Archives of Rehabilitation Research and Clinical Translation (2022) 4, 100178

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Rehabilitation Research and Clinical Translation

Archives of Rehabilitation Research and Clinical Translation 2022;4:100178

Available online at www.sciencedirect.com

Original Research

Acute Inpatient Rehabilitation Improves Function Independent of Comorbidities in Medically Complex Patients

Shangming Zhang, MD [a], Dan Lin, MPH [b], Megan E. Wright, MS, PA-C [c], Nicole Swallow, MD, FACP [d]

[a] *Department of Physical Medicine and Rehabilitation, Penn State Health Milton S. Hershey Medical Center, Hershey, Pennsylvania*
[b] *Department of Public Health Sciences, Penn State University College of Medicine, Hershey, Pennsylvania*
[c] *Department of Neurology, Division of Rehabilitation Medicine, University of Maryland Medical Center, Baltimore, Maryland*
[d] *Department of Internal Medicine, Penn State Health Milton S. Hershey Medical Center, Hershey, Pennsylvania, United States*

KEYWORDS
Centers for Medicare and Medicaid Services;
Comorbidity;
Rehabilitation

Abstract *Objectives:* (1) To evaluate the benefits of acute inpatient rehabilitation for a medically complex patient population and (2) to assess the effect of comorbid conditions on rehabilitation outcomes.
Design: Retrospective cohort study.
Setting: Freestanding inpatient rehabilitation facility.
Participants: A total of 270 medically complex adult patients including those with cardiac, pulmonary, and orthopedic conditions, with mean age of 73.6 years; 52.6% were female and 47.4% were male (N=270).
Interventions: Not applicable.
Main Outcome Measures: Functional Independence Measure (FIM) gain, FIM efficiency, rehabilitation length of stay (RLOS), home discharge rate, and readmission to acute care (RTAC).
Results: Among 270 medically complex patients, mean total FIM gain, mean RLOS, and mean FIM efficiency with SD were 26.0±13.6 points, 12.6±5.9 days, and 2.3±1.6, respectively. A total of 71.9% of patients were discharged to home, 12.2% for RTAC, and 15.9% to a skilled nursing facility (SNF). Hypertension (HTN) was the only comorbidity significantly associated with FIM gain (53.7% [total FIM gain ≥27] vs 67.2% [total FIM gain <27]; *P*=.024) and FIM efficiency (53.3% [FIM efficiency ≥2.12] vs 67.4% [FIM efficiency <2.12]; *P*=.025), independent of age, body mass index, sex, race, ethnicity, insurance type, and Charlson Comorbidity Index. The 5 most common

List of abbreviations: BMI, body mass index; CCI, Charlson Comorbidity Index; CMS, Centers for Medicare and Medicaid Services; HTN, hypertension; IGC, Impairment Group Code; IRF, inpatient rehabilitation facility; OR, odds ratio; RIC, rehabilitation impairment category; RLOS, rehabilitation length of stay; RTAC, readmission to acute care; SCI, spinal cord injury; SNF, skilled nursing facility; TBI, traumatic brain injury.
Disclosures: none
Cite this article as: Arch Rehabil Res Clin Transl. 2022;4:100178

https://doi.org/10.1016/j.arrct.2022.100178

reasons for RTAC were cardiac, pulmonary, acute blood loss anemia, infection, and neurologic conditions.
Conclusions: Among 270 medically complex patients, 71.9% were discharged to home, 15.9% to an SNF, and 12.2% for RTAC with a mean RLOS 12.6 days, mean total FIM gain of 26 points, and mean FIM efficiency of 2.3, which were all better than those of all admissions at our facility in 2018. Furthermore, RLOS, total FIM gain and FIM efficiency in this study were all better than their corresponding eRehabData weighted national benchmarks (RLOS, 15.82 days; FIM gain, 25.57; FIM efficiency, 2.13) for a total of 202,520 discharges in 2018. These findings support acute inpatient rehabilitation for this patient population. With the exception of HTN, no medical comorbidities or demographic variables were associated with rehabilitation outcomes.

In the United States, intensive inpatient rehabilitation is performed within inpatient rehabilitation facilities (IRFs). The Centers for Medicare and Medicaid Services (CMS) is the largest payer source for patients admitted to IRF and provides reimbursement according to the Inpatient Rehabilitation Facility Prospective Payment System. CMS requires IRFs to comply with the "60 Percent Rule," which states that at least 60% of patients admitted to IRFs must have 1 of 13 specified diagnoses[1] including stroke, brain injury, spinal cord injury, neurologic disorders, and so on.[2]

The benefits of acute inpatient rehabilitation have been studied in patients with CMS "60% compliant," such as stroke, traumatic brain injury (TBI), spinal cord injury (SCI), Guillain-Barré syndrome, multiple sclerosis, Parkinson disease, lower limb amputation, burn injuries, and unilateral hip fractures.[2-14] Previous studies have also shown that patients with other "noncompliant" diagnoses such as cancer,[15,16] heart failure,[17-19] and chronic graft-vs-host disease[20] also benefited from acute inpatient rehabilitation. Readmission to acute care (RTAC) in acute rehabilitation settings were studied in medically complex patients consisting of Impairment Group Codes (IGCs) 17.1-17.9, [21] as well as mixed CMS compliant and noncompliant IGCs.[22]

Inpatient rehabilitation outcomes are influenced by the type and severity of impairments, age, sex, social support, comorbid medical conditions, and functional status on admission.[7,23,24] Comorbidities play an important role in inpatient rehabilitation outcomes in patients with SCI, stroke, and TBI.[6,25-28] Comorbidities have been used to predict functional outcomes in patients with stroke in multiple studies.[29,30] Preexisting medical comorbidities were associated with lower levels of function on admission and discharge for patients with TBI in IRFs, but there was no association between comorbidities and functional status in patients post orthopedic surgery.[7] A prior study of patients admitted to acute inpatient rehabilitation after hip and knee arthroplasty found that indications for surgery, number of comorbidities, marital status, and race were associated with rehabilitation length of stay (RLOS).[31] However, acute inpatient rehabilitation and the effect of variables such as comorbidities on inpatient rehabilitation outcomes have not been investigated in medically complex patients excluding the CMS "60% compliant" diagnoses. Such an assessment would help inform rehabilitation preadmission assessments and identify opportunities to medically optimize patients and improve functional outcomes.

The aims of our investigation were (1) to evaluate the benefits of acute inpatient rehabilitation for a medically complex patient population that does not carry one of the CMS "60% compliant" diagnoses and (2) to assess the effect of comorbid conditions and other variables on rehabilitation outcomes. We hypothesized that (1) medically complex patients who are admitted to an IRF will functionally benefit from acute inpatient rehabilitation and (2) medical comorbidities and/or demographic variables will account for differences in functional outcomes among this patient population.

Methods

Study design and setting

This study, approved by the institutional review board, is a retrospective cohort of medically complex patients admitted to a freestanding IRF with academic affiliation. Informed consent was not applicable because of the nature of the study.

Inclusion criteria

IGCs and rehabilitation impairment categories (RICs) were assigned to each patient and reflected the primary reason for admission to the IRF. This study included 270 patients 18 years or older who were admitted to an IRF between December 2016 and July 2018 with a variety of IGCs under 4 RICs: RIC-9 (other orthopedic), RIC-14 (cardiac), RIC-15 (pulmonary), and RIC-20 (miscellaneous). RIC-9, RIC-14, and RIC-15 included IGC08.9, IGC9, and IGC10.1 and 10.9, respectively. RIC-20 covers numerous IGCs such as IGC16 (debility), IGC17.1 (infection), IGC17.2 (neoplasms), IGC17.3 (nutrition with or without intubation), IGC17.4 (circulation disorder), IGC17.5 (respiratory disorders), IGC17.6 (terminal care), IGC17.7 (skin disorders), IGC17.8 (medical/surgical complications), and IGC17.9 (other medically complex conditions). The aforementioned IGCs under RIC-9, 14, 15, and 20 are noncompliant with the CMS's "60 Percent Rule" and are defined as "medically complex" in this study.

Exclusion criteria

This study excluded patients under RIC-1-8, 10-13, 17-19, or 21 who are CMS's "60 Percent Rule" complaint. However, 55 patients with intensive care unit—acquired weakness[32] equivalent to critical illness myopathy who are considered CMS compliant under RIC-6 were included in this study because they are often coded as having debility (IGC16) under RIC-20.

Data collection

Data were obtained from eRehabData, which is a database composed of RIC, IGC, *International Classification of Diseases, Tenth Revision*, demographic, medical, and functional information extracted from the Inpatient Rehabilitation Facility Patient Assessment Instrument. Sociodemographic data (age, sex, race, ethnicity, insurance type) and clinical characteristics (body mass index [BMI], major comorbidities) were extracted along with functional data (admission Functional Independence Measure [FIM] and discharge FIM). RLOS (total number of days spent at IRF not including the day of discharge) and discharge disposition (home/assisted living facility/transitional care, skilled nursing facility [SNF], acute care hospital) were also assessed.

The Charlson Comorbidity Index (CCI) was used to assess comorbidities. The CCI is a validated scoring tool frequently used for prognostication and comorbidity adjustment that considers 19 conditions, each assigned an integer weight from 1-6, with a weight of 6 representing the most severe morbidity.[33,34] Additional comorbidities were also tracked beyond those included in the CCI, such as anemia, atrial fibrillation, respiratory failure, bacteremia, hypertension, orthostatic hypotension, and obstructive sleep apnea.

The FIM instrument was in use at the time of the study to assess functional status. The FIM instrument is a valid and reliable tool that indicates how much assistance an individual requires to complete a task.[35] It is scored for 18 items across 13 motor and 5 cognitive domains, and each item is scored on a 7-point ordinal scale from 1-7; thus, total FIM scores range from 18 to 126, with higher values indicating greater functional independence. This study examined FIM admission score, FIM gain (FIM discharge score minus FIM admission score), and FIM efficiency (FIM gain divided by RLOS).

Statistical analysis

A dichotomy using the median score of FIM total gain or median score of FIM efficiency was used to categorize 270 patients. Patients were divided into 2 groups: (1) score <27 (n=134) and ≥27 (n = 136) for FIM total gain or (2) score <2.12 (n = 135) and score ≥2.12 (n = 135) in FIM efficiency. Fisher exact test for categorical variables and *t* test for continuous variables were used to determine the association between patient characteristics and FIM gain, patient characteristics, and FIM efficiency. Fisher exact test for categorical variables and analysis of variance for continuous variables were used to assess associations between discharge destinations and patient characteristics. Multinomial logistic regressions of odds ratios (ORs) and 95% CIs were conducted to further assess the relationship between discharge destinations and FIM total gain or FIM efficiency with the adjustment of age (continuous), BMI (continuous), sex (male, female), insurance type (Medicare, commercial insurance), RLOS (continuous), and hypertension (HTN) (yes, no). HTN was included in the model because it was the only acute managed comorbidity associated with FIM total gain (*P*=.02) and FIM efficiency (*P*=.03) in our population. All analyses were conducted using SAS version 9.4.[a]

Results

A total of 270 medically complex patients met the inclusion and exclusion criteria. Table 1 summarizes the demographic, medical, and functional characteristics of all the patients. The mean age was 73.6 years, and 52.6% were female. The majority of participants were White (94.4%) and non-Hispanic (98.9%). Nearly 80% of participants were Medicare beneficiaries, and the 5 most common medical comorbidities were HTN (60.4%), atrial fibrillation (28.9%), congestive heart failure (27.4%), diabetes without chronic complications (24.8%), and anemia (15.6%). The mean total FIM scores improved significantly from 61.4±12.0 on admission to 87.3±16.5 on discharge (*P*<.001). The mean FIM motor scores improved from 36.4±9.2 on admission to 58.6±13.2 on discharge (*P*<.001), and the mean FIM cognitive scores improved from 25.0±5.6 on admission to 28.7±5.1 on discharge (*P*<.001). The mean total FIM gain with SD was 26.0±13.6 points (interquartile range [IQR], 19.0; range, −10.0 to 78.0), mean FIM efficiency was 2.3±1.6 (IQR, 1.9; range, −3.3 to 11.4), and mean RLOS was 12.6±5.9 days (IQR, 16.0 days; range, 1.0-43.0 days). Of all 270 patients, 71.9% were discharged to home, 15.9% to an SNF, and 12.2% to an RTAC.

Regarding total FIM gain, table 2 details that patients with total FIM gain ≥27 were more likely to be discharged to home than those with total FIM gain <27 (86.8% vs 56.7%; *P*<.001), less likely to be discharged to an SNF (8.8% vs 23.1%; *P*<.001), and less likely to be emergently transferred to an acute care hospital (4.4% vs 20.2%; *P*<.001). HTN was the only comorbidity significantly negatively associated with FIM gain (53.7% [total FIM gain ≥27] vs 67.2% [total FIM gain <27]; *P*=.024). There were no significant differences in age, BMI, sex, race, ethnicity, insurance type, CCI, or RLOS between patients with total FIM gain <27 and those with total FIM gain ≥27.

As shown in table 3, patients with FIM efficiency ≥2.12 had a shorter RLOS than those with FIM efficiency <2.12 (10.7±3.8 vs 14.5±7.0 days; *P*<.001), were more likely to be discharged to home (83% vs 60.7%; *P*<.001), less likely to be discharged to an SNF (7.4% vs 24.4%; *P*<.001), and less likely to be emergently transferred (9.6% vs 14.8%; *P*<.001). HTN was the only comorbidity significantly negatively associated with FIM efficiency (53.3% [FIM efficiency ≥2.12] vs 67.4% [FIM efficiency <2.12]; *P*=.025). There were no significant differences in age (*P*=.77), BMI (*P*=.28), sex (*P*=.33), race (*P*=.60), ethnicity (*P*=.99), insurance type (*P*=.13), or CCI (*P*=.50) between patients with FIM efficiency <2.12 and those with FIM efficiency ≥2.12.

As shown in table 4, patients discharged to an acute care hospital were younger than those discharged to home (67.2±15.1 vs 73.7±11.9 years; *P*=.015) or SNF (67.2±15.1 vs 78.0±11.4 years; *P*<.001). More patients with commercial insurance were emergently transferred to an acute care hospital as opposed to home or SNF (39.4% vs 20.6% and 4.6%, respectively; *P*<.001). RLOS was significantly lower for

Table 1 Characteristics of 270 medically complex patients

Characteristic	Total n=270
Age (y), mean ± SD	73.6±12.5
BMI, mean ± SD	29.6±10.0
Sex, n (%)	
Female	142 (52.6)
Male	128 (47.4)
Race, n (%)	
White	255 (94.4)
Non-White	15 (5.6)
Ethnicity, n (%)	
Hispanic	3 (1.1)
Non-Hispanic	267 (98.9)
Insurance type, n (%)	
Commercial insurance	55 (20.4)
Medicare	215 (79.6)
CCI score category, n (%)	
Low (0-2)	38 (14.1)
Moderate (3-4)	119 (44.1)
High (>4)	113 (41.8)
FIM score at admission, mean ± SD	
Motor	36.4±9.2
Cognitive	25.0±5.6
Total subscales	61.4±12.0
FIM score at discharge, mean ± SD	
Motor	58.6±13.2
Cognitive	28.7±5.1
Total subscales	87.3±16.5
FIM gain, mean ± SD	
Motor	22.2±11.2
Cognitive	3.7±4.5
Total subscales	26.0±13.6
FIM efficiency, mean ± SD	
Motor	2.0±1.3
Cognitive	0.3±0.5
Total subscales	2.3±1.6
RLOS (d), mean ± SD	12.6±5.9
Discharge destination, n (%)	
Home	194 (71.9)
Acute care hospital	33 (12.2)
Skilled nursing facilities	43 (15.9)
Acutely managed comorbidities, n (%)	
CHF	74 (27.4)
Peripheral vascular disease	11 (4.1)
Diabetes without chronic complications	67 (24.8)
Renal disease, mild to moderate	38 (14.1)
Liver disease, mild	8 (3.0)
Chronic pulmonary disease	9 (3.3)
Myocardial infarction	10 (3.7)
Diabetes with chronic complications	30 (11.1)
Renal disease, severe	31 (11.5)
Liver disease, moderate to severe	4 (1.5)
Metastatic solid tumor	2 (0.7)
AIDS	12 (4.4)
Anemia*	42 (15.6)
Atrial fibrillation*	78 (28.9)
Respiratory failure*	4 (1.5)
Acute pneumonia*	26 (9.6)
Bacteremia*	2 (0.7)
HTN*	163 (60.4)
Orthostatic hypotension*	10 (3.7)
OSA*	27 (10.0)

NOTE. BMI calculated as weight in kilograms divided by height in meters squared.
Abbreviations: CHF, congestive heart failure; HTN, essential (primary) hypertension; OSA, obstructive sleep apnea.
* Not included in CCI.

patients emergently discharged to an acute care hospital than those discharged to home or SNF (9.1±7.9 vs 12.7±5.3 and 15.1±5.6 days, respectively; P<.001). Metastatic solid tumors were the only comorbidity significantly associated with discharge location (6.1% [acute care hospital] vs 0% [home] and 0% [SNF]; P=.015). There were no significant differences in BMI (P=.91), sex (P=.99), race (P=.43), ethnicity (P=.38), or CCI (P=.98) between patients discharged to home, SNF, or acute care hospital. The association between renal disease and discharge destination was not statistically significant (P=.059).

The total FIM score at discharge was significantly associated with discharge disposition (see table 4). Patients discharged to home had the highest total discharge FIM followed by those discharged to an SNF and those discharged to acute care (91.2±14.4, 80.9±13.8 and 72.8±20.6, respectively; P<.001). This pattern was also observed for discharge FIM motor subscores (62.1 [home] vs 52.8 [SNF] and 45.4 [acute care hospital]; P<.001) but not for discharge FIM cognitive subscores (29.1 [home] vs 28.1 [SNF] and 27.4 [acute care hospital]; P=.14). As shown in table 5, when compared with patients with total FIM gain <27, those with total FIM gain ≥27 were 89% less likely to be discharged to an acute care hospital (OR, 0.11; P<.001) and 78% less likely to be discharged to an SNF (OR, 0.22; P<.001), after adjustment. Similarly, patients with FIM efficiency ≥2.12 were 75% less likely to be discharged to an SNF (OR, 0.25; P<.001) and 71% less likely to be discharged to an acute care hospital (OR, 0.29; P=.008).

The reasons for RTAC (n=33) are listed in table 6. The 5 most common reasons for RTAC were cardiac (21.1%), pulmonary (21.1%), acute blood loss anemia (21.1%), infection (15.2%), and neurologic (12.2%) conditions.

Discussion

To our knowledge, this is the first study to investigate acute inpatient rehabilitation outcomes (FIM gain, FIM efficiency, RLOS, discharge destination, RTAC) in medically complex patients defined by non-CMS–compliant conditions, including a variety of IGCs, such as IGC08.9, IGC9, IGC10.1, IGC10.9, IGC16, and IGC 17.1-17.9. We have shown that medically complex patients greatly benefit from inpatient rehabilitation. A total of 71.9% were discharged to home, 15.9% to an SNF, and 12.2% for RTAC, with a mean RLOS of 12.6 days, mean total FIM gain of 26, and mean FIM

Table 2 Associations between total FIM gain and characteristics in 270 medically complex patients

Characteristic	Total FIM Gain <27 n=134	Total FIM Gain ≥27 n=136	*P* Value
Age (y), mean ± SD	74.3±13.2	72.8±11.8	.31
BMI, mean ± SD	29.6±12.1	29.7±7.5	.91
Sex, n (%)			.71
Female	72 (53.7)	70 (51.5)	
Male	62 (46.3)	66 (48.5)	
Race, n (%)			.77
White	126 (94.0)	129 (94.9)	
Non-White	8 (6.0)	7 (5.2)	
Ethnicity, n (%)			.62
Hispanic	2 (1.5)	1 (0.7)	
Non-Hispanic	132 (98.5)	135 (99.3)	
Insurance type, n (%)			.49
Commercial insurance	25 (18.7)	30 (22.1)	
Medicare	109 (81.3)	106 (77.9)	
CCI score category, n (%)			.6
Low (0-2)	16 (11.9)	22 (16.2)	
Moderate (3-4)	60 (44.8)	59 (43.4)	
High (>4)	58 (43.3)	55 (40.4)	
RLOS (d), mean ± SD	12.1±6.2	13.1±5.6	.14
Discharge setting, n (%)			<.001*
Home	76 (56.7)	118 (86.8)	
Acute care hospital	27 (20.2)	6 (4.4)	
Skilled nursing facilities	31 (23.1)	12 (8.8)	
Acutely managed comorbidities, n (%)			
CHF	36 (26.9)	38 (27.9)	.84
Peripheral vascular disease	4 (3.0)	7 (5.2)	.54
Diabetes without chronic complications	27 (20.2)	40 (29.4)	.078
Renal disease, mild to moderate	20 (14.9)	18 (13.2)	.69
Liver disease, mild	1 (0.8)	7 (5.2)	.066
Chronic pulmonary disease	4 (3.0)	5 (3.7)	.999
Myocardial infarction	3 (2.2)	7 (5.2)	.33
Diabetes with chronic complications	18 (13.4)	12 (8.8)	.23
Renal disease, severe	17 (12.7)	14 (10.3)	.54
Liver disease, moderate to severe	0	4 (2.9)	.12
Metastatic solid tumor	1 (0.8)	1 (0.7)	.999
AIDS	7 (5.2)	4 (2.9)	.38
Anemia†	18 (13.4)	24 (17.7)	.34
Atrial fibrillation†	40 (29.9)	38 (27.9)	.73
Respiratory failure†	1 (0.8)	3 (2.2)	.62
Acute pneumonia†	11 (8.2)	15 (11.0)	.43
Bacteremia†	0	2 (1.5)	.5
HTN†	90 (67.2)	73 (53.7)	.024‡
Orthostatic hypotension†	2 (1.5)	8 (5.9)	.1
OSA†	13 (9.7)	14 (10.3)	.87

NOTE. BMI calculated as weight in kilograms divided by height in meters squared.
Abbreviations: CHF, congestive heart failure; HTN, essential (primary) hypertension; OSA, obstructive sleep apnea.
* *P*<.001.
† Not included in CCI.
‡ *P*<.05.

efficiency of 2.3 in 270 medically complex patients. The mean RLOS, FIM efficiency, RTAC rate, and community discharge rate of medically complex patients were all better than their corresponding 15.82 days, 2.07, 13.83, and 70.9%, respectively, for all 1092 admissions at our facility in 2018. The mean FIM gain was similar between these 2 groups. Furthermore, RLOS, total FIM gain and FIM efficiency in this study were all better than their corresponding eRehabData-weighted national benchmarks (RLOS, 15.82 days; FIM gain, 25.57; FIM efficiency, 2.13) for a total of 202,520 discharges in 2018.[36] RTAC and community discharge of eRehabData-weighted national benchmarks for all discharges in 2018 were 11.62% and 72.32%, respectively, which are similar to our results. When compared with patients with

Table 3 Associations between FIM efficiency and characteristics in 270 medically complex patients

Characteristic	FIM efficiency <2.12 n=135	FIM efficiency ≥2.12 n=135	*P* Value
Age (y), mean ± SD	73.3±12.7	73.8±12.3	.77
BMI, mean ± SD	30.3±11.6	29.0±8.2	.28
Sex, n (%)			.33
Female	75 (55.6)	67 (49.6)	
Male	60 (44.4)	68 (50.4)	
Race, n (%)			.6
White	126 (93.3)	129 (95.6)	
Non-White	9 (6.7)	6 (4.4)	
Ethnicity, n (%)			.999
Hispanic	1 (0.7)	2 (1.5)	
Non-Hispanic	134 (99.3)	133 (99.5)	
Insurance type, n (%)			.13
Commercial insurance	33 (24.4)	22 (16.3)	
Medicare	102 (75.6)	113 (83.7)	
CCI score category, n (%)			.5
Low (0-2)	16 (11.9)	22 (16.2)	
Moderate (3-4)	59 (43.7)	60 (44.4)	
High (>4)	60 (44.4)	53 (39.2)	
RLOS (d), mean ± SD	14.5±7.0	10.7±3.8	<.001*
Discharge setting, n (%)			<.001*
Home	82 (60.7)	112 (83.0)	
Acute care hospital	20 (14.8)	13 (9.6)	
Skilled nursing facilities	33 (24.4)	10 (7.4)	
Acutely managed comorbidities, n (%)			
CHF	41 (30.4)	33 (24.4)	.28
Peripheral vascular disease	6 (4.4)	5 (3.7)	.999
Diabetes without chronic complications	31 (23.0)	36 (26.7)	.48
Renal disease, mild to moderate	20 (14.8)	18 (13.3)	.86
Liver disease, mild	1 (0.7)	7 (5.2)	.067
Chronic pulmonary disease	4 (3.0)	5 (3.7)	.999
Myocardial infarction	3 (2.2)	7 (5.2)	.33
Diabetes with chronic complications	17 (12.6)	13 (9.6)	.44
Renal disease, severe	20 (14.8)	11 (8.2)	.086
Liver disease, moderate to severe	0	4 (3.0)	.12
Metastatic solid tumor	1 (0.7)	1 (0.7)	.999
AIDS	8 (5.9)	3 (2.2)	.22
Anemia†	20 (14.8)	22 (16.3)	.74
Atrial fibrillation†	39 (28.9)	39 (28.9)	.999
Respiratory failure†	0	4 (3.0)	.12
Acute pneumonia†	8 (5.9)	18 (13.3)	.062
Bacteremia†	1 (0.7)	1 (0.7)	.999
HTN†	91 (67.4)	72 (53.3)	.025‡
Orthostatic hypotension†	5 (3.7)	5 (3.7)	.999
OSA†	16 (11.9)	11 (8.2)	.31

NOTE. BMI calculated as weight in kilograms divided by height in meters squared.
Abbreviations: CHF, congestive heart failure; HTN, essential (primary) hypertension; OSA, obstructive sleep apnea.
* $P<.001$.
† Not included in CCI.
‡ $P<.05$.

orthopedic diagnoses,[7] medically complex patients in this study performed better in total FIM gain but not in FIM efficiency. This is likely related to differences in length of stay, which is factored into the FIM efficiency calculation. To compare with the CMS "60% compliant diagnoses," total FIM gain in this study was lower than that in patients with stroke, Parkinson disease, and Guillain-Barre syndrome after inpatient rehabilitation, whereas their FIM efficiencies (1.6-2.04)[10] were lower than FIM efficiency in medically complex patients. In another study, total FIM gain and FIM efficiency in patients with stroke and TBI[7] were lower than those in medically complex patients. Therefore, medically complex patients greatly benefit from inpatient rehabilitation and should be recommended for acute inpatient rehabilitation.

Table 4 Associations between discharge settings and characteristics in 270 medically complex patients

Characteristic	Acute Care Hospital n=33	Home n=194	Skilled Nurse Facility n=43	*P* Value
Age (y), mean ± SD	67.2±15.1	73.7±11.9	78.0±11.4	<.001*
BMI, mean ± SD	30.0±15.0	29.7±9.2	29.1±9.3	.91
Sex, n (%)				.99
Female	17 (51.5)	102 (52.6)	23 (53.5)	
Male	16 (48.5)	92 (47.4)	20 (46.5)	
Race, n (%)				.43
White	30 (90.9)	185 (95.4)	40 (93.0)	
Non-White	3 (9.1)	9 (4.6)	3 (7.0)	
Ethnicity, n (%)				.38
Hispanic	1 (3.0)	2 (1.0)	0	
Non-Hispanic	32 (97.0)	192 (99.0)	43 (100.0)	
Insurance type, n (%)				<.001*
Commercial insurance	13 (39.4)	40 (20.6)	2 (4.6)	
Medicare	20 (60.6)	154 (79.4)	41 (95.4)	
CCI score category, n (%)				.98
Low (0-2)	5 (15.2)	28 (14.4)	5 (11.6)	
Moderate (3-4)	15 (45.5)	84 (43.3)	20 (46.5)	
High (>4)	13 (39.4)	82 (42.3)	18 (41.9)	
RLOS (d), mean ± SD	9.1±7.9	12.7±5.3	15.1±5.6	<.001*
FIM score at admission, mean ± SD				
Motor	33.0±10.4	37.1±8.8	35.7±9.6	.051
Cognitive	26.0±6.8	24.7±5.5	25.4±4.5	.4
Total subscales	59.0±14.7	61.8±11.4	61.1±12.1	.45
FIM score at discharge, mean ± SD				
Motor	45.4±15.8	62.1±11.2	52.8±11.1	<.001*
Cognitive	27.4±6.8	29.1±4.9	28.1±4.2	.14
Total subscales	72.8±20.6	91.2±14.4	80.9±13.8	<.001*
Acutely managed comorbidities, n (%)				
CHF	9 (27.3)	53 (27.3)	12 (27.9)	>.99
Peripheral vascular disease	3 (9.1)	8 (4.1)	0	.12
Diabetes without chronic complications	5 (15.2)	50 (25.8)	12 (27.9)	.4
Renal disease, mild to moderate	1 (3.0)	28 (14.4)	9 (20.9)	.059
Liver disease, mild	0	7 (3.6)	1 (2.3)	.85
Chronic pulmonary disease	2 (6.1)	7 (3.6)	0	.34
Myocardial infarction	1 (3.0)	9 (4.6)	0	.44
Diabetes with chronic complications	6 (18.2)	20 (10.3)	4 (9.3)	.39
Renal disease, severe	5 (15.2)	23 (11.9)	3 (7.0)	.48
Liver disease, moderate to severe	0	4 (2.1)	0	>.99
Metastatic solid tumor	2 (6.1)	0	0	.015†
AIDS	2 (6.1)	9 (4.6)	0	.32
Anemia‡	8 (24.2)	28 (14.4)	6 (14.0)	.35
Atrial fibrillation‡	7 (21.2)	53 (27.3)	18 (41.9)	.1
Respiratory failure‡	1 (3.0)	3 (1.6)	0	.5
Acute pneumonia‡	4 (12.1)	18 (9.3)	4 (9.3)	.8
Bacteremia‡	0	2 (1.0)	0	>.99
HTN‡	21 (63.6)	114 (58.8)	28 (65.1)	.69
Orthostatic hypotension‡	0	9 (4.6)	1 (2.3)	.59
OSA‡	4 (12.1)	19 (9.8)	4 (9.3)	.9

NOTE. BMI calculated as weight in kilograms divided by height in meters squared.
Abbreviations: CHF, congestive heart failure; HTN, essential (primary) hypertension; OSA, obstructive sleep apnea.
* $P<.05$.
† $P<.001$.
‡ Not included in CCI.

Patients with total FIM gain ≥27 were more likely to be discharged to home than those with total FIM gain <27 (86.8% vs 56.7%; $P<.001$), less likely to be discharged to an SNF (8.8% vs 23.1%; $P<.001$), and less likely to be discharged to RTAC (4.4% vs 20.2%; $P<.001$). Similarly, patients with FIM efficiency ≥2.12 had a shorter RLOS than those with FIM efficiency <2.12 (3.8 days vs 7.0 days; $P<.001$), were more likely to be discharged to home (83% vs 60.7%; $P<.001$), less

Table 5 Adjusted* logistic regression for relationships between discharge destination and FIM total gain and FIM efficiency

Discharge Settings	OR (95% CI)	
	FIM Total Gain	FIM Efficiency
Home (n=194)	Reference	Reference
Acute care hospital (n=33)	0.11 (0.04-0.34)†	0.29 (0.12-0.73)‡
Skilled nursing facilities (n=43)	0.22 (0.10-0.49)†	0.25 (0.11-0.56)†

* Adjusted for age, BMI, sex, insurance type, CCI category, RLOS, and HTN.
† *P*<.001.
‡ *P*<.05.

Table 6 Reasons for RTAC in 33Sof 270 medically complex patients

Reason	Frequency (%)
Cardiac (chest pain, NSTEMI, third degree block, bradycardia, or tachycardia)	21.2
Pulmonary (PE, hypoxia, PNA, malignant pleural effusion, or pneumothorax)	21.2
Acute blood loss anemia (GIB on anticoagulation or postoperative bleeding)	21.2
Infection (postoperative wound infection, neutropenic fever, sepsis, or osteomyelitis)	15.2
Neurologic (aphasia, severe headache, or altered mental status)	12.2
Others (subtherapeutic INR for LVAD, SBO, or CKD with decreased urine output)	9.0

Abbreviations: CKD, chronic kidney disease; GIB, gastrointestinal bleed; INR, international normalized ratio; LVAD, left ventricular assist device; NSTEMI, non-ST segment elevation myocardial infarction; PE, pulmonary embolism; PNA, pneumonia; SBO, small bowel obstruction.

likely to be discharged to an SNF (7.4% vs 24.4%; *P*<.001), and less likely to be emergently transferred (9.6% vs 14.8%; *P*<.001). These findings demonstrate an FIM gain of 27 or FIM efficiency of 2.12 predicts a high likelihood of home discharge and low likelihood of RTAC. However, discharge dispositions are multifactorial, including motor and cognitive functional status on admission or at discharge, socioeconomic situation, level of assistance that family or a caregiver can provide, and home setup.[7,23,24,37] Medically complex patients usually having slower and/or chronic onset of impairments may have the advantage of being more likely to have an already established social support system and thus be more likely to be able to go home than those who have acute functional impairments secondary to a stroke.

HTN was the only comorbidity that negatively affected the total FIM gain and FIM efficiency in this study. There was no association observed between total FIM gain or FIM efficiency and patient age, BMI, sex, race, ethnicity, insurance type, RLOS, or CCI. However, it is possible that 1 or more comorbidities, in addition to HTN, that may be associated with rehabilitation outcomes were not captured in this study. The lack of association between total FIM gain or FIM efficiency and comorbidities is consistent with a previous study that reported that preexisting medical comorbidities had no effect on admission or discharge FIM scores in the postorthopedic surgery group, although the premorbid conditions were associated with lower admission and discharge FIM scores in the population with TBI.[7] Similarly, no association between comorbidities and RLOS, total FIM gain, or community discharge rate was demonstrated in a study consisting of 280 patients (26% with ischemic/hemorrhagic stroke, 22% with other neurologic conditions, 52% with orthopedic conditions).[38]

Metastatic solid tumors were the only comorbidity associated with RTAC in our study (n=2, 6.1%; *P*=.015). However, only 2 patients with metastatic solid tumors in our study weakened this association. Alam et al reported that patients with neoplasms experience higher transfer rates than those without neoplasms because of increased susceptibility to infection.[39] Lack of correlation between comorbidities and RTAC observed in this study is consistent with previous studies showing that medical comorbidities were not associated with RTAC, and functional status better predicted RTAC in patients with stroke, traumatic SCI, and other conditions.[22,40,41] A recent study confirmed an increased risk for RTAC from a freestanding IRF when compared with IRFs housed within an acute care hospital.[42] A recent narrative review further provides strong evidence that the principal predictors of RTAC are lower functional status on admission, more severe injury, and higher numbers of comorbidities.[43] This review also highlights that RTAC is a complex, multifactorial patient issue with a complex interplay between the predictors and reasons for RTAC.[43]

The 5 most common reasons for RTAC in this study were cardiac, pulmonary, and acute blood loss anemia (21.1% for each category); infection (15.2%); and neurologic (12.2%) conditions, consistent with previous findings.[8,9] The most common medical reasons for RTAC are infection (27%), neurologic (27%), and noninfectious respiratory (16%) conditions in patients with nontraumatic SCI.[9] Hammond et al reported that the most common RTAC reasons were surgery (36%), infection (22%), noninfectious respiratory conditions (14%), and gastrointestinal conditions (8%).[8] Therefore, knowing those potentially preventable conditions and then optimally managing them should be one of the focuses of our inpatient rehabilitation clinicians to reduce preventable RTAC, improve overall rehabilitation outcomes, and lower the cost.

Study limitations

This study had several limitations. This was a single-center retrospective study at a freestanding IRF, which may limit the ability to extrapolate results to inpatient rehabilitation units located within acute care hospitals. All study participants were admitted under the care of 1 attending physician, introducing the possibility of selection bias. The patient population in our study was predominantly White and non-Hispanic and therefore may not have captured racial or ethnic disparities, if present. Additionally, there are limitations associated with only 2 levels of FIM gain or FIM efficiency as rehabilitation measures using the median dichotomy design that fails to reflect the association between variables and outcome measures. We did not capture other factors that could affect medical complexity, such as concurrent psychiatric diagnoses, family and/or social support during and/or after acute care hospitalization and in the rehabilitation setting, cognitive impairment, and socioeconomic challenges. Further research allowing for these variables may find significant associations with other aspects of a patient's complexity that could lead to better FIM gains and increased home dispositions.

Conclusions

Although admission of medically complex patients to an IRF does not contribute to compliance with CMS's "60 Percent Rule," there is ample evidence to support the benefits of acute inpatient rehabilitation on functional outcomes in this patient population. Except for HTN, no comorbidity or demographic variables were associated with functional outcomes in our study. Cardiac, pulmonary, acute blood loss anemia, infection, and neurologic conditions were the most common reasons for RTAC, and a focus on medical optimization in these areas may reduce unanticipated acute care transfers in medically complex patients. Medically complex patients in our study had better functional outcomes (total FIM gain, FIM efficiency, RLOS) than eRehabData-weighted national benchmarks, further supporting acute inpatient rehabilitation for this patient population.

Supplier

a. SAS version 9.4; SAS Institute, Cary, NC.

Corresponding author

Shangming Zhang, MD. *E-mail address:* szhang5@pennstatehealth.psu.edu.

References

1. de Andrade DC, Jacobsen Teixeira M, Galhardoni R, et al. Pregabalin for the prevention of oxaliplatin-induced painful neuropathy: a randomized, double-blind trial. Oncologist 2017;22:1154-e105.
2. Centers for Medicare and Medicaid Services, Department of Health and Human Services. Inpatient rehabilitation facility prospective payment system. Available at: https://www.cms.gov/Medicare/Medicare-Fee-for-Service-Payment/InpatientRehabFacPPS/Criteria. Accessed June 10, 2021.
3. Scrutinio D, Monitillo V, Guida P, et al. functional gain after inpatient stroke rehabilitation: correlates and impact on long-term survival. Stroke 2015;46:2976-80.
4. Lin C, Katkar M, Lee J, Roth E, Harvey RL, Prabhakaran S. Functional measures upon admission to acute inpatient rehabilitation predict quality of life after ischemic stroke. Arch Phys Med Rehabil 2019;100:481-7.
5. Chan V, Mollayeva T, Ottenbacher KJ, Colantonio A. Sex-specific predictors of inpatient rehabilitation outcomes after traumatic brain injury. Arch Phys Med Rehabil 2016;97:772-80.
6. Hammond FM, Horn SD, Smout RJ, et al. Readmission to an acute care hospital during inpatient rehabilitation for traumatic brain injury. Arch Phys Med Rehabil 2015;96(8 Suppl):S293-303.
7. Lew HL, Lee E, Date ES, Zeiner H. Influence of medical comorbidities and complications on FIM change and length of stay during inpatient rehabilitation. Am J Phys Med Rehabil 2002;81:830-7.
8. Hammond FM, Horn SD, Smout RJ, et al. Acute rehospitalizations during inpatient rehabilitation for spinal cord injury. Arch Phys Med Rehabil 2013;94(4 Suppl):S98-105.
9. Robinson DM, Bazzi MS, Millis SR, Bitar AA. Predictors of readmission to acute care during inpatient rehabilitation for non-traumatic spinal cord injury. J Spinal Cord Med 2018;41:444-9.
10. Andrews AW, Middleton A. Improvement during inpatient rehabilitation among older adults with Guillain-Barré syndrome, multiple sclerosis, Parkinson disease, and stroke. Am J Phys Med Rehabil 2018;97:879-84.
11. Monticone M, Ambrosini E, Laurini A, Rocca B, Foti C. In-patient multidisciplinary rehabilitation for Parkinson's disease: a randomized controlled trial. Mov Disord 2015;30:1050-8.
12. Venkataraman K, Fong NP, Chan KM, et al. Rehabilitation outcomes after inpatient rehabilitation for lower extremity amputations in patients with diabetes. Arch Phys Med Rehabil 2016;97:1473-80.
13. Schneider JC, Gerrard P, Goldstein R, et al. The impact of comorbidities and complications on burn injury inpatient rehabilitation outcomes. PM R 2013;5:114-21.
14. Mathew RO, Hsu WH, Young Y. Effect of comorbidity on functional recovery after hip fracture in the elderly. Am J Phys Med Rehabil 2013;92:686-96.
15. Gallegos-Kearin V, Knowlton SE, Goldstein R, et al. Outcome trends of adult cancer patients receiving inpatient rehabilitation: a 13-year review. Am J Phys Med Rehabil 2018;97:514-22.
16. Fu JB, Raj VS, Guo Y. A guide to inpatient cancer rehabilitation: focusing on patient selection and evidence-based outcomes. PM R 2017;9:S324-34.
17. Scalvini S, Grossetti F, Paganoni AM, La Rovere MT, Pedretti RF, Frigerio M. Impact of in-hospital cardiac rehabilitation on mortality and readmissions in heart failure: a population study in Lombardy, Italy, from 2005 to 2012. Eur J Prev Cardiol 2019;26:808-17.
18. Zanini M, Nery RM, de Lima JB, Buhler RP, da Silveira AD, Stein R. Effects of different rehabilitation protocols in inpatient cardiac rehabilitation after coronary artery bypass graft surgery: a randomized clinical trial. J Cardiopulm Rehabil Prev 2019;39:E19-25.
19. Motoki H, Nishimura M, Kanai M, et al. Impact of inpatient cardiac rehabilitation on Barthel Index score and prognosis in patients with acute decompensated heart failure. Int J Cardiol 2019;293:125-30.
20. Leung J, Smith S, Kalpakjian C. Functional outcomes of acute inpatient rehabilitation in patients with chronic graft-versus-host disease. PM R 2018;10:567-72.
21. Shih SL, Gerrard P, Goldstein R, et al. Functional status outperforms comorbidities in predicting acute care readmissions in medically complex patients. J Gen Intern Med 2015;30:1688-95.
22. Shih SL, Zafonte R, Bates DW, et al. Functional status outperforms comorbidities as a predictor of 30-day acute care readmissions in the inpatient rehabilitation population. J Am Med Dir Assoc 2016;17:921-6.
23. Tan WS, Heng BH, Chua KS, Chan KF. Factors predicting inpatient rehabilitation length of stay of acute stroke patients in Singapore. Arch Phys Med Rehabil 2009;90:1202-7.
24. Giaquinto S. Comorbidity in post-stroke rehabilitation. Eur J Neurol 2003;10:235-8.

25. Horn SD, Smout RJ, DeJong G, et al. Association of various comorbidity measures with spinal cord injury rehabilitation outcomes. Arch Phys Med Rehabil 2013;94(4 Suppl):S75–86.
26. Ferriero G, Franchignoni F, Benevolo E, Ottonello M, Scocchi M, Xanthi M. The influence of comorbidities and complications on discharge function in stroke rehabilitation inpatients. Eura Medicophys 2006;42:91–6.
27. Karatepe AG, Gunaydin R, Kaya T, Turkmen G. Comorbidity in patients after stroke: impact on functional outcome. J Rehabil Med 2008;40:831–5.
28. Chen AY, Zagorski B, Parsons D, Vander Laan R, Chan V, Colantonio A. Factors associated with discharge destination from acute care after acquired brain injury in Ontario, Canada. BMC Neurol 2012;12:16.
29. Liu M, Domen K, Chino N. Comorbidity measures for stroke outcome research: a preliminary study. Arch Phys Med Rehabil 1997;78:166–72.
30. Goldstein LB, Samsa GP, Matchar DB, Horner RD. Charlson Index comorbidity adjustment for ischemic stroke outcome studies. Stroke 2004;35:1941–5.
31. Lin JJ, Kaplan RJ. Multivariate analysis of the factors affecting duration of acute inpatient rehabilitation after hip and knee arthroplasty. Am J Phys Med Rehabil 2004;83:344–52.
32. Rudra RT, Lin D, Miller B, Du P, Zhang S. Investigating inpatient rehabilitation outcomes of patients with intensive care unit-acquired weakness, and identifying comorbidities associated with unfavorable outcomes. PM R 2021 Feb 2. [Epub ahead of print].
33. Austin SR, Wong YN, Uzzo RG, Beck JR, Egleston BL. Why summary comorbidity measures such as the Charlson Comorbidity Index and Elixhauser score work. Med Care 2015;53:e65–72.
34. Glasheen WP, Cordier T, Gumpina R, Haugh G, Davis J, Renda A. Charlson Comorbidity Index. Am Health Drug Benefits 2019;12:188–97.
35. Linacre JM, Heinemann AW, Wright BD, Granger CV, Hamilton BB. The structure and stability of the Functional Independence Measure. Arch Phys Med Rehabil 1994;75:127–32.
36. eRehabData. Welcome to eRehabData.com. Available at: https://web2.erehabdata.com/erehabdata/index.jsp. Accessed June 30, 2021.
37. Bottemiller KL, Bieber PL, Basford JR, Harris M. FIM score, FIM efficiency, and discharge disposition following inpatient stroke rehabilitation. Rehabil Nurs 2006;31:22–5.
38. New PW, Earnest A, Scroggie GD. A comparison of two comorbidity indices for predicting inpatient rehabilitation outcomes. Eur J Phys Rehabil Med 2017;53:493–500.
39. Alam E, Wilson RD, Vargo MM. Inpatient cancer rehabilitation: a retrospective comparison of transfer back to acute care between patients with neoplasm and other rehabilitation patients. Arch Phys Med Rehabil 2008;89:1284–9.
40. Slocum C, Gerrard P, Black-Schaffer R, et al. Functional status predicts acute care readmissions from inpatient rehabilitation in the stroke population. PLoS One 2015;10:e0142180.
41. Huang D, Slocum C, Silver JK, et al. Functional status predicts acute care readmission in the traumatic spinal cord injury population. J Spinal Cord Med 2019;42:20–31.
42. Shea CA, Turcu R, Wong BS, et al. Variation in 30-day readmission rates from inpatient rehabilitation facilities to acute care hospitals. J Am Med Dir Assoc 2021;22:2461–7.
43. McKechnie D, Pryor J, McKechnie R, Fisher MJ. Predictors of readmission to acute care from inpatient rehabilitation: an integrative review. PM R 2019;11:1335–45.