Published in final edited form as:
Arch Phys Med Rehabil. 2013 October ; 94(10): 1951–1958. doi:10.1016/j.apmr.2013.05.028.

Functional Status Impairment Is Associated With Unplanned Readmissions

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Abstract

Objective: To determine whether functional status on admission to a Comprehensive Integrated Inpatient Rehabilitation Program (CIIRP) is associated with unplanned readmission to acute care.

Design: Retrospective cohort study.

Setting: Academic hospital-based CIIRP.

Participants: Consecutive patients (N=1515) admitted to a CIIRP between January 2009 and June 2012.

Interventions: Patients' functional status, the primary exposure variable, was assessed using tertiles of the total FIM score at CIIRP admission, with secondary analyses using the FIM motor and cognitive domains. A propensity score, consisting of 25 relevant clinical and demographic variables, was used to adjust for confounding in the analysis.

Main Outcome Measures: Readmission to acute care was categorized as (1) readmission before planned discharge from the CIIRP, (2) readmission within 30 days of discharge from the CIIRP, and (3) total readmissions from both groups, with total readmissions being the a priori primary outcome.

Results: Among the 1515 patients, there were 347 total readmissions. Total readmissions were significantly associated with FIM scores, with adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for the lowest and middle FIM tertiles versus the highest tertile (AOR=2.6; 95% CI, 1.9–3.7; P<.001 and AOR=1.7; 95% CI, 1.2–2.4; P=.002, respectively). There were similar findings for secondary analyses of readmission before planned discharge from the CIIRP (AOR=3.5; 95% CI, 2.2–5.8; P<.001 and AOR=2.1; 95% CI, 1.3–3.5l P=.002, respectively), and a

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No commercial party having a direct financial interest in the results of the research supporting this article has or will confer a benefit on the authors or on any organization with which the authors are associated.

weaker association for readmissions after discharge from the CIIRP (AOR=1.6; 95% CI, 1.0–2.4; P=.047 and AOR=1.3; 95% CI, 0.8–1.9; P=.28, respectively). The FIM motor domain score was more strongly associated with readmissions than the FIM cognitive score.

Conclusions: Functional status on admission to the CIIRP is strongly associated with readmission to acute care, particularly for motor aspects of functional status and readmission before planned discharge from the CIIRP. Efforts to reduce hospital readmissions should consider patient functional status as an important and potentially modifiable risk factor.

Keywords

Patient readmission; Propensity score; Rehabilitation

Potentially avoidable readmissions to acute care hospitals have been targeted by payers and hospitals as an important quality indicator, and ongoing federally mandated pay-for-performance initiatives seek to reduce readmission rates.[1–3] Although reasons for readmissions vary, including suboptimal care coordination, disease progression, and social factors, it is clear that many patients are discharged from an acute care hospital in a physiological state that makes them vulnerable to medical complications.[4] Decreased functional status, in particular, is an important and potentially modifiable factor that may contribute to acute care hospital readmissions.[5–7]

For patients admitted to a Comprehensive Integrated Inpatient Rehabilitation Program (CIIRP), prior studies suggest that functional status may be associated with readmission.[8–18] However, it is difficult to generalize these findings for several reasons. Some studies included readmissions that occurred as far as 180 days after discharge[13,15–17] or evaluated only specific patient populations (eg, stroke[15,17,18]). Moreover, some prior studies did not adjust for potential confounders of readmission, such as length of stay (LOS) and severity of illness (SOI).[5,19–22]

The primary objective of this study was to evaluate the association between functional status on admission to a hospital-based CIIRP and 30-day readmission to an acute care hospital. As a secondary analysis, we also investigated separate associations between motor and cognitive domains of functional status and 2 subgroups of readmitted patients: (1) those readmitted to an acute care hospital before planned discharge from the CIIRP and (2) those readmitted within 30 days after discharge from the CIIRP.

Methods

Participants

We conducted a single-center, retrospective study of patients admitted to a hospital-based CIIRP between January 2009 and June 2012. The CIIRP was located within Johns Hopkins Hospital, an urban academic medical center. All patients had their acute care admission at Johns Hopkins Hospital before transfer to the CIIRP. Planned readmissions to acute care (n=208) and patients who died in the CIIRP (n=2) were excluded from analysis.

Data sources

Data were derived from several sources. First, the Uniform Data System for Medical Rehabilitation provided the following data at CIIRP admission[23–25]: FIM score, impairment categories (as defined by functional related groups, a case-mix system for medical rehabilitation[24,26]), pain score, and the presence of a pressure ulcer. Second, the Johns Hopkins Hospital Datamart financial database, used for mandatory reporting to the State of Maryland, provided the following patient data: demographics, comorbidity status (measured using Agency for Healthcare Research and Quality [AHRQ] methodology, a tool to associate comorbidity measures with outcome measures for large administrative datasets[27]), acute care diagnosis codes, all payer refined-diagnosis related group (APRDRG) and SOI combinations (a tool to group patients into clinically comparable disease and SOI categories expected to use similar resources and experience similar outcomes), acute care LOS, discharge destination, and days from CIIRP admission to acute care readmission at Johns Hopkins Hospital. This data system has the capability to capture planned readmissions. Third, MedTel Outcomes data (a post-discharge, phone-based patient survey service with an 87.4% response rate) were used to identify readmissions to other acute facilities that occurred within 30 days of discharge from the CIIRP.[28] Finally, the University HealthSystem Consortium database provided national readmission rates for all APRDRG-SOI combinations using a methodology described by Oduyebo et al.[29] The databases were linked, at the patient level, using a combination of the patient's unique medical record number and the date of discharge from the CIIRP.

Primary outcome: readmission

All patients with unplanned transfer back to an acute care hospital before planned discharge from the CIIRP or readmitted within 30 days of CIIRP discharge were defined as total readmissions. As a secondary analysis, we also considered 2 mutually exclusive subsets of total readmissions: (1) patients readmitted before planned discharge from the CIIRP and (2) patients readmitted within 30 days after discharge from the CIIRP.

Primary exposure: functional status (FIM score)

Functional status, the primary exposure variable, was measured using the FIM score.[30] The FIM score is an 18-item reliable measure of functional status that can be grouped into separate motor (13 items) and cognitive (5 items) domains.[25,31] Each item is scored on a scale ranging from 1 to 7 (dependent to independent). Admission FIM scores are obtained by trained personnel within 72 hours of CIIRP admission. Because a recent study showed that only the motor domain FIM score was associated with readmission, we performed secondary analyses separately evaluating the FIM motor and cognitive domains.[18] One item in the motor domain, tub/shower transfer, was not observed (scored as 0) in 65% of the admission scores; hence, as done in prior research, the motor domain was scored based on the 12 remaining items for this analysis,[32] and all 18 items were included in the total FIM score.[15,16,18]

In the adjusted analysis of the association between FIM score and readmission, we divided the FIM scores into tertiles (total FIM: <60, 60–76, >76; motor domain: <32, 32–43, >43;

cognitive domain: <27, 27–33, >33) to divide patients into categories of high-, medium-, and low-risk groups and to make comparisons between these groups.

Covariates

Potential confounding variables considered in this analysis were identified primarily based on published literature and clinical practice guidelines[33–35] and included the following: age, sex, race (white, black, other), marital status (binary), payer (Medicare, Medicaid, commercial Health Maintenance Organization, non-Health Maintenance Organization, other) as a proxy for socioeconomic status,[36] admission impairment category[30] (stroke, nonstroke brain injury, other neurologic disease, spinal cord injury, orthopedic, cardiac, debility, medically complex, other), expected 30-day readmission rate based on APRDRG and SOI,[29] comorbidity AHRQ comorbidity index (which is an update to the original Elixhauser methodology[27]), acute care hospital LOS prior to the CIIRP, CIIRP admission pain score (range, 0–10), presence of a pressure ulcer at CIIRP admission (binary), and 3 variables separately indicating a history of psychiatric disease, substance abuse, and smoking, as per the *International Classification of Diseases–9th Revision* coding.[17,37,38]

Statistical analysis

Logistic regression was used to calculate *P* values for the association of readmission status with the primary exposure and with each of the covariates. To adjust for potential confounding variables in evaluating the association between FIM scores and readmission, we used a propensity score methodology, with stratification, as previously described.[39] This strategy permitted adjustment for all clinical variables with a single covariate and yields a measure of association between the exposure and outcome that is closer to the true marginal treatment effect than a logistic regression model in which all confounders are included in a multivariable model.[40,41]

To create the propensity score, we included all covariates (as previously described) into a multivariable logistic regression model with FIM score as the dependent variable. Consistent with the modeling of the FIM score, we dichotomized the total FIM score at the upper tertile; therefore, the logistic regression produced a probability of subjects having a FIM score in the upper tertile (>76 vs ≤76 points). We then divided the propensity scores into deciles, assigning each patient a score from 1 to 10, reflecting the likelihood of having a total FIM score >76 points. To assess the fit of the propensity model, we used a receiver operating characteristic curve C statistic, with the propensity score decile as the independent variable and the dichotomized total FIM score as the dependent variable. The propensity score decile predicted patients' FIM scores with C statistics for total, motor, and cognitive scores (69, .64, and .77, respectively). Covariates significantly associated with a total FIM score in the upper tertile were age, sex, marital status, psychiatric history, LOS in an acute care hospital, presence of a pressure ulcer on CIIRP admission, payer, AHRQ comorbidity index, and admission impairment category. This propensity score stratification approach was deemed successful because it removed the association between each confounding variable and the dichotomized FIM score.[42]

The range of propensity scores to predict whether a patient had a total admission FIM score >76 was .02 to .71. The observed total FIM scores were heterogeneous within each propensity score decile, such that lower deciles contained patients with high observed FIM scores, and vice versa. At the propensity score decile level, we observed an inverse relation between readmission rates and higher FIM scores. To ensure that the results from the primary analysis were not driven by patients with either very low or high predicted FIM scores, we also performed a sensitivity analysis by excluding patients in the 1st and 10th propensity deciles. The results of this sensitivity analysis were virtually identical to those of the primary analysis; as such, only the primary analysis is presented.

As an additional sensitivity analysis to propensity score modeling, we also conducted a multivariable logistic regression analysis to assess the relation between total FIM score and all readmissions. In 2 separate models, we included all covariates from the propensity score model and only those covariates that were significantly associated with readmission in the bivariate analysis. In both cases, the results of this sensitivity analysis were also virtually identical to those of the primary analysis; as such, only the primary analysis is presented.

Finally, we performed subanalyses in which we examined the motor and cognitive components of the FIM score separately. We dichotomized the motor FIM (>43 vs ≤43 points) and cognitive FIM (>33 vs ≤33 points) scores. As with the primary analysis, propensity score adjustment to predict motor and cognitive domain FIM scores eliminated the association among the confounding covariates and the domain scores.

Statistical significance was defined as $P<.05$. Data were analyzed with R software (version 2.15.0[a]). This study was approved by the Johns Hopkins Institutional Review Board.

Results

Readmitted patients

A total of 1725 consecutive patients were admitted to the CIIRP between January 2009 and June 2012. We excluded 208 planned readmissions and 2 patients who died during the CIIRP. The remaining 1515 patients were included for analysis. A total of 347 (20%) patients had an unplanned readmission, with 177 (51%) readmitted before discharge from the CIIRP and 170 (49%) readmitted within 30 days after CIIRP discharge (mean time to readmission from the CIIRP discharge ± SD, 13±8d). rate of readmission is similar to other reported CIIRP readmission rates.[15–17]

Table 1 compares characteristics of readmitted versus non-readmitted patients, with the following variables being significantly different between these patient groups: LOS in an acute care hospital, presence of a pressure ulcer on CIIRP admission, AHRQ comorbidity index, expected University HealthSystem Consortium readmission rate based on the APRDRG-SOI combination, admission impairment categories, and FIM scores.

[a]. R software; http://www.r-project.org.

The etiologies for readmission were diverse, with the most common categories for hospital readmission being infection and pulmonary, neurologic, renal, and organ transplant complications. We did not observe a consistent association between admission functional status and reason for readmission. We also found that patients made functional gains with rehabilitation during their CIIRP admission with mean ± SD increases in total FIM scores of 19.8±12.3 points.

FIM scores and risk of readmission

Figure 1 shows that patients in the lowest tertile of total FIM score had a higher unadjusted rate of readmission versus the middle and highest tertiles. We also observed that patients in the lowest tertile of motor and cognitive FIM scores had a higher unadjusted rate of readmission versus the middle and highest tertiles (table 2).

Multivariable and secondary analysis

The propensity score-adjusted odds ratio for total readmissions for the lowest and middle versus highest tertiles of total FIM score was 2.6 (95% confidence interval [CI], 1.9–3.7; $P<.001$) and 1.7 (95% CI, 1.2–2.4; $P=.002$), respectively. In a secondary analysis, FIM scores in the motor domain had a stronger association with readmission than scores in the cognitive domain, and total FIM scores had a stronger association with readmissions during CIIRP stay than readmissions within 30 days of CIIRP discharge (table 3).

The association between total FIM score and readmissions did not change substantially in the unadjusted versus the adjusted propensity score analysis, in part because the magnitude of the association between the covariates that were associated with both the primary exposure and primary outcome was not strong. Additionally, the relation between the 2 covariates, pressure ulcer presence and AHRQ comorbidity index, and the primary exposure and primary outcome had similar magnitudes but in opposite directions, which may have minimized their confounding effect.[43]

Discussion

In this study of 1515 consecutive patients admitted to a single hospital-based CIIRP using propensity score methods, we investigated the association between functional status on CIIRP admission and subsequent readmission to an acute care hospital. After adjustment for 25 demographic and clinical variables, the total FIM score at CIIRP admission was strongly associated with readmission to an acute care hospital. Hence, physical disability may be a modifiable risk factor to help prevent hospital readmission, and efforts to maintain or improve functional status during acute care hospitalization may decrease readmissions.

This association between functional status and readmission is supported by previous studies in both acute care and CIIRP settings.[7,44] In the acute care setting, for example, Coleman et al[7] reported that including functional status based on survey data improved the prediction of readmissions compared with the use of administrative data alone in Medicare beneficiaries. Bohannon and Lee[6] also found that in patients with acute ischemic stroke, functional measures were predictive of readmissions independent of other demographic and clinical factors. In the context of inpatient rehabilitation, studies have separately evaluated readmissions that occurred during CIIRP and post-CIIRP discharge. For example, Chung et al[18] recently demonstrated in severely affected stroke patients that the motor FIM score at CIIRP admission was the only variable significantly associated with acute care readmission during CIIRP admission. Several studies evaluating readmissions after planned discharge from the CIIRP have also demonstrated that the FIM score was associated.[13–17]

We extended the results of these previous studies by controlling for additional covariates associated with readmission.[45] For instance, we found that longer LOS in the acute care hospital, presence of a pressure ulcer on CIIRP admission, and a higher AHRQ comorbidity index were associated with both total FIM score and hospital readmission. These findings suggest that lower FIM scores may reflect patient physiological vulnerability to complications. For example, we found that readmitted patients who presented to the CIIRP had longer LOSs in acute care. The prolonged acute care hospitalization may have made them more vulnerable to the deleterious effects of the hospitalized inpatient experience.[5,19–22] The association between total FIM score and readmission did not change substantially in the unadjusted versus adjusted propensity score analysis. This indicates that demographic and clinical variables did not play a large role in confounding the association between functional status and readmission.

In this study, we also examined the association between functional status and timing of readmission after admission to the CIIRP. FIM scores were more strongly associated with readmissions during the CIIRP stay than readmissions after CIIRP discharge. In the patients readmitted after CIIRP discharge, the increased time between FIM assessment at CIIRP admission and the acute care hospital readmission may have decreased the strength of this association, especially because FIM scores are expected to markedly increase by CIIRP discharge. Inpatient rehabilitation may have served as a successful treatment for decreased functional status in patients that completed their inpatient rehabilitation and were discharged to the community. Patients made substantial gains in their functional status with rehabilitation during their CIIRP admission, consistent with other studies showing the benefits of exercise and mobility during inpatient rehabilitation, acute care, and even in an intensive care unit setting.[4,44] We focused on admission CIIRP variables, but discharge FIM scores may be more closely associated with acute care hospital readmissions after CIIRP discharge; this should be evaluated in future studies.

When evaluating the FIM domains scores in stroke CIIRP patients, previous studies have suggested that the motor domain may be more predictive of readmission than the cognitive domain.[32,46–49] Our findings extend this observation to a more diverse patient population. Compared with the cognitive score, lower motor FIM scores may be a stronger marker of lower physiological reserve, which may make patients more prone to medical complications.[15,18] Cognitive scores were also associated with readmission, but to a lesser extent. Indeed, impaired cognition may lead to readmission after discharge into the community because of factors, such as suboptimal medication or dietary compliance, or improper dressing changes for wounds. However, defects in cognition may be overcome to a large extent by having adequate supervision and support at home.

Study limitations

We acknowledge that this study has several potential limitations. Its generalizability may be limited because it was conducted at a single large academic medical institution and the patient population did not include certain diagnoses commonly seen in other CIIRPs, such as amputees and burn patients. Although we observed a similar readmission rate, as reported in other studies, it is possible that readmissions to outside hospitals were missed because postdischarge patient phone interviews had high completion rates, but they were not 100%. Additionally, we did not include clinical data available at admission to the CIIRP, such as laboratory data and vital signs. However, previous readmission studies in the acute care setting showed that the addition of those variables did not improve modeling.[50,51] The goal was to examine the overall association between functional status and hospital readmission. However, this approach does not provide prediction of readmission at the individual patient level, an important area for future research. The findings suggest that future readmission prediction models should include factors related to functional status to identify higher-risk patients.

Conclusions

For patients admitted to the CIIRP, we found a strong association between admission functional status and readmissions to an acute care hospital, particularly for those patients readmitted before planned discharge from the CIIRP and for those with a lower FIM motor domain score. Hence, assessment of functional status can be helpful to identify which patients may be at a higher risk for readmission. The effect of interventions to maintain and improve functional status in the acute inpatient setting should be evaluated as a potential method to reduce hospital readmissions. Active prevention of the deconditioning that all too often accompanies hospitalization may prove to be a valuable tool to improve clinical outcomes and prevent avoidable rehospitalizations.

Acknowledgments

We thank Nathan Neufeld, MD (Johns Hopkins University), for early review of the project.

Hoyer is supported by the Rehabilitation Medicine Scientist Training Program (grant no. 5K12HD001097); and Brotman is supported by the Centers for Medicare and Medicaid Services (grant no. IC1-12-0001).

List of abbreviations:

AHRQ	Agency for Healthcare Research and Quality
APRDRG	all payer refined-diagnosis related group
CI	confidence interval
CIIRP	Comprehensive Integrated Inpatient Rehabilitation Program
LOS	length of stay
SOI	severity of illness

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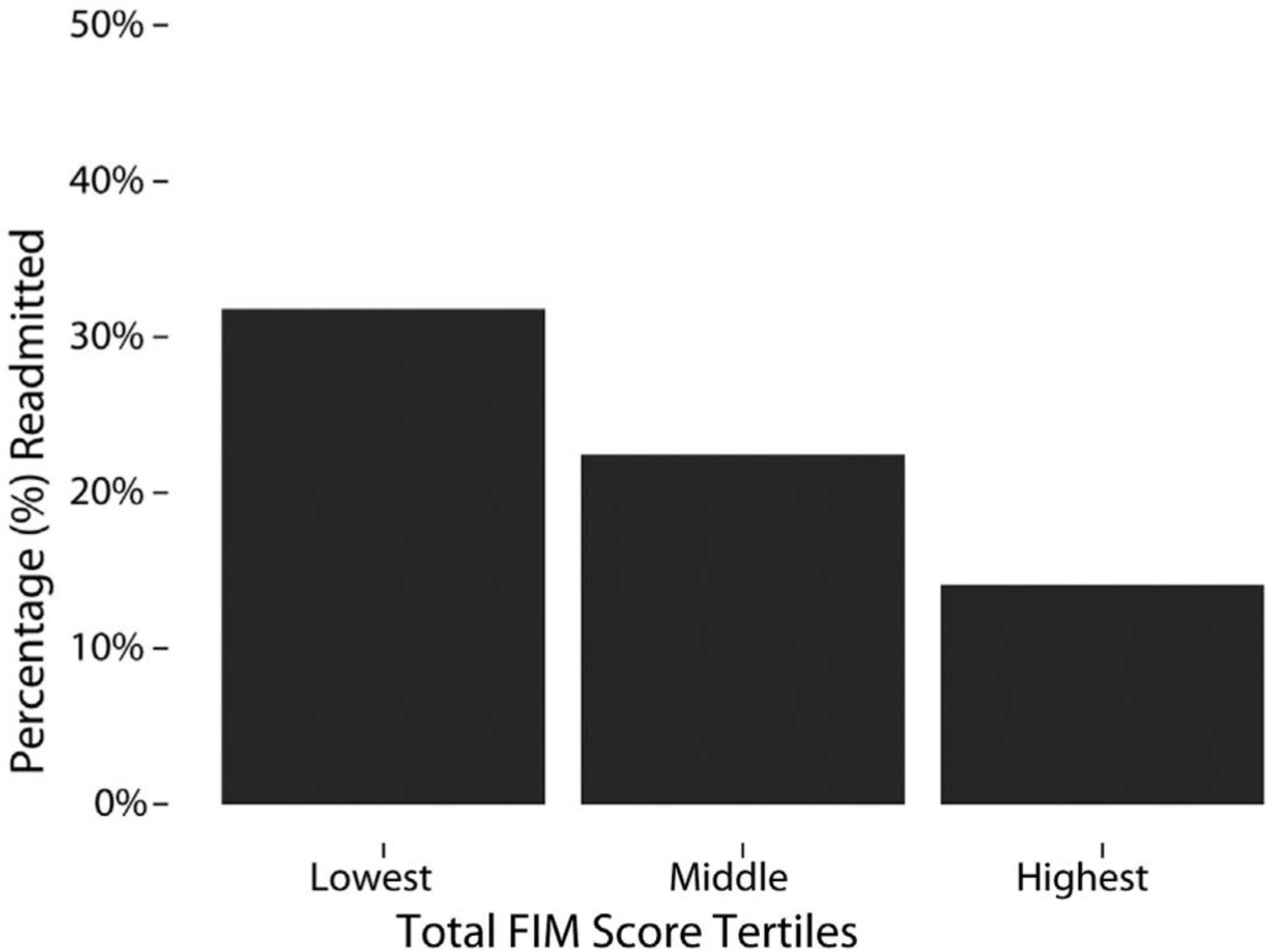

Fig 1.
Percentage of CIIRP patients readmitted to an acute care hospital by total FIM score tertile (highest tertile >76 points, middle tertile 60–76 points, and lowest tertile <60 points).

Table 1

Characteristics of all CIIRP patients by readmission status

Characteristic	All Patients (N=1515)	Readmitted (n=347)	Not Readmitted (n=1168)	*P*†
Age (y)	61.6±16.6	61.8±15.7	61.6±16.8	.820
Male	716 (47)	166 (48)	550 (47)	.810
Married	811 (54)	197 (57)	614 (53)	.170
Race				.890
White	987 (65)	226 (65)	761 (65)	
Black	410 (27)	92 (27)	318 (27)	
Other	118 (8)	29 (8)	89 (8)	
Psychiatric history	513 (34)	123 (35)	390 (33)	.480
Smoking history	154 (10)	33 (10)	121 (10)	.650
Substance abuse history	89 (6)	17 (5)	72 (6)	.380
LOS in acute care hospital (d)	13.3±13.5	17.9±19.1	11.9±10.9	<.001
Pressure ulcer at CIIRP admission	103 (7)	33 (10)	70 (6)	.020
Pain score on admission*	3.7±3.3	3.5±3.3	3.8±3.3	.130
Payer				.450
Medicare	778 (51)	187 (54)	591 (51)	
Medicaid	132 (9)	22 (6)	110 (9)	
Commercial	364 (24)	82 (24)	282 (24)	
Non-HMO				
HMO	182 (12)	41 (12)	141 (12)	
Other	59 (4)	15 (4)	44 (4)	
AHRQ comorbidity index	3.3±1.6	3.5±1.6	3.2±1.6	<.001
APRDRG-SOI expected readmission rate (%)	15.2±7.2	17.9±7.8	14.4±6.7	<.001
Admission impairment categories				<.001
Stroke	157 (10)	34 (10)	123 (11)	
Nonstroke brain injury	182 (12)	45 (13)	137 (12)	
Other neurologic disease	92 (6)	22 (6)	70 (6)	
Spinal cord injury	304 (20)	58 (17)	246 (21)	
Orthopedic	118 (8)	14 (4)	104 (9)	
Cardiac	207 (14)	34 (10)	173 (15)	
Debility	297 (20)	88 (25)	209 (18)	
Medically complex	94 (6)	33 (10)	61 (5)	
Other	64 (4)	19 (5)	45 (4)	
Admission FIM scores				
Total FIM score	66.2±18.3	61.1±18.3	67.8±18.1	<.001
Motor domain score	37.0±13.2	33.2±12.7	38.1±13.1	<.001
Cognitive domain score	28.0±7.3	27.0±7.8	28.3±7.1	.004

NOTE. Binary and categorical data are presented as n (%), and continuous variables are represented as mean ± SD.

Abbreviation: HMO, Health Maintenance Organization.

*Pain scores are measured on a visual analog scale (range, 0–10).

†*P* values were calculated using bivariate logistic regression analysis.

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Table 2

Unadjusted and adjusted readmission rates by FIM tertile

	FIM Domains		
FIM Domains	**Total FIM Score**	**Motor FIM Score**	**Cognitive FIM Score**
Unadjusted			
Highest tertile	14.1 (10.4–17.8)	14.6 (11.0–18.1)	19.0 (15.3–22.7)
Middle tertile	22.4 (18.9–26.0)	22.2 (18.5–25.9)	24.6 (20.8–28.4)
Lowest tertile	31.8 (28.2–35.4)	32.0 (28.4–35.6)	25.1 (21.5–28.7)
Propensity score adjusted			
Highest tertile	14.9 (11.0–18.7)	15.9 (12.3–19.5)	19.7 (15.7–23.7)
Middle tertile	22.4 (18.9–26.0)	22.3 (18.7–26.0)	24.6 (20.8–28.4)
Lowest tertile	31.0 (27.3–34.8)	30.5 (26.9–34.2)	24.4 (20.6–28.3)

NOTE. Readmission rates are presented as percentage (95% CIs).

Table 3

Association of FIM scores with readmissions

Functional Status Measure	Total Readmissions (n=347) OR (95% CI)	*P*	Readmissions During the CIIRP (n=177) OR (95% CI)	*P*	Readmissions After CIIRP Discharge (n=170) OR (95% CI)	*P*
Total FIM score						
Unadjusted						
Highest tertiLe	Referent		Referent		Referent	
Middle tertile	1.8 (1.3–2.5)	<.001	2.2 (1.4–3.5)	.001	1.3 (0.9–2.0)	.180
Lowest tertile	2.8 (2.1–3.9)	<.001	3.7 (2.4–5.8)	<.001	1.8 (1.2–2.7)	.006
Propensity score adjusted						
Highest tertile	Referent		Referent		Referent	
Middle tertile	1.7 (1.2–2.4)	.002	2.1 (1.3–3.5)	.002	1.3 (0.8–1.9)	.290
Lowest tertile	2.6 (1.9–3.7)	<.001	3.5 (2.2–5.8)	<.001	1.6 (1.0–2.4)	.047
Motor FIM score						
Unadjusted						
Highest tertile	Referent		Referent		Referent	
Middle tertile	1.7 (1.2–2.3)	.002	2.3 (1.4–3.7)	<.001	1.2 (0.8–1.8)	.440
Lowest tertile	2.8 (2.0–3.8)	<.001	3.8 (2.5–6.1)	<.001	1.6 (1.1–2.4)	.020
Propensity score adjusted						
Highest tertile	Referent		Referent		Referent	
Middle tertile	1.6 (1.1–2.2)	.007	2.2 (1.4–3.5)	.001	1.1 (0.7–1.7)	.640
Lowest tertile	2.4 (1.7–3.3)	<.001	3.4 (2.2–5.4)	<.001	1.4 (0.9–2.1)	.110
Cognitive FIM score						
Unadjusted						
Highest tertile	Referent		Referent		Referent	
Middle tertile	1.4 (1.0–1.9)	.030	1.7 (1.1–2.5)	.020	1.1 (0.7–1.6)	.670
Lowest tertile	1.4 (1.1–1.9)	.020	1.7 (1.2–2.6)	.006	1.1 (0.7–1.6)	.710
Propensity score adjusted						
Highest tertile	Referent		Referent		Referent	
Middle tertile	1.3 (1.0–1.8)	.070	1.7 (1.1–2.6)	.020	1.0 (0.7–1.5)	.950
Lowest tertile	1.3 (0.9–1.9)	.110	1.8 (1.1–2.8)	.010	0.9 (0.6–1.5)	.740

NOTE. *P* values were calculated using logistic regression analysis.

Abbreviation: OR, odds ratio.