Hospital Readmission Following Discharge From Inpatient Rehabilitation for Older Adults With Debility

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Background. Debility accounts for 10% of inpatient rehabilitation cases among Medicare beneficiaries. Debility has the highest 30-day readmission rate among 6 impairment groups most commonly admitted to inpatient rehabilitation.

Objective. The purpose of this study was to examine rates, temporal distribution, and factors associated with hospital readmission for patients with debility up to 90 days following discharge from inpatient rehabilitation.

Design. A retrospective cohort study was conducted using records for 45,424 Medicare fee-for-service beneficiaries with debility discharged to community from 1,199 facilities during 2006–2009.

Methods. Cox proportional hazard regression models were used to estimate hazard ratios for readmission. Schoenfeld residuals were examined to identify covariate-time interactions. Factor-time interactions were included in the full model for Functional Independence Measure (FIM) discharge motor functional status, comorbidity tier, and chronic pulmonary disease. Most prevalent reasons for readmission were summarized by Medicare severity diagnosis related groups.

Results. Hospital readmission rates for patients with debility were 19% for 30 days and 34% for 90 days. The highest readmission count occurred on day 3 after discharge, and 56% of readmissions occurred within 30 days. A higher FIM discharge motor rating was associated with lower hazard for readmissions prior to 60 days (30-day hazard ratio=0.987; 95% confidence interval=0.986, 0.989). Comorbidities with hazard ratios >1.0 included comorbidity tier and 11 Elixhauser conditions, 3 of which (heart failure, renal failure, and chronic pulmonary disease) were among the most prevalent reasons for readmission.

Limitations. Analysis of Medicare data permitted only use of variables reported for administrative purposes. Comorbidity data were analyzed only for inpatient diagnoses.

Conclusions. One-third of patients were readmitted to acute hospitals within 90 days following rehabilitation for debility. Protective effect of greater motor function was diminished by 60 days after discharge from inpatient rehabilitation.

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Debility, also known as deconditioning, involves decline in functional mobility or activities of daily living, or both.[1,2] This condition commonly occurs in older adults during an acute hospitalization, with profound decline, such as loss of independence, observed in some patients.[3–5] For example, a multicenter trial showed that 1 in 6 previously independent older adults was unable to independently walk across a room after an acute hospital stay.[5] Referral to a postacute inpatient rehabilitation facility may be indicated for patients who experience acute functional decline associated with debility and demonstrate potential to improve from intensive interdisciplinary physical rehabilitation.[6]

Debility as an admission diagnosis for inpatient rehabilitation is defined as generalized deconditioning not attributable to any other Centers for Medicare & Medicaid Services (CMS) rehabilitation impairment groups, such as stroke or orthopedic conditions.[7] Inpatient rehabilitation is the only postacute setting that has an admission group specifically for debility. Primary medical diagnosis for this impairment group may be debility, generalized weakness, or an infection or other multisystem pathology for which there are numerous diagnostic codes.[8]

The percentage of Medicare beneficiaries with debility receiving postacute rehabilitation increased substantially in the past decade.[9] In 2004, 6% of beneficiaries receiving inpatient medical rehabilitation were in the debility rehabilitation impairment group.[9] Between 2010 and 2013, 10% of beneficiaries in inpatient rehabilitation were admitted for debility.[9] Patients with debility represent the fourth largest impairment group receiving inpatient rehabilitation services following stroke, other neurological conditions (eg, multiple sclerosis), and lower extremity fracture.[9] There is relatively little research examining outcomes for patients with debility.

A critical outcome for inpatient rehabilitation is the patient's ability to return to community living. The debility impairment group has a high prevalence (11%–14%) of discharges directly from inpatient rehabilitation to acute care settings compared with other impairment groups.[2,8,10,11] Patients who are discharged to a community setting are also at risk of readmission to an acute care setting.[12] A recent study of hospital readmission for the 6 largest inpatient rehabilitation impairment categories showed that debility had the highest rate, with 19% of patients readmitted to acute care hospitals within 30 days of discharge to the community.[12] Frequent reasons for readmission included heart failure, septicemia, and kidney and urinary tract infections.[12]

The CMS recently proposed 30-day readmission to acute care hospitals following discharge from inpatient rehabilitation as a quality measure to begin in fiscal year 2017[13]; this measure has been endorsed by the National Quality Forum.[14] Thus, research to better understand patient and facility factors associated with high readmission risk in people who have common conditions, such as debility, is important.

Existing research on inpatient rehabilitation for patients with debility has focused primarily on descriptive outcomes upon discharge[2,8,10,11] or within 30 days.[12] Further investigation of factors associated with key postdischarge measures such as readmission is merited to guide evidence-based clinical decision making and strategies for prevention of adverse outcomes. The objective of this study was to investigate the rates, distribution, and factors associated with hospital readmission for up to 90 days after discharge from inpatient rehabilitation for older adults receiving inpatient rehabilitation for debility. Although 30 days is currently relevant to readmission as a quality measure for CMS, we followed patients for 90 days based on proposed changes in the delivery of postacute care. For example, CMS's Bundled Payments for Care Improvement (BPCI) initiative is currently studying services and payment models based on episodes of care that may extend to 90 days.[15] We used Medicare claims files to examine the temporal distribution of hospital readmission rates within 90 days after discharge and the associated factors for older adults receiving inpatient rehabilitation for debility.

Method

Study Sample

We studied a sample of Medicare fee-for-service beneficiaries who received inpatient rehabilitation for debility from January 2006 through September 2009. The Beneficiary Summary File includes Medicare beneficiary enrollment information,[16] which we used to create an analytical file based on inclusion and exclusion criteria. We used CMS Inpatient Rehabilitation Facility–Patient Assessment Instrument (IRF-PAI) data to identify debility impairment group, demographic variables, admission variables, impairment group code, discharge information, and functional status ratings.[7] Medicare Provider Analysis and Review (MedPAR) files were used to identify hospital readmissions and cormobidities.[17] The research was reviewed by the University of Texas Medical Branch Institutional Review Board and complied with the data use agreement obtained from CMS.

The debility impairment group code included "cases with generalized deconditioning not attributable to any of the other Impairment Groups."[7] The Rehabilitation Impairment Category (RIC) for debility was "miscellaneous" (20).[7] The initial sample contained 130,148 Medicare beneficiaries identified as recipients of inpatient rehabilitation during 2006–2009 in the CMS debility impairment group. Additional inclusion criteria were: (1) patient lived in the community prior to hospitalization; (2) admission directly from acute care for initial inpatient rehabilitation; (3) record included no program interruptions (a program interruption occurred when a patient was temporarily transferred to an acute care setting for up to 3 days and then returned for further inpatient rehabilitation[7]); (4) inpatient rehabilitation length of stay was between 3 and 30 days; (5) Medicare beneficiary did not reside in the state of Maryland (different CMS payment structure); (6) patient was discharged to a community setting by September 30, 2009 (to allow for 90 days of follow-up after discharge); (7) age at admission was between 66 and 100

years; (8) Medicare entitlement was for Old Age and Survivors Insurance; (9) Medicare fee-for-service status; and (10) beneficiary did not die during inpatient rehabilitation or within 90 days postdischarge. Of the 130,148 Medicare beneficiaries in the debility impairment group, 45,424 (35%) met the criteria and were included in the eligible sample. Figure 1 illustrates the flow and number of patients included and excluded in each phase of the data set construction. This cohort included patients from 1,199 inpatient rehabilitation facilities.

Variable Definitions

Hospital readmission, to a short-stay acute care hospital, was the dependent outcome identified using CMS MedPAR information for 90 days after discharge from inpatient rehabilitation. Patients discharged directly from inpatient rehabilitation to acute care hospital were excluded from this calculation. Time, measured in days, from inpatient rehabilitation discharge to acute hospital readmission was used in the analysis. Only the first readmission following discharge was included.

Reasons for hospital readmission were identified by Medicare severity diagnosis related groups (MS-DRG). The MS-DRG is a classification system for hospital inpatient prospective payment systems that accounts for illness severity and resource utilization for Medicare beneficiaries.[18] Levels of illness severity are: MCC (major complication/comorbidity), CC (complication/comorbidity), and non-complication/comorbidity.[18] The MCC and CC illness severities for the same diagnosis were combined for descriptive purposes.

Patient characteristics were extracted from the IRF-PAI file, including age (continuous), marital status (married versus not married), sex, race/ethnicity (non-Hispanic white, black, Hispanic, and other), and prehospital living status (alone versus with someone). Living in the community prior to hospitalization and community discharge were recoded from the prior living setting and discharge setting variables, respectively, in the IRF-PAI files; community included home, assisted living residence, board and care, and transitional living categories in both variables.[7,19]

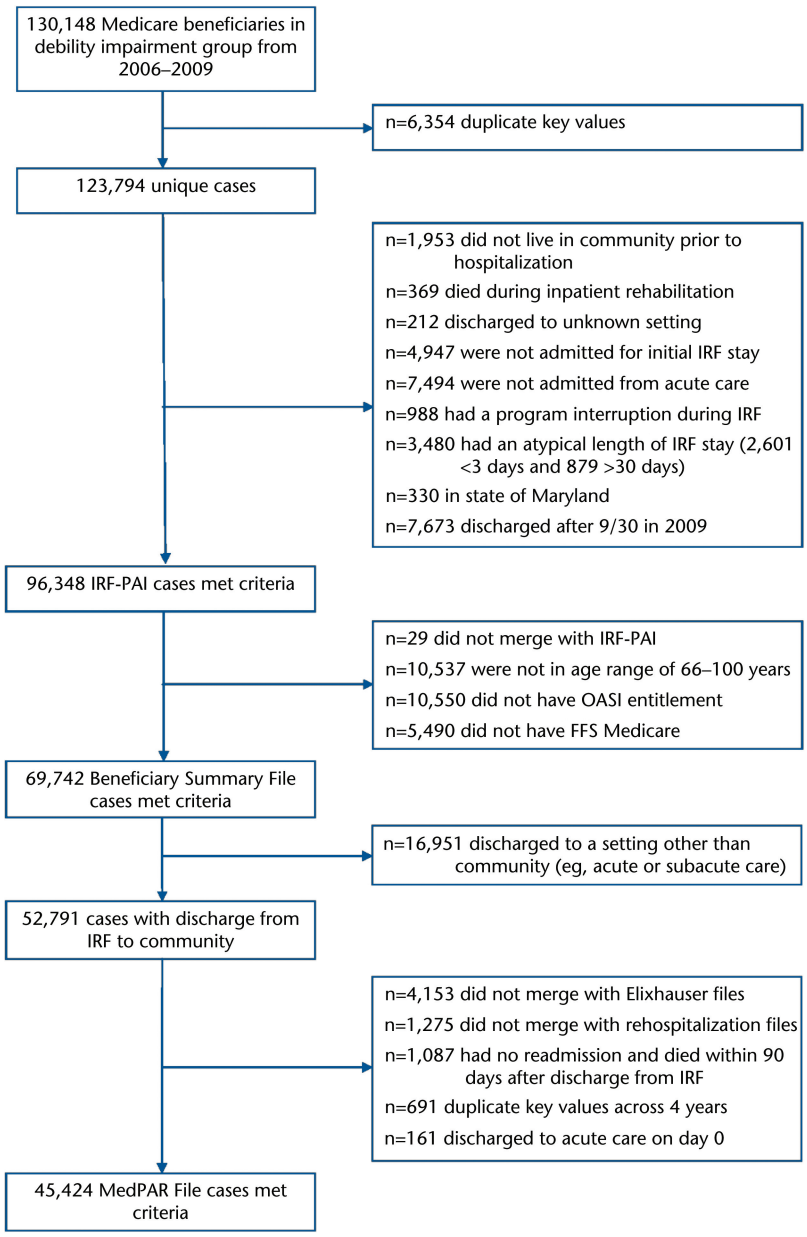

Figure 1.
Flowchart for inclusion and exclusion criteria. IRF=inpatient rehabilitation facility, IRF-PAI=Inpatient Rehabilitation Facility–Patient Assessment Instrument, OASI=Old Age and Survivors Insurance, FFS=fee-for-service, MedPAR=Medicare Provider Analysis and Review.

Functional status was determined using the 18 items originally developed for the Functional Independence Measure (FIM) instrument[19] and included in the IRF-PAI. The 18 items were divided into motor and cognitive subscales. Thirteen motor items assessed self-care (eating, grooming, bathing, upper body dressing, lower body dressing, and toileting), sphincter control (bowel and bladder), transfers (bed/chair/wheelchair, toilet, and tub/shower), and locomotion (walk/wheelchair and stairs).[7,20,21] Five cognitive items assessed communication (comprehension and expression) and social cognition (social interaction, problem solving, and memory).[7,20,21] Each item was

Table 1.
Sample Characteristics Stratified by Hospital Readmission Status 90 Days After Discharge From Inpatient Rehabilitation for Debility[a]

Variable	Total	Readmission		*P*
		Yes	No	
Patients, n	45,424	15,439	29,985	
Readmission rate	34.0%	100%	0%	
Age (y), $\bar{X}$ (SD)	80.8 (7.0)	80.6 (7.0)	80.9 (7.0)	<.001
Sex (female)	60.1%	57.9%	61.2%	<.001
Race/ethnicity[b] (n=44,461)				
White	86.4%	85.9	86.6%	.003
Black	7.4%	8.0%	7.2%	
Hispanic	3.0%	3.1%	2.9%	
Other	1.1%	0.97%	1.2%	
Marital status[b] (n=44,891)				.002
Not married	56.2%	55.2%	56.7%	
Living situation[b] (n=43,627)				<.001
Living with others	61.8%	64.5%	60.4%	
CMG comorbidity tier[b] (n=45,422)				
No tier	57.2%	52.3%	59.7%	<.001
Low cost	29.1%	30.6%	28.3%	
Medium cost	9.9%	11.7%	8.9%	
High cost	3.9%	5.5%	3.1%	
LOS (d), $\bar{X}$ (SD)	11.9 (4.7)	12.4 (4.8)	11.7 (4.6)	<.001
FIM admission motor, $\bar{X}$ (SD)	41.4 (10.8)	40.4 (10.8)	42.0 (10.7)	<.001
FIM admission cognition, $\bar{X}$ (SD)	25.3 (6.4)	24.9 (6.5)	25.4 (6.3)	<.001
FIM discharge motor, $\bar{X}$ (SD)	65.0 (12.1)	63.0 (12.7)	66.0 (11.6)	<.001
FIM discharge cognition, $\bar{X}$ (SD)	28.7 (5.2)	28.3 (5.4)	28.9 (5.1)	<.001

[a] CMG=case-mix group, LOS=length of stay, FIM=Functional Independence Measure.
[b] Missing values with sample size provided.

rated from 1 ("complete dependence") to 7 ("complete independence"), for a total possible rating of 18 to 126.[7] Higher ratings represented greater functional independence. Functional status items were administered by a trained professional within 36 hours of admission and discharge. The reliability, validity, and responsiveness for the functional status items have been examined by CMS and others and found to be adequate.[22–29]

Two measures of comorbidity were examined. The case-mix group (CMG) comorbidity tier was developed by CMS as part of the prospective payment system for inpatient rehabilitation. These tier categories were based on the presence of specific comorbidities associated with increased costs.[30] Payments were adjusted for comorbidities using a 4-tier system: tier 1 (high cost), tier 2 (medium cost), tier 3 (low cost), and no tier.[31] If a patient had more than one comorbidity on a tier list, the highest cost tier was assigned.[7] Examples of tier 1 (high cost) comorbidities from 2006–2009 were vocal paralysis, tracheostomy, and renal dialysis.[32] We also used the 29 Elixhauser comorbidities derived from MedPAR data using the Agency for Healthcare Research and Quality (AHRQ)-Web ICD-9-CM version to assess conditions not linked directly to payment.[33] Elixhauser et al[34] recommended analysis of each comorbidity variable rather than a simplified index for applicability to various diseases.

Data Analysis

Time to hospital readmission, measured in days, after discharge from inpatient rehabilitation was the dependent outcome for time-to-event analysis. The log-rank test of survival function across 4 years was used to validate the appropriateness of combining all 4 years. Patients who did not experience readmission during 90 days following discharge from inpatient rehabilitation were censored as no readmission.[35,36] We plotted actual readmission day frequency counts as a histogram over the entire 90-day study period. We also calculated cumulative unadjusted readmission rates for the following day intervals: 3, 7, 15, 30, 60, and 90 days. These time points correspond to the first few days following discharge,

the first week, midway to first month, and monthly for the study period.

Characteristics of patients who were readmitted to an acute care hospital 90 days following discharge from inpatient rehabilitation were compared to patients who did not experience readmission. Missing data for race/ethnicity, marital status, living situation, and CMG comorbidity tier were reported in Table 1. No data were missing for functional status. Differences in readmission status were evaluated with *t* tests for continuous variables and chi-square tests for categorical variables. The Spearman correlation matrix for CMG comorbidity tier and individual Elixhauser comorbidities was examined for potential collinearity prior to multivariable modeling. The criterion for strong association was a correlation coefficient greater than .75.[37]

Hazard ratios for covariate parameters were computed using Cox proportional hazard regression. Covariates in the full model included demographics, functional motor and cognitive subscales at discharge, CMG comorbidity tier, and Elixhauser comorbidities with significant bivariate differences. An assumption of Cox regression analysis was consistency of hazard over time. Schoenfeld residuals were examined for potential interactions between individual covariates and time.[36] Interaction terms were subsequently included for factors that varied significantly with time ($P<.05$).

Statistical analyses were conducted using SAS (version 9.2) LIFETEST[36,38] and PHREG[36,38,39] procedures. The aggregate option was used in the model statement to account for facility as a cluster variable.[35] The exact method was used for ties with readmission time.[36] Adjusted hazard ratios were computed with 95% confidence intervals (CIs). The dependent variable was hazard (risk)[40] of hospital readmission after discharge from inpatient rehabilitation. Covariates with hazard ratios greater than 1.0 were associated with a higher probability of hospital readmission after discharge from inpatient rehabilitation.[40] A hazard ratio less than 1.0 indicated that the covariate was protective, associated with decreased probability of readmission.[40] Level of statistical significance was .05.

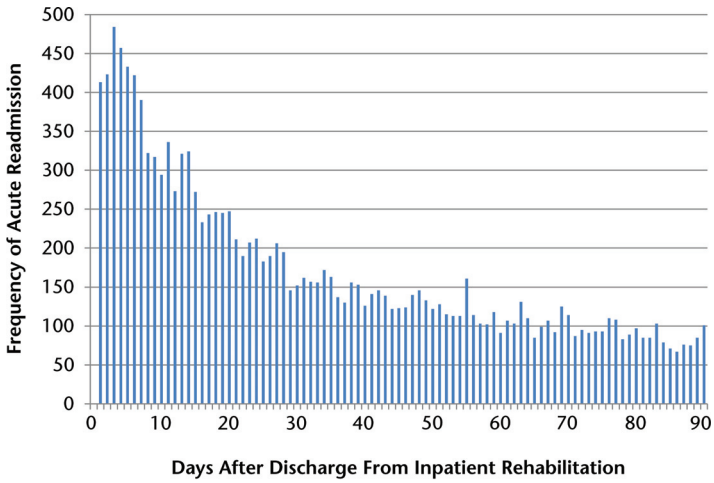

Figure 2.
Distribution of hospital readmission for 90 days after discharge from inpatient rehabilitation for debility.

Role of the Funding Source

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Results

Distribution of hospital readmission time after discharge from inpatient rehabilitation depicted the highest peak in frequency of readmission within the first week (Fig. 2). Cumulative readmission rates were 2.9% for 3 days, 6.7% for 7 days, 12.1% for 15 days, 18.9% for 30 days, 27.7% for 60 days, and 34.0% for 90 days after discharge from inpatient rehabilitation. For the 15,439 patients who experienced hospital readmission within 90 days, the mean time from inpatient rehabilitation discharge to readmission was 32.4 days (SD=25.6). Fifty-six percent of readmissions occurred within 30 days, and 82% of readmissions occurred within 60 days. Survival probability was similar across discharge years 2006–2009 ($P=.24$). Therefore, all years were combined in subsequent analyses.

Patient and Clinical Characteristics

The mean patient age was 80.8 years (SD=7.0). The majority of patients were female (60.1%), non-Hispanic white (86.4%), not married (56.2%), and living with others prior to acute hospitalization (61.8%). The mean length of inpatient rehabilitation stay was 11.9 days (SD=4.7). Mean FIM ratings at discharge were 65.0 (SD=12.1) for motor subscale, 28.7 (SD=5.2) for cognition subscale, and 93.7 (SD=15.3) for FIM total. These characteristics were stratified by readmission outcome in Table 1. The FIM discharge motor score was 3 points lower (63.0 versus 66.0) for patients who were readmitted. Percentages of patients with low-, medium-, and high-cost CMG comorbidity tiers were higher for the readmission group.

Elixhauser comorbidities are listed by readmission status in Table 2 in descending order of prevalence. Seventeen conditions had significantly different frequencies among readmission groups: hypertension, chronic pulmonary disease, congestive heart failure, fluid and electrolyte disorders, renal failure, hypothyroidism, other neurological disorders, peripheral vascular disease, diabetes with chronic complications, depression, weight loss, solid tumor without metastasis, obesity, coagulopathy, metastatic cancer, lymphoma, and liver disease. The remaining 12 conditions were not significantly different among readmission groups. Correlation coefficients between pairs of Elixhauser comorbidities had low strength and ranged from −.10 to

Table 2.
Elixhauser Comorbidities Stratified by Hospital Readmission Status 90 Days After Discharge From Inpatient Rehabilitation for Debility

Comorbidity	Total	Readmission		P^a
		Yes	No	
Hypertension	56.5%	53.1%	58.3%	<.0001
Chronic pulmonary disease	21.2%	23.1%	20.3%	<.0001
Congestive heart failure	19.5%	23.3%	17.5%	<.0001
Diabetes without chronic complications	19.1%	18.9%	19.2%	.53
Deficiency anemias	17.6%	17.3%	17.8%	.21
Fluid and electrolyte disorders	15.4%	16.0%	15.1%	.02
Renal failure	15.1%	19.2%	12.9%	<.0001
Hypothyroidism	10.6%	9.3%	11.3%	<.0001
Other neurological disorders	9.4%	8.9%	9.6%	.009
Peripheral vascular disease	9.3%	10.1%	8.8%	<.0001
Diabetes with chronic complications	7.6%	8.8%	6.9%	<.0001
Depression	7.5%	6.8%	7.9%	<.0001
Weight loss	7.0%	7.6%	6.6%	<.0001
Solid tumor without metastasis	6.5%	7.0%	6.3%	.002
Paralysis	5.7%	5.7%	5.7%	.87
Obesity	5.0%	4.5%	5.3%	.0002
Valvular disease	4.8%	5.0%	4.7%	.23
Rheumatoid arthritis/collagen vascular diseases	3.5%	3.6%	3.4%	.24
Pulmonary circulation disease	3.0%	3.0%	2.9%	.66
Coagulopathy	2.5%	3.1%	2.2%	<.0001
Metastatic cancer	2.3%	3.4%	1.8%	<.0001
Psychoses	2.1%	2.0%	2.2%	.20
Lymphoma	1.6%	2.2%	1.2%	<.0001
Chronic blood loss anemia	1.3%	1.3%	1.2%	.41
Liver disease	1.1%	1.5%	0.86%	<.0001
Alcohol abuse	0.88%	0.78%	0.93%	.10
Drug abuse	0.11%	0.09%	0.11%	.48
Peptic ulcer disease excluding bleeding	0.06%	0.06%	0.05%	.69
Acquired immunodeficiency syndrome	0.02%	0.03%	0.02%	.33

[a] Seventeen comorbidities with significant differences included in Cox regression.

.12. Correlation coefficients between CMG comorbidity tiers and individual Elixhauser comorbidities were weak to fair (.11–.26) and thus did not indicate concern for collinearity in the multivariable model.

Multivariable Survival Analysis

Correlations between Schoenfeld residuals for covariates and time were significant for FIM discharge motor rating ($P<.0001$), CMG comorbidity tier–medium cost ($P<.0001$), chronic pulmonary disease ($P=.01$), and fluid/electrolyte disorders ($P=.02$). Interaction terms for these covariates with readmission time were included in the Cox regression model. Interaction for fluid/electrolyte disorders with time was subsequently dropped as nonsignificant ($P=.82$).

Hazard ratios, adjusted for all other covariates, for hospital readmission within 90 days of discharge from inpatient rehabilitation are depicted in Table 3. For variables with significant time interactions, hazard ratios were reported by readmission time (days 3, 7, 15, 30, 60, and 90) (Tab. 3). Single hazard ratios were reported for all other variables, as hazard did not significantly vary with time of readmission (Tab. 3). Age was associated with 0.5% decreased readmission hazard for 1 year older. Sex was not a significant factor, and race/ethnicity was only protective for the other group (not black or Hispanic) compared with white. Not married was associated with a 6%

increase in readmission hazard, but living alone versus with someone was not significant.

Higher FIM discharge motor ratings were more protective for early hospital readmissions; hazard ratios incrementally increased to 1.0 (95% CI=0.999, 1.002) by day 60. Further analysis of individual FIM discharge motor items revealed significant adjusted hazard ratios (unit=1 FIM point) for walk/wheelchair locomotion (0.95; 95% CI=0.93, 0.96), stair locomotion (0.96; 95% CI=0.95, 0.97), lower body dressing (0.96; 95% CI=0.94, 0.98), eating (0.96; 95% CI=0.94, 0.98), bowel control (0.97; 95% CI=0.96, 0.99), and bladder control (0.98; 95% CI=0.97, 0.99). As observed for the FIM discharge motor subscale (Tab. 3), bladder control, walk/wheelchair locomotion, and stair locomotion were not protective by day 60. Eating and bowel control were not protective by day 30. Lower body dressing was the only significant motor item that did not interact with time (ie, remained protective through day 90). The FIM discharge motor items not associated with readmission were grooming, bathing, upper body dressing, toileting, bed/chair/wheelchair transfers, toilet transfers, and tub/shower transfers.

Comorbidities significantly associated with higher hazard of readmission included: CMG comorbidity tier and chronic pulmonary disease (up to 30 days), congestive heart failure, fluid/electrolyte disorders, renal failure, peripheral vascular disease, weight loss, solid tumor without metastasis, coagulopathy, metastatic cancer, lymphoma, and liver diseases. Comorbidities significantly associated with lower hazard for readmission (hazard ratios <1.0) were hypertension, hypothyroidism, other neurological disorders, and obesity.

Causes of Readmission

Table 4 lists the most prevalent reasons for hospital readmission as coded by MS-DRG. The cumulative percentage for these 14 readmission categories was 37%. Common diagnoses included heart failure, kidney/urinary tract infections, renal failure, pneumonia, chronic obstructive pulmonary disease, nutri-

Table 3.
Results of Cox Regression Model for Hospital Readmission Within 90 Days of Discharge From Inpatient Rehabilitation for Debility[a]

Characteristics	HR	95% CI
Age (unit=1 y)	0.995	0.992, 0.997
Sex (male vs female)	1.01	0.98, 1.05
Race/ethnicity		
Black vs white	0.96	0.91, 1.02
Hispanic vs white	0.93	0.86, 1.01
Other vs white	0.83	0.73, 0.93
Not married vs married	1.06	1.02, 1.10
Living with someone vs alone	1.03	0.99, 1.07
FIM discharge cognitive (unit=1)	1.00	0.996, 1.002
FIM discharge motor (unit=1)[b]		
Day 3	0.976	0.974, 0.977
Day 7	0.977	0.976, 0.979
Day 15	0.981	0.980, 0.982
Day 30	0.987	0.986, 0.989
Day 60	1.000	0.999, 1.002
Day 90	1.014	1.012, 1.015
CMG comorbidity tier[b]		
Tier 3 (low cost) vs no tier		
Day 3	1.14	1.08, 1.19
Day 7	1.13	1.08, 1.18
Day 15	1.11	1.06, 1.16
Day 30	1.08	1.04, 1.12
Day 60	1.02	0.98, 1.06
Day 90	0.96	0.90, 1.02
Tier 2 (medium cost) vs no tier		
Day 3	1.30	1.22, 1.39
Day 7	1.29	1.21, 1.37
Day 15	1.26	1.19, 1.34
Day 30	1.22	1.16, 1.28
Day 60	1.14	1.08, 1.20
Day 90	1.07	0.98, 1.16
Tier 1 (high cost) vs no tier		
Day 3	1.55	1.40, 1.72
Day 7	1.50	1.36, 1.65
Day 15	1.40	1.28, 1.53
Day 30	1.24	1.15, 1.33
Day 60	0.97	0.90, 1.04
Day 90	0.76	0.68, 0.83
Hypertension	0.94	0.91, 0.97

(Continued)

Table 3
Continued

Characteristics	HR	95% CI
Chronic pulmonary disease[b]		
Day 3	1.15	1.10, 1.21
Day 7	1.14	1.09, 1.19
Day 15	1.12	1.07, 1.17
Day 30	1.08	1.04, 1.12
Day 60	1.00	0.97, 1.04
Day 90	0.93	0.89, 0.99
Congestive heart failure	1.16	1.12, 1.21
Fluid and electrolyte disorders	1.07	1.03, 1.12
Renal failure	1.22	1.17, 1.27
Hypothyroidism	0.94	0.90, 0.99
Other neurological disorders	0.92	0.87, 0.97
Peripheral vascular disease	1.12	1.07, 1.18
Diabetes with chronic complications	1.04	0.98, 1.11
Depression	0.95	0.90, 1.01
Weight loss	1.09	1.02, 1.16
Solid tumor without metastasis	1.15	1.09, 1.22
Obesity	0.89	0.83, 0.96
Coagulopathy	1.13	1.02, 1.24
Metastatic cancer	1.42	1.29, 1.55
Lymphoma	1.28	1.15, 1.44
Liver disease	1.23	1.07, 1.43

[a] Hazard ratios (HR) were adjusted for all other covariates listed in the table. CI=confidence interval, CMG=case-mix group, FIM=Functional Independence Measure.
[b] Variable with significant time interaction; HR reported by time of hospital readmission.

tional disorders, and gastrointestinal disorders. More than 500 different MS-DRG codes were listed for readmissions within 90 days of discharge from inpatient rehabilitation for debility.

Discussion

We examined rate of hospital readmission and factors associated with hazard of readmission for 90 days following discharge from inpatient rehabilitation in a large sample of older adults with debility. One-third of the cohort experienced readmission. This finding was consistent with 90-day readmission rates among Medicare fee-for-service beneficiaries after acute hospitalization.[41] The 30-day hospital readmission rate of 19% in our study was not as high as reported for Medicare beneficiaries in skilled nursing facilities (23%–24%).[42,43] However, our study focused on patients who were discharged to the community, with readmission time beginning after discharge from inpatient rehabilitation rather than acute hospital. Frequency distribution showed that the highest number of readmissions occurred on day 3 following discharge from inpatient rehabilitation. More than half (56%) of readmissions in the 90-day observation period occurred within the first month. This information may help in developing postdischarge monitoring and treatment plans.

We studied hazard for demographic, functional, and comorbidity factors associated with hospital readmission. Demographic factors associated with readmission hazard for patients with debility were age, race/ethnicity (other versus white), and marital status. Older age as a protective factor differed from findings in other readmission studies.[41,44] Survivor effect was a potential influence if older patients with debility who survived the observation period were healthier.[45]

Comorbidity findings for patients with debility indicated that higher-cost CMG comorbidity tiers were associated with higher readmission hazard up to 30 days following discharge. For Elixhauser comorbidities, congestive heart failure, renal failure, and chronic pulmonary disease were among the top reasons associated with hospital readmission. These generally prevalent conditions have implications for developing and targeting hospital readmission reduction programs for patients with debility. For instance, heart failure was also the most frequent reason for readmission after discharge from acute care for patients with Medicare fee-for-service[41] and 1 of 3 diagnoses measured for the acute care hospital readmissions reduction program.[46] Metastatic cancer was a less prevalent condition but had the highest hazard ratio among the Elixhauser comorbidities. Weight change was also a noteworthy factor, as weight loss, weakness, and low physical activity are operational criteria for frailty.[47] The relationship between frailty and debility is a potentially valuable topic for future research.

Of the Elixhauser comorbidities with hazard ratios less than 1, paradoxical effects have been described in literature for hypertension[48] and obesity.[49] In patients with heart failure, low blood pressure was associated with increased risk of long-term mortality and hospitalization.[48] Although obesity is a risk factor for development of heart failure, it has been associated with lower risk-adjusted mortality in patients with established heart failure.[49] A theory applicable to patients with debility and comorbidities is that greater adipose tissue provides reserve for catabolic changes that occur with disease processes.[49]

Functional status was important to examine because it is a primary outcome measure for inpatient rehabilitation and a potentially modifiable factor. For older adults with debility, FIM discharge motor subscale ratings, but not cognition subscale ratings, were associated with lower readmission. This finding was consistent

with a study of readmission among patients with stroke.[50] A study of patients with hip fracture showed an association between higher FIM total rating and lower readmission risk, but motor and cognition subscales were not differentiated.[44]

The interaction between FIM discharge motor ratings and time of readmission was an interesting finding. Trend in hazard ratios for readmission time indicated that a higher FIM discharge motor rating was more protective for earlier readmissions. An increase of 1 point in FIM discharge motor rating was associated with 2% lower hazard for readmission within the first 2 weeks and with a 1% lower hazard for readmissions at 1 month. The mean FIM discharge motor rating was 3 points higher (66.0 versus 63.0) for patients who did not experience readmission compared with those who had a readmission within 90 days. A 3-point higher FIM discharge motor rating was associated with 7% hazard reduction for readmissions that occurred within 1 week following discharge. The FIM discharge motor rating was not protective 2 months or longer following discharge. As more time passed postdischarge, unmeasured factors such as daily activity and home or outpatient therapy may have played an important role in a patient's functional status. A report of follow-up information collected 80 to 180 days after discharge from inpatient rehabilitation showed that 61% of patients with debility received no additional therapy.[51] Further research is needed to explore the effect of follow-up therapy on the trajectory of functional status after discharge from postacute care for patients with debility.

To our knowledge, this was the first study to explore hospital readmission for patients with debility over a 90-day period. The strengths of this study included use of CMS data, which provided a large national sample and allowed the analysis of numerous factors observed in everyday clinical practice. Multiple CMS files provided the opportunity to link inpatient rehabilitation variables with acute hospital readmission information. Time-to-event analysis allowed us to observe the distribution of readmission time and identified variables with time-dependent hazard.

Table 4.
Most Common MS-DRG Codes for Hospital Readmission 90 Days After Discharge From Inpatient Rehabilitation for Debility[a]

Rank	MS-DRG Codes	%
1	Heart Failure and Shock (291, 292)	7.6
2	Kidney and Urinary Tract Infections (689, 690)	3.8
3	Nutritional and Miscellaneous Metabolic Disorders (640, 641)	3.6
4	Renal Failure (682, 683)	3.3
5	Simple Pneumonia and Pleurisy (193, 194)	3.2
6	Septicemia Without MV 96+ Hours With MCC (871)	3.1
7	Esophagitis, Gastrointestinal, and Miscellaneous Digestive Disorders (391, 392)	3.1
8	Syncope and Collapse (312)	1.7
9	Major Gastrointestinal Disorders and Peritoneal Infections With MCC (371)	1.5
10	Chronic Obstructive Pulmonary Disease With MCC (190)	1.5
11	Gastrointestinal Hemorrhage With MCC (377)	1.3
12	Cardiac Arrhythmia and Conduction Disorders With MCC (308)	1.2
13	Respiratory Infections and Inflammations With MCC (177)	1.1
14	Intracranial Hemorrhage or Cerebral Infarction With MCC (064)	1.1

[a] MCC=major complication/comorbidity, MS-DRG=Medicare severity diagnosis related groups, MV=mechanical ventilation.

Our study had several limitations associated with use of administrative data including coding errors and missing data. For variables with known distributions, descriptive statistics were screened to identify potential data errors. Statistical screening can be used to identify extreme measures, but not categorical misclassifications. We were limited to the variables included in the claims files which frequently lack sensitivity. This was particularly true in areas related to social support. For example, marital status and living status were crude proxies for social support. Only comorbidity data recorded for inpatient admission was examined in this study, and outpatient comorbidity data may have also been relevant.[52]

Our study was limited to Medicare fee-for-service beneficiaries who received inpatient rehabilitation for debility and were discharged to a community setting. Combined criteria for inclusion and exclusion and merging of multiple files resulted in a sample size that was 35% of all cases. These cases were generalizable to patients who had Medicare fee-for-service benefits for old age and completed a typical course of inpatient rehabilitation for debility following an acute hospitalization. We used only the first hospital readmission following discharge, and patients may have had multiple readmissions during the 90-day period. We examined all-cause readmissions and did not differentiate between preventable and unpreventable readmissions. The findings were not generalizable to the entire Medicare population or to Medicare-managed care. Other post–acute care settings, such as skilled nursing facility, long-term acute care, and home health, were not examined, and the influence of selection criteria for post–acute care setting was unknown.

Despite the above limitations, our findings have implications relevant to clinical practice and health policy. Patients with debility who have comorbid conditions associated with increased readmission hazard should be monitored for changes in medical status. For example, vital signs and signs and symptoms of decompensation in patients with heart failure (ie, weight gain, worsening fatigue, dyspnea, or functional decline)[53] are important to monitor and discuss with the interdisciplinary team. These signs and symptoms

may be recognized days (median=7 days) before "overt heart failure decompensation."[53] Evaluating discharge motor function and comorbidity profile may help the team to identify patients with a higher probability of hospital readmission. In addition, the timing of readmissions indicates that early follow-up may maximize prevention efforts. These considerations are relevant to discharge planning and transition of care from inpatient rehabilitation to community. Patients with debility who have lower motor function and comorbid conditions associated with increased readmission hazard should be monitored for functional trajectory and medical stability during inpatient rehabilitation and postdischarge. Optimizing independence levels for motor function during inpatient rehabilitation is an important consideration for reducing hospital readmissions. Emphasis on higher-intensity resistance training and motor task-specific training rather than general conditioning (without specific exercise parameters) has been recommended for older adults with hospital-associated deconditioning.[54] Analysis of individual FIM discharge motor items in our study indicated that walk/wheelchair and stair locomotion, lower body dressing, eating, and bowel and bladder control are the most important functions for readmission hazard among patients with debility.

These study findings also are applicable to health reform initiatives aimed to reduce hospital readmissions for high-risk Medicare beneficiaries through coordination of care across acute and post–acute care settings.[55,56] Proposed risk adjustment for readmission rates postdischarge for inpatient rehabilitation includes demographics, diagnoses, comorbid conditions, and CMGs, which incorporate functional motor score.[57] Physical therapists contribute functional status information that is relevant to assessment of a patient's probability for hospital readmission. In collaboration with an interdisciplinary team, physical therapists also provide recommendations for follow-up care after discharge from inpatient rehabilitation (ie, home health or outpatient services). Patient education for monitoring signs and symptoms associated with change in acuity of comorbid conditions and function is also a relevant component of discharge planning and readiness to transition from inpatient rehabilitation to the community.

In conclusion, Medicare fee-for-service beneficiaries who receive inpatient rehabilitation for debility experienced a high rate of hospital readmission in the sample we studied. Discharge motor functional status, several comorbid conditions, and marital status were associated with readmission. Interactions with time were found with the following variables: discharge motor functional status, CMG comorbidity tier, and chronic pulmonary disease. Future research should build upon these findings to help develop evidence-based guidelines for care transitions in patients with debility.

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