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Inpatient Rehabilitation Outcomes Following Severe COVID-19 Infections: A Retrospective Cohort Study

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Abstract

Objective: To describe the characteristics and functional outcomes of patients undergoing acute inpatient rehabilitation following hospitalization for COVID-19.

Design: Using a retrospective chart review, patients were identified who were admitted to inpatient rehabilitation following COVID-19. Patient information collected included socio-demographic characteristics, comorbidities, length of stay, discharge disposition, and self-care, mobility, and cognitive functioning. These patients were compared to patients (controls) without COVID-19 with similar impairment codes treated at the same facility before the COVID-19 pandemic.

Results: There were 43 patients who were admitted to the inpatient rehabilitation hospital following COVID-19 infection and 247 controls. Patients who had COVID-19 were significantly more likely to be African American and to have been admitted to a long-term acute care hospital. They also had a longer length of rehabilitation stay. The groups did not differ by age, gender, or insurance. Functionally, although presenting with significantly worse mobility, self-care, and motor scores, the patients previously infected with COVID-19 had similar functional outcomes at time of discharge to the control group.

Conclusions: While patients with a history of COVID-19 had worse function at time of admission to acute rehabilitation, inpatient rehabilitation significantly improved their function to comparable levels as patients who did not have COVID-19.

Keywords

Inpatient Rehabilitation; COVID-19; Post-ICU Syndrome; Long-COVID; Post-Acute Sequelae of SARS-CoV-2 infection

Introduction

The coronavirus disease 2019 (COVID-19) pandemic has led to over two million hospitalizations in the United States,¹ of whom 15–25% required admission to the intensive care unit (ICU).^{2–4} Common complications of those hospitalized with COVID-19 include acute respiratory failure, acute respiratory distress syndrome, acute kidney failure, sepsis, shock, acute ischemic heart disease, neurologic disorders, and venous thromboembolism.⁴

One potential adverse outcome following hospitalization, particularly among those requiring ICU admission and mechanical ventilation, is post-ICU syndrome (PICS). PICS is a constellation of new or worsening cognitive, functional, and psychiatric functioning following critical illness.⁵ It has been estimated to occur in more than half of ICU survivors and residual effects can last beyond 12 months following hospital discharge.⁶ In the physical domain, PICS often manifests as generalized weakness, critical illness polyneuropathy (CIP), and critical illness myopathy (CIM).

Recent evidence suggests that individuals infected with COVID-19 may develop PICS at higher rates than other critically ill populations. A small observational cohort study of 111 individuals found that 9.9% of ICU patients infected with COVID-19 developed CIP/CIM compared to 3.4% of a general ICU population.⁷ In addition to PICS, individuals previously infected COVID-19 report a wide variety of persistent symptoms, including cognitive dysfunction (also known as “brain fog”), anxiety, depression, dyspnea, fatigue, poor endurance, and insomnia.^{8–12} These symptoms can occur even in COVID-19 patients who were not hospitalized during their acute illness and is collectively known as Post-Acute Sequelae of SARS-CoV-2 Infection (PASC).¹³ The extent to which patients who were critically ill from COVID-19 have a similar post-acute course compared with patients who were critically ill for other reasons remains unknown.

Rehabilitation services provided in an inpatient setting is potentially well-suited to mitigate the debilitating sequelae of COVID-19 and related complications.^{14,15} Despite the potential benefit of post-acute inpatient rehabilitation, only 4% of patients hospitalized with COVID-19 in the United States between March and August of 2020 were discharged to ongoing care (including long term acute care and acute inpatient rehabilitation).¹⁶

The purpose of this study was to describe the characteristics and functional outcomes of a population of COVID-19 survivors receiving inpatient rehabilitation at an urban rehabilitation hospital and to compare them to a population who received inpatient rehabilitation for similar, although non-COVID-19, related impairments.

Methods

Setting.

The study was performed at the Penn Institute for Rehabilitation Medicine, an academic rehabilitation hospital located in Philadelphia, PA. This work was done under the University of Pennsylvania IRB through an approved research protocol. IRB waived the requirement for written informed consent. This study conforms to ALL Strobe guidelines and reports the required information accordingly (see Supplementary Checklist).

Study Design and Variable Definitions.

This retrospective cohort study includes all consecutive, unique patients admitted to inpatient rehabilitation hospital from May 1 to November 15, 2020 following a hospitalization primarily for COVID-19 infection and related complications. Patients who tested positive for COVID-19 during their inpatient hospitalization were not included if their primary reason for admission was felt to be due to other causes by the study team. To maximize comparability, the comparator cohort of non-COVID-19 infected inpatient rehabilitation patients was restricted to those admitted with impairment codes of “debility,” “other pulmonary,” and “polyneuropathy,” which were the most common rehabilitation admission impairment codes for the COVID-19 infected population (accounting for 86% of impairment codes). Only patients who were admitted in 2019 were included in the comparison group in order to ensure a population completely free of individuals with COVID-19.

Information regarding these patients, as well as the comparative patient population was obtained from the Uniform Data System for Medical Rehabilitation database, which is used to track outcomes from over 80% of inpatient rehabilitation facilities in the U.S. Data collected included demographics (e.g. age, gender, ethnicity, insurance status, and pre-admission living arrangement), presence of comorbid conditions (as defined by ICD-10 codes) and impairment codes at admission. In addition, data was collected on admission source, length of stay (LOS), and discharge disposition.

Assessment and Functional Measures.

All patients underwent a customized inpatient rehabilitation protocol, which included therapies aimed at improving mobility, self-care and independent functioning. All patients had at least three hours of therapy per day, a minimum of five days per week, which included physical therapy and occupational therapy. If needed, speech therapy was included in the three hours per day total.

All admitted patients underwent the same standardized assessments. Functional assessments conducted at the time of admission evaluated the patient’s motor and cognitive functioning.

Self-care and mobility were assessed at time of admission and time of discharge using the summed totals from items included in Section GG0130 (self-care) and GG1070 (mobility) of IRF-PAI Version 3.0. The IRF-PAI is required by the Centers for Medicare & Medicaid Services for all inpatient rehabilitation facilities and gathers data on the outcomes of

inpatient rehabilitation. Section GG is comprised of a standardized set of patient assessments outlined in the Post-Acute Care Transformation Act (IMPACT). Self-care measures include eating, oral hygiene, toilet hygiene, shower/bathing, upper body dressing, lower body dressing, and putting on/taking off footwear. Mobility measures include abilities to roll left and right in bed, to go from sitting to lying and vice versa while in bed, to go from sit to stand, to transfer (from toilet, chair, and car), to walk several distances and surfaces and to take stairs. Each item is scored on an ordinal scale from 1 (dependent) to 6 (independent).¹⁷ These measures have undergone a rigorous analysis by CMS to demonstrate reliability and validity.¹⁸

Other required elements of the IRF-PAI include the Quality Indicator (QI) motor score and the Brief Interview for Mental Status (BIMS). The QI motor score is a weighted sum of functioning in dimensions of: eating, oral hygiene, toileting, showering/bathing, upper and lower body dressing, including footwear, sit to lying, lying to sitting on side of bed, sit to stand, transferring and walking. It also includes assessments of bladder and bowel continence. Cognitive functioning was assessed using the Brief Interview for Mental Status¹⁹, which is a short performance-based cognitive measure for inpatient rehabilitation and skilled nursing home patients.

Data Analysis.

The cohort of COVID-19 inpatient rehabilitation patients at the study health system was compared to inpatient rehabilitation patients treated in 2019 (i.e., non-COVID-19 infected patients) at the same facility using standard t- and Fisher's exact statistical tests.

Results

Table 1 presents summary statistics for the 43 COVID-19 inpatient rehabilitation patients included in the study cohort. Four patients had a history of a positive COVID test incidental to their main reason for admission and were excluded from analysis (one traumatic brain injury, one traumatic spinal cord injury, one non-traumatic spinal cord injury and one amputation). Of those 43, 25 (58%) were African-American, 12 (28%) white, 2 (5%) were Hispanic, 4 (9) belonged to other ethnic groups or were unknown. The mean age of the group was 62.6 years old (SD=12.5 years) and 26 (60%) were male. 8 (19%) were covered by Medicaid insurance plans and 20 (47%) had a Medicare plan. 5 (12%) lived alone at the time of their admission. The mean BMI was 30.1 (SD=7.9). The mean LOS in the rehabilitation hospital among COVID-19 patients was 20.5 days (SD=11.8 days). Nearly three-quarters, 31 (72%), were discharged from rehabilitation to home (with or without home health), 5 (12%) to a skilled nursing facility and 5 (12%) were transferred back to an acute care hospital.

As shown in Table 1, inpatient rehabilitation patients admitted with a primary diagnosis of COVID-19 differed from the non-COVID-19 group in several dimensions. COVID-19 patients were nearly three times more likely to be African American/Black (58.0% vs. 19.4%, respectively, $p < 0.001$), were more likely to be admitted from a long-term acute care hospital (18.6% vs 4.9%, $p < 0.0001$), and had a significantly longer LOS in rehabilitation (20.5 vs. 14.3 days, $p = 0.033$). Although there was no statistically significant difference in

the likelihood of discharge home (with or without home health care), COVID-19 patients were less likely to be readmitted to an acute care hospital (11.6% vs. 19.8%, $p=0.04$) but more likely to be discharge to a SNF (11.6% vs. 5.7%, $p=0.04$) than non-COVID-19 patients.

In Table 2, we present and contrast the health and functioning characteristics at admission of COVID-19 and non-COVID-19 patients admitted to inpatient rehabilitation. COVID-19 patients had lower QI motor scores at admission than their non-COVID-19 counterparts (48.2 vs. 57.8, respectively, $p=0.0001$). Differences in cognitive functioning at admission were smaller in magnitude and not statistically significant at conventional levels (12.7 vs. 13.4, respectively, $p=0.14$). In the lower panel of Table 2, we describe the top twenty comorbidities and complications by ICD-10 codes of patients admitted to inpatient rehabilitation with COVID-19.

Figure 1 shows self-care and mobility functioning scores at admission and discharge for COVID-19 and non-COVID-19 inpatient rehabilitation patients. For both metrics, COVID-19 patients scored lower at admission than their non-COVID-19 counterparts. For self-care, COVID-19 patients scored 2.6 points lower than non-COVID-19 patients (21.5 vs. 24.1, $p=0.02$). Differences were more pronounced with respect to mobility scores with COVID-19 patients scoring on average 8.8 points less than the non-COVID-19 group (28.6 vs. 37.4, $p<0.0001$). There was no difference across groups in the discharge assessments for either metric, suggesting that inpatient rehabilitation improved functioning of COVID-19 patients to the level of non-COVID-19 individuals, despite their lower functioning at admission. On average, there was a 41% improvement in self-care scores among COVID-19 patients from 21.5 at admission to 30.3 at discharge ($p=0.01$). Mobility scores improved by 93% from 28.6 to 55.1 ($p<0.001$). Improvements in self-care and mobility functioning between admission and discharge, although evident, were less marked for non-COVID-19 patients (26% and 54% increase in scores, respectively).

Discussion

COVID-19 is a disease characterized by damage to multiple organ systems and can lead to significant physical and cognitive impairment along with PICS in those who were critically ill. Despite this, few patients hospitalized with COVID-19 infection are discharged to acute rehabilitation and the characteristics and outcomes of these patients are unknown. Those persons admitted to inpatient rehabilitation likely represent patients with the most profound impairments following their acute infections.

The current study found that COVID-19 patients had significantly lower functional status at admission to inpatient rehabilitation relative to non-COVID-19 patients admitted with similar impairment codes. The current data also suggest that COVID-19 patients are more medically complex, as evidenced by their higher rate of admissions from long term acute care hospitals (LTACHs) and longer length of stay. Perhaps most importantly, despite greater deficits at admission, COVID-19 infected patients eventually reach similar functional outcomes and were less likely to be readmitted to the acute care hospital than those admitted to inpatient rehabilitation with etiologies not due to COVID-19 infection.

Our study contributes to the emerging literature on the benefits of rehabilitation to patients admitted to inpatient rehabilitation following COVID-19 infection. Three European studies have demonstrated improvement following inpatient rehabilitation programs. Improvements were found in physical performance status, ability to perform ADLs, and pulmonary measures. These studies have limited comparability to the current study given significantly lower amount of time in rehabilitation, greater focus on pulmonary rehabilitation, and lack of a comparison group.²⁰⁻²²

There have also been a limited number of studies describing the characteristics and outcomes of patients undergoing inpatient rehabilitation following hospitalization with COVID-19 in the United States. Olezene et al. (2021) evaluated the effectiveness of inpatient rehabilitation for 29 patients presenting following COVID-19 infection, showing statistically significant improvements in mobility, cognition, speech, swallowing and balance by time of discharge.²³ Jain et al. (2021) examined the outcomes of 64 patients admitted to acute inpatient rehabilitation following COVID-19. They also compared 18 patients admitted to inpatient rehabilitation following an admission for COVID-19 to 18 patients with the same impairment code and similar ages. They found that individuals with COVID had similar functional outcomes, longer lengths of stay, and more cognitive symptoms compared to the comparison group.²⁴

The U.S. system of inpatient rehabilitation is highly formalized and regulated, guided by strict rules for admission and treatment, including the requirement of 15 hours per week of rehabilitation, mandated by the Centers for Medicare and Medicaid Services (CMS), the agency responsible for the largest public health insurance programs in the country. In contrast to previous literature, our study leverages these mandatory standardized assessments by using uniform outcome metrics, thereby enabling us to make more direct, valid comparisons across COVID and non-COVID patients both at admission and discharge.

Our findings highlight the potential of inpatient rehabilitation in restoring functioning of even the sickest patients with COVID-19. Patients in the study experienced marked improvement in their motor and self-care scores during their stay. By providing intensive therapies targeted at improving respiratory function, exercise endurance, and self-care with basic and instrumental ADLs, inpatient rehabilitation offers a promising pathway to mitigate some of the well-documented long-term sequelae of COVID-19.²⁵⁻²⁸

Patients admitted to the study inpatient rehabilitation facility following COVID-19 infection were almost three times more likely to be African American/Black than the non-COVID-19 group. This finding is consistent with previous evidence suggesting that African Americans are more likely to test positive, to be hospitalized, and to experience more severe COVID-19-related outcomes.^{29,30} Taken together, the higher prevalence of African Americans receiving inpatient rehabilitation and the overall better outcomes of patients treated in this setting suggest that inpatient rehabilitation may be a means of reducing racial disparities in outcomes following COVID hospitalization. This is critically important as under-served and other marginalized patient populations may be unable to return to their pre-COVID independent living arrangement in the absence of these post-hospitalization resources compared to more affluent patients.

It is worth reiterating that in order to qualify as inpatient rehabilitation facility in the United States, at least 60% of admissions must be patients having one of 13 specific qualifying conditions. Debility following COVID-19, PICS and post-COVID-19 syndrome would generally not qualify outside of documented critical illness polyneuropathy. Furthermore, insurance providers often attempt to stop admissions to acute rehabilitation or may limit admissions to certain qualifying conditions. This study suggests that patients who were admitted with COVID-19 sequelae may also benefit from inpatient rehabilitation and CMS and insurance rules may need to be modified to accommodate this patient cohort.

There are several important limitations to this study. Given its retrospective nature, patients were only evaluated in a limited number of domains. There have been recommendations for a standardized set of comprehensive measures for the COVID patient population in order to more uniformly analyze treatment protocols and efficacy.³¹ In addition, patients admitted to acute rehabilitation are possibly a selected group more likely to benefit from such services. For this reason, our findings may not be generalizable to the larger population of SARS-CoV-2 infected patients. Finally, although we attempted to homogenize the samples by selecting the comparison group to be comprised of inpatient rehabilitation patients likely to suffering from non-COVID-related PICS, there may be unmeasured differences given the broad range of diagnoses in the comparison cohort (in addition to the baseline differences discussed). For these reasons, although consistent with the small but growing literature on the subject, our findings must be interpreted with caution as the greater improvement in the COVID-19 cohort may also represent a regression to the mean effect.

Despite these limitations, the use of validated standardized outcome measures applied consistently to COVID patients and a comparison group of non-COVID inpatient rehabilitation subjects admitted with similar impairments is a unique strength of this study. Use of impairment group codes is relevant as it is the measure used by Medicare and other third-party payers to determine expected outcomes, cost, reimbursement, and length of stay of acute inpatient rehabilitation. The comparison group was drawn from 2019, a time period when the inpatient rehabilitation units were under the same regulatory requirements and the same set of data metrics were routinely collected as part of the regulatory requirements for inpatient rehabilitation centers. Similar types of care were given and similar hours of care per week were provided across COVID-19 and the control group from a year earlier. This strengthens our findings and provides a benchmark for interpreting the functional outcomes of a smaller group of persons infected with COVID-19 undergoing acute inpatient rehabilitation.

Conclusion

While COVID-19 patients had worse function at the time of their admission, early patient-centered rehabilitation therapies received at an inpatient setting resulted in discharge outcomes similar to those of non-COVID patients, suggesting that inpatient rehabilitation is an effective strategy to restore functioning to the large and growing number of COVID-19 survivors.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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What is Known

COVID-19 leads to significant short and long-term morbidity and functional impairment.

What is New

Although initially presenting with significantly worse mobility and self-care, by the time of discharge, patients in inpatient rehabilitation following COVID-19 had similar functional outcomes compared to rehabilitation patients who did not have COVID-19 (although similar impairment codes). Comprehensive rehabilitation may be an effective way to improve functional outcomes following severe COVID-19 infection.

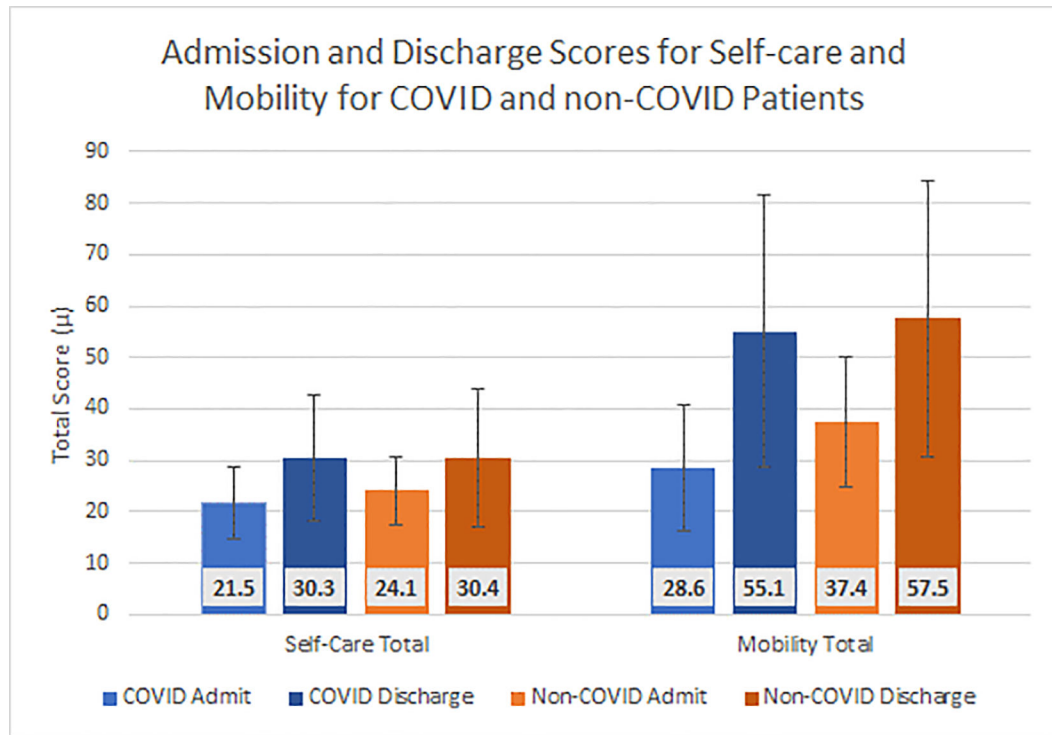


Figure 1. Admission and discharge scores for self-care and mobility for COVID and non-COVID patients.

Table 1.

Sociodemographic characteristics.

	COVID-19 Patients (N=43)	Non-COVID patients ^a N= (247)	p-value
Age, mean (SD), years	62.6 (12.5)	59.2 (14.8)	0.16
Male, No. (%)	26 (60)	154 (62)	0.82
Ethnicity, No. (%)			<0.0001
African American/Black	25 (58)	48 (19)	
Hispanic	2 (5)	11 (4)	
White	12 (28)	171 (69)	
Other/unknown	4 (9)	17 (7)	
Body Mass Index, mean (SD)	30.0 (7.9)	29.8 (23.3)	0.96
Primary Payer, No. (%)			0.39
Medicare FFS	13 (30)	88 (36)	
Medicare Advantage	7 (16)	37 (15)	
Medicaid	8 (19)	33 (13)	
HMO plan	4 (9)	49 (20)	
Private Insurance	11 (26)	40 (16)	
Pre-admit Living Arrangement, No. (%)			0.86
Alone	5 (12)	34 (14)	
With Family	36 (84)	194 (79)	
With Others	2 (5)	19 (8)	
Admission source=LTACH, No. (%)	8 (19)	12 (5)	0.0011
Length of Stay, mean (SD), days	20.5 (11.8)	14.3 (7.7)	<0.0001
Discharge Destination, No. (%)			0.04
Home without Home Health Services	2 (5)	41 (17)	
Home with Home Health Services	29 (67)	141 (57)	
Acute Re-hospitalization	5 (12)	49 (20)	
SNF	5 (12)	14 (6)	
Unknown	2 (5)	2 (1)	

^aNon-COVID patients refer to the subset of patients admitted to the study facility during 2019 (pre-pandemic) with impairment groups 16, 10.9, and 3.3.

Table 2.

Health and Functioning of COVID and non-COVID patients at admission

	COVID-19 Patients N=43	Non-COVID patients ^a N= 247	p-value
QI Motor Score at Admission, mean (SD)	48.2 (15.5)	57.8 (14.3)	0.0001
BIMS Summary Score at Admission mean (SD)	12.7 (4.0)	13.4 (2.6)	0.14
Comorbidities at Admission ^b , No. (%)			
Essential (primary) hypertension	20 (47)	82 (33)	0.092
Severe protein-calorie malnutrition	18 (42)	90 (36)	0.49
Dysphagia	17 (40)	61 (25)	0.043
Type 2 diabetes	15 (35)	54 (22)	0.06
Anemia	14 (33)	55 (22)	0.14
Hyperlipidemia	12 (28)	56 (23)	0.46
Obesity	11 (26)	26 (11)	0.006
Obstructive sleep apnea	10 (23)	37 (15)	0.17
Long term use of anticoagulants	10 (23)	45 (18)	0.43
Anxiety disorder	8 (19)	58 (24)	0.48
Gastro-esophageal reflux disease	8 (19)	85 (34)	0.041
Insomnia	8 (19)	24 (10)	0.085
Tracheostomy Present	8 (19)	21 (9)	0.042
Gastrostomy Tube Present	8 (19)	10 (4)	0.0002
Personal history of nicotine	8 (19)	44 (18)	0.90
Dependence on supplemental oxygen	7 (16)	6 (2)	<0.0001
History of Extracorporeal Membrane Oxygenation	6 (14)	36 (15)	0.92
Acute kidney failure	6 (14.0)	50 (20)	0.34
Major depressive disorder	5 (12)	40 (16)	0.44
Sacral Pressure Ulcer	5 (12)	13 (5)	0.11

^aNon-COVID patients refer to the subset of patients admitted to the study facility during 2019 (pre-pandemic) with impairment group codes of 16, 10.9, and 3.3.

^bSubset of 20 most prevalent comorbidities or complications (ICD-10 codes) documented at admission for the inpatient rehabilitation COVID population.