they expe-

Table 3. Risk Factors Associated with 1-Year Mortality in the Derivation Cohort in Multivariable Analyses

Risk Factor	Adjusted Odds Ratio (95% Confidence Interval)	*P* Value	Points
Male sex	1.4 (1.1-1.8)	.01	1
ADL dependencies at discharge*			
Dependent in 1-4 ADLs	2.1 (1.6-2.8)	<.001	2
Dependent in all ADLs	5.7 (4.2-7.7)	<.001	5
Comorbid conditions			
Congestive heart failure	2.0 (1.5-2.5)	<.001	2
Cancer			
Solitary cancer	2.6 (1.7-3.9)	<.001	3
Metastatic cancer	13.4 (6.2-29)	<.001	8
Laboratory values on admission			
Creatinine, mg/dL†			
>3.0	1.7 (1.2-2.5)	.01	2
Albumin, g/dL			
3.0-3.4	1.7 (1.2-2.3)	.001	1
<3.0	2.1 (1.4-3.0)	<.001	2

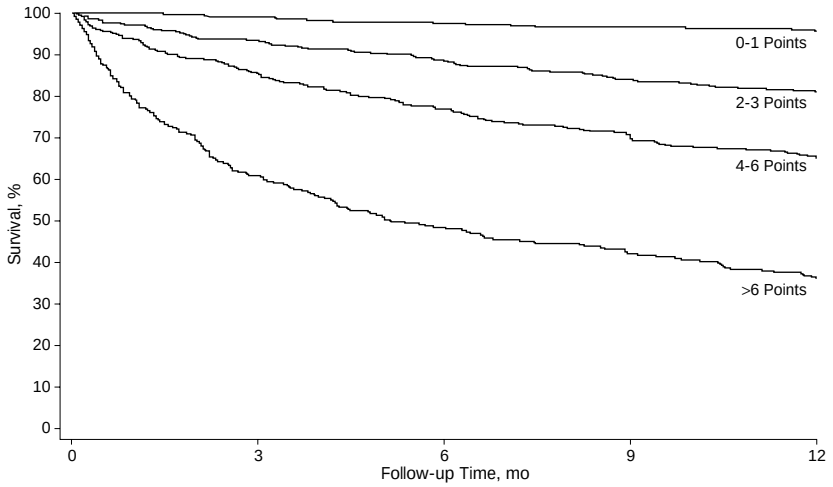
*ADL indicates activities of daily living.
†To convert to µmol/L, multiply by 88.4.

Table 4. Validation of Prognostic Index: 1-Year Mortality in Derivation and Validation Cohorts by Risk Strata

	Derivation Cohort		Validation Cohort	
Risk Strata	No. Who Died/ No. at Risk	% (95% Confidence Interval)	No. Who Died/ No. at Risk	% (95% Confidence Interval)
Logistic Regression Model				
Quartile of risk				
1	51/379	13 (10-16)	59/633	9 (7-11)
2	82/401	20 (16-24)	64/267	23 (18-28)
3	130/349	37 (32-42)	104/258	40 (34-46)
4	229/366	63 (58-68)	171/269	64 (58-70)
ROC curve area*	0.75		0.80	
Bedside Risk Scoring System				
Risk group, points†				
0-1	46/356	13 (10-16)	14/364	4 (2-6)
2-3	77/382	20 (16-24)	74/391	19 (15-23)
4-6	176/475	37 (33-41)	137/399	34 (29-39)
>6	193/282	68 (63-73)	173/273	64 (58-70)
ROC curve area*	0.75		0.79	

*Area under the receiver operating characteristic (ROC) curve is reported for overall score.
†Male sex, 1 point; activities of daily living (ADL) dependency: 2 points for 1-4 ADLs and 5 points for all ADLs; congestive heart failure, 2 points; cancer: 3 points for solitary and 8 points for metastatic; creatine level higher than 3 mg/dL (265 µmol/L), 2 points; albumin: 1 point for levels between 3 and 3.4 g/dL and 2 points for levels lower than 3 g/dL.

Figure. Kaplan-Meier Survival Curves



Curves are for each of the 4 risk groups in the validation cohort according to the bedside risk scoring system: male sex, 1 point; activities of daily living (ADL) dependency: 2 points for 1 to 4 ADLs and 5 points for all ADLs; congestive heart failure, 2 points; cancer: 3 points for solitary and 8 points for metastatic; creatinine level higher than 3 mg/dL (265 µmol/L), 2 points; albumin: 1 point for level between 3 and 3.4 g/dL and 2 points for level lower than 3 g/dL.

rience a major event like hospitalization. Our index may be useful to clinicians in initiating and guiding discussions about prognosis with patients at both low and high risk for 1-year mortality. For example, an 80-year-old woman admitted for pneumonia with no ADL dependencies at discharge and no major comorbid conditions may be relieved to know that her 1-year risk of death is similar to an 80-year-old woman living in the general community who has not been hospitalized (<10%).[38] In contrast, an 80-year-old man who is dependent in 3 ADLs at discharge, has a creatinine level of 3.5 mg/dL (309.4 µmol/L) and an albumin level of 2.8 g/dL has a greater than 60% risk of death in the ensuing year. Such information may stimulate a conversation about the goals of care.

Our study has several limitations. First, we did not have information about clinical care or patient preferences after discharge so that in some cases poor survival may have been affected by decisions to limit treatment. Also, there are different ways to ask about ADLs. For example, inquiring about difficulty instead of dependence would have resulted in higher levels of ADL impairment.[39] Users of our index should be aware that the performance of our index will differ if the way of inquiring about ADLs is changed from our method. Finally, since the patients were involved in a study to improve functional outcomes, it is possible that the selection process for the study or the process of being observed in a study could affect the generalizability of our index. However, this seems unlikely because the intervention did not significantly improve outcomes after 1 year and the patients randomly selected for the study were representative of those admitted to the medical services of the 2 hospitals.[17] As with all prognostic indices, the true validity and generalizability of our index needs to be established by cumulative testing to determine if the index remains accurate in other locations and groups of patients.[16,28]

In summary, our index provides a potentially useful prognostic tool to estimate the likelihood of 1-year mortality after hospitalization for older medical patients. The index uses 6 risk factors, all of which are easily available at hospital discharge, and a simple additive point system. The index had good discrimination and calibration, and it generalized well in an independent sample of patients at a different site. These characteristics suggest that our index may be useful for guiding clinical care and for risk adjustment.

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Facts which at first seem improbable will, even on scant explanation, drop the cloak which has hidden them and stand forth in naked and simple beauty.
—Galileo Galilei (1564-1642)