ORIGINAL RESEARCH

Measuring Discharge Outcomes, Length of Stay, and Functional ADL Score During COVID-19 in Inpatient Rehabilitation Hospitals

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Abstract

Objective: To measure discharge disposition, length of stay (LOS), and functional activities of daily living (ADL) scores for patients admitted to acute inpatient rehabilitation hospitals (IRHs) during the coronavirus disease 2019 (COVID-19) pandemic and to compare these parameters with a period prior to the pandemic.

Design: Retrospective cohort study via systematic retrospective chart review of consecutive patients admitted to IRHs from January 1-February 19, 2020 (pre−COVID-19T), and COVID-19 time period/patients admitted from April 1, 2020-May 9, 2020 (COVID-19T).

Setting: System of 3 IRHs in the Northeastern United States.

Participants: Pre−COVID-19T, n=739; COVID-19T, n=335, of whom n=139 were positive for COVID-19 (COVID+) and n=196 were negative (COVID−) (N=1074).

Interventions: Not applicable.

Main Outcome Measures: Discharge disposition, LOS, and functional ADL scores.

Results: COVID-19T patients were younger (*P*=.03) and less likely to be White (*P*=.03). These patients also had a higher case mix index (CMI; *P*<.01), longer acute care LOS (*P*<.01), and longer IRH LOS (*P*<.01). Patients who were COVID+ (during COVID-19T) were less likely to be White (*P*<.01), had lower CMI (*P*<.01), had higher admission and discharge functional ADL scores (*P*=.02, *P*<.01), and had longer acute care LOS compared with those who were COVID− (*P*<.01). There were no differences in discharge outcomes between pre−COVID-19T and COVID-19T cohorts (*P*=.75), including when stratified for COVID-19 status (*P*=.74). Functional ADL scores on admission and discharge were lower in COVID-19T than in pre−COVID-19T (*P*=.01), including when stratified for COVID-19 status though not significant (*P*=.06).

Conclusions: There were no differences in discharge outcomes for any group. IRH LOS was significantly increased during the pandemic, but there were no statistically significant differences between the COVID+ and COVID− cohorts within COVID-19T. Functional ADL scores were significantly lower during COVID-19T, but COVID status was not a significant predictor. This suggests that COVID+ status was not a barrier to discharge or functional outcomes. This supports the importance of IRHs to restore function and discharge patients to home, even with a more medically complex COVID-19 pandemic population.

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Coronavirus disease 2019 (COVID-19) is caused by the severe acute respiratory syndrome coronavirus 2,[1] and at the time of this article submission there have been over 175 million confirmed cases in the world[2] with over 33.2 million cases and 590,000 deaths in the United States.[3] Because of the severity and transmissibility of COVID-19,

early in the pandemic period many acute care hospitals (ACHs) operated over capacity[4] with limited essential medical equipment, supplies, medications, and interventions.[5,6] The need to discharge patients to postacute facilities including inpatient rehabilitation hospitals (IRHs), a term corresponding to Medicare's term inpatient rehabilitation facility, increased to facilitate availability of acute care beds[7-11] and for continued care of such debilitated patients.[11,12] Some IRHs converted into acute hospital units to support ACHs, and others

facilitated rehabilitative care of patients with impairments secondary to COVID-19.[10,11,13] This change required operational challenges to protect patients and staff from exposure to the virus while providing appropriate and comprehensive medical and rehabilitative care to the patients.[14]

Individuals who require comprehensive rehabilitation are often older, have multiple comorbidities, and require assistance to perform activities of daily living (ADL), and thus are among those most vulnerable to severe complications from COVID-19.[15] Under usual circumstances, discharge from an IRH is a complex process with numerous factors affecting success, including age, marital status, functional status, presence of depression, severity of illness, and premorbid living arrangement.[16] Typical discharge planning involves the collaboration of multiple professionals with the patient and family to plan the most appropriate location for an individual's discharge.[17] For those patients who were admitted to an IRH during the COVID-19 pandemic, given the changes in therapy, family training, and visitation, the discharge process was understandably disrupted. Prohibition of visitors to the hospital at the beginning of the pandemic limited almost all in-person family visitation,[18,19] requiring the use of phone and video conferencing to complete most education and training, potentially causing discharge delays. Additionally, nursing homes, a discharge option for those individuals who are unable to return home, were referred to as the "ground zero" of COVID-19,[20] with many of the initial outbreaks occurring in these facilities housing the population among the most vulnerable to the pandemic,[9,10,15,20-22] possibly discouraging unnecessary discharges to skilled nursing facilities (SNFs) from IRHs. Given these numerous changes to the discharge process and discharge dispositions, we sought to measure how discharge outcomes, length of stay (LOS), and functional ADL scores in patients in an IRH may have been affected during the early COVID-19 time period.

The purpose of this study was to measure discharge outcomes, LOS, and functional ADL scores within a system of 3 IRHs during the beginning of the COVID-19 time period/patients admitted from April 1, 2020-May 9, 2020 (COVID-19T) and to compare with the previous quarter (pre−COVID-19T), before the COVID-19 pandemic time period. We hypothesized the following: an increased proportion of discharges to home, longer LOS, and decreased functional ADL scores at discharge during COVID-19T.

Methods

This study was a retrospective cohort study performed via systematic chart review of patient discharge outcomes during the early

List of abbreviations:	
ACH	acute care hospital
ADL	activities of daily living
BMI	body mass index
CMI	case mix index
COVID-19	coronavirus disease 2019
COVID-19T	COVID-19 time period/patients admitted from April 1, 2020-May 9, 2020
GG	Functional Abilities and Goals subscale scores
IRH	inpatient rehabilitation facility
LOS	length of stay
LTACH	long-term acute care hospital
OR	odds ratio
pre-COVID-19T	pre-COVID-19 time period/patients admitted from January 1, 2020-February 19, 2020
SNF	skilled nursing facility

part of the COVID-19 pandemic. The study was approved by our affiliated institutional review board. Inclusion criterion included patients admitted to a system of 3 acute IRHs from April 1, 2020-May 9, 2020, considered the COVID-19 time period (COVID-19T) and correlating with the highest COVID-19 surge in New Jersey (the *International Classification of Diseases* 10th Revision code for COVID-19 was first introduced on April 1, 2020).[23,24] This cohort was compared with patients admitted from January 1, 2020-February 19, 2020 (pre−COVID-19T) for outcome measures. Exclusion criteria included those patients who expired during admission or who were found to be COVID positive (COVID+) while admitted to the IRH. The few patients who were believed to be COVID negative (COVID−) within the ACH but tested COVID+ upon IRH admission were excluded from the respective analysis because this study was aimed at evaluating patients recovering from COVID. For patients with multiple admissions (discharged and then subsequently readmitted within the same cohort time frame), only information from the first admission and discharge was included. The data collection process involved manual extraction from the electronic medical record for COVID+/COVID− status as well as running reports from large rehabilitation data repositories using specialized filters. The databases were merged and then the deidentified preselected factors of interest were analyzed by statisticians.

Descriptive analyses were conducted in R[a] to evaluate the association between variables in relation to time frame and COVID-19 status. Baseline demographic characteristics including age, body mass index (BMI), sex, and race were collected and compared between the different cohorts via Welch 2-sample *t* test or Pearson chi-square test. Analogous statistical methods were used to analyze acute care LOS, IRH LOS, and case mix index (CMI). CMI for patients admitted during respective time frames was extracted from the data repository and compared directly to assess medical complexity between cohorts[25,26] because this could confound discharge outcome and functional ADL score. Section GG: Functional Abilities and Goals subscale scores (GG Scores) from the Inpatient Rehabilitation Facility-Patient Assessment Instrument were combined to compare the functional and self-care status at IRH admission and discharge for the 2 cohorts, with a score of 1 representing dependence and score of 6 representing independence for each measured category.[27] (GG scores are functional measures standardized by Medicare,[28] similar to the previously measured functional independence measures, which were the previous functional measure set forth by Medicare.[29]) The following standardized subcategories of the GG scores were combined into a functional ADL score for every admitted IRH patient: eating, oral hygiene, toileting, shower/bathe, dressing (upper and lower), transfer bed to chair, transfer to toilet, walk 10 feet, walk 1 step, wheel within a wheelchair 50 feet, and bladder and bowel. In both the admission and discharge analyses, GG scores of 88, 10, 9, 7 (not attempted, not collected, not applicable, or refused, respectively) or those that contained a missing value were converted to align with case mix group calculation methodology.[29] Differences in functional ADL scores between the different patient cohorts were analyzed via Welch 2-sample *t* test. Finally, a Pearson chi-square test was used to evaluate the differences in racial background between patient cohorts.

Multinomial and linear regression models were performed to evaluate the association of different clinical variables including comorbidities, COVID-19 status, and demographic characteristics in relation to discharge disposition, IRH LOS, and functional ADL score at IRH discharge. Discharge dispositions were

stratified to the following: home/home with health aid, subacute rehabilitation/SNF, and hospital other than SNF (including ACHs, long-term ACHs [LTACHs], and hospice). For the discharge disposition regression analyses, discharge: SNF and race: Black were used as the null categories. The variables used in the discharge disposition regression model included age, BMI, race, ACH LOS, IRH LOS, change in functional ADL score, and CMI. For IRH LOS regression modeling, the variables evaluated included age, ACH LOS, change in functional ADL score, neurologic diagnosis, hypertension diagnosis, and CMI. Neurologic diagnosis was considered because neurologic manifestations are known to be very common in those affected by COVID-19.[30–33] Hypertension diagnosis was considered because of its known high association with COVID-19 infection, especially severe cases.[34,35] Finally, for discharge functional ADL score regression analysis, the following factors were analyzed: age, ACH LOS, neurologic diagnosis, and CMI. Change in functional ADL score as a variable in all regression models was calculated by subtracting the discharge functional ADL score from the admission functional ADL score. For regression models solely analyzing the COVID-19T patient population, COVID status was an additional variable for analysis. Model analyses were conducted utilizing R Studio version 1.3.1056[a] and considered statistically significant at $P<.05$.

Results

Baseline characteristics

A total of 1074 patients were included in this study, including 739 from the first quarter of 2020 (pre−COVID-19T) and 335 during the COVID-19 time period (COVID-19T). Within the COVID-19T group, 139 patients tested positive for COVID-19 and 196 patients tested negative for the virus within the ACH. One patient died during IRH admission (COVID-19T, COVID− patient) and 19 patients tested positive for COVID-19 upon IRH admission (previously negative at ACH). Therefore, 20 patients were excluded from all analyses per exclusion criteria. The difference in cohort size between pre−COVID-19T and COVID-19T is attributed to the decreased patient capacity during the pandemic

because all double/multiple-capacity rooms were adjusted to single occupancy.

The baseline characteristics of the patient records used in this study are shown in table 1. Analysis found several key differences between the patients admitted during pre−COVID-19T and COVID-19T. Patients admitted during COVID-19T were found to be significantly younger than those admitted during pre−COVID-19T (P=.03). The distribution of racial backgrounds of patients admitted was also statistically different between pre−COVID-19T and COVID-19T (P=.03), with COVID-19T having a lower percentage of White patients. Patients admitted in COVID-19T had higher LOS in acute care than patients in pre−COVID-19T ($P<.01$). Furthermore, CMI was also higher in the COVID-19T cohort with an average CMI of 1.73 vs 1.56 from pre−COVID-19T ($P<.01$).

A number of baseline characteristics were found to differ when stratifying COVID-19T patients by COVID status. Age was not found to be significantly different between COVID+ and COVID− patients. Notably, the distribution of racial background of COVID− patients differed significantly from COVID+ patients ($P<.01$). In particular, a significantly higher percentage of COVID+ patients identified as Other. BMI and sex were not found to be statistically different between admission time points or by COVID status. COVID+ patients, on average, had longer acute care LOS than COVID− patients ($P<.01$). Finally, CMI, which is often used as a surrogate marker of medical complexity of the patient,[25,26] was higher in COVID− patients with an average of 1.80 compared with 1.62 in COVID+ patients ($P<.01$).

Discharge disposition

Figure 1 and table 2 summarize the discharge destinations (home/home with health aid, SNF, hospital other than SNF) of patients admitted during pre−COVID-19T and COVID-19T and by COVID status within COVID-19T. Of note, 'hospital other than SNF' includes discharge to ACHs, LTACHs, and hospice. Because there were no patients discharged to a LTACH or hospice during COVID-19T, hospital other than SNF is equivalent to discharge to an ACH in this analysis. Overall, discharge disposition was not found to be statistically significant between pre−COVID-19T and COVID-19T (P=.75) (see table 2). Analogous testing found that

Table 1	Patient demographic characteristics (N=1074)						
Characteristics	Pre−COVID-19T	COVID-19T	P Value	COVID−	COVID+	P Value
No. of patients	739	335		196	139	
Age, mean ± SD	68.5±16.0	65.9±16.9	.03*	66.2±17.3	65.9±16.6	.87
Female, % (n)	48.4 (358)	44.0 (148)	.18	46.2 (91)	41.0 (57)	.35
BMI, mean ± SD	28.1±6.33	28.1±6.61	.89	27.6±6.00	28.9±7.36	.1
Race, % (n)			.03*			.003*
White	77.0 (569)	71.6 (240)		73.5 (144)	69.0 (96)	
Black	16.0 (118)	16.4 (55)		19.4 (38)	12.2 (17)	
Other	7.0 (52)	11.9 (40)		7.1 (14)	18.7 (26)	
IRH LOS, mean ± SD	16.7±12.8	18.8±10.9	.00*	19.6±11.8	17.7±9.50	.12
Admission mobility score, mean ± SD	28.5±9.35	24.4±9.38	7.97e-11*	23.5±9.25	25.8±9.47	.02*
Discharge mobility score, mean ± SD	44.0±17.4	41.0±18.0	.01*	38.3±17.4	44.9±18.32	.00*
Acute care hospital LOS, mean ± SD	10.7±16.7	14.9±12.7	9.94e-06*	12.3±12.3	18.5±12.5	8.95e-06*
Case mix index, mean ± SD	1.56±0.51	1.73±0.48	6.02e-07*	1.80±0.53	1.62±0.41	.00*

NOTE. Mobility score is a combination of Functional Abilities and Goals subscale scores of the following: eating, oral hygiene, toileting, shower/bathe, dressing (upper and lower), transfer bed to chair, transfer to toilet, walk 10 feet, walk 1 step, wheel 50 feet, and bladder and bowel. Functional Abilities and Goals subscale scores of 88, 10, 9, and 7 were converted to 1, because these values indicated scores not attempted, not collected, not applicable, or refused.
* Indicates statistical significance, $P<.05$.
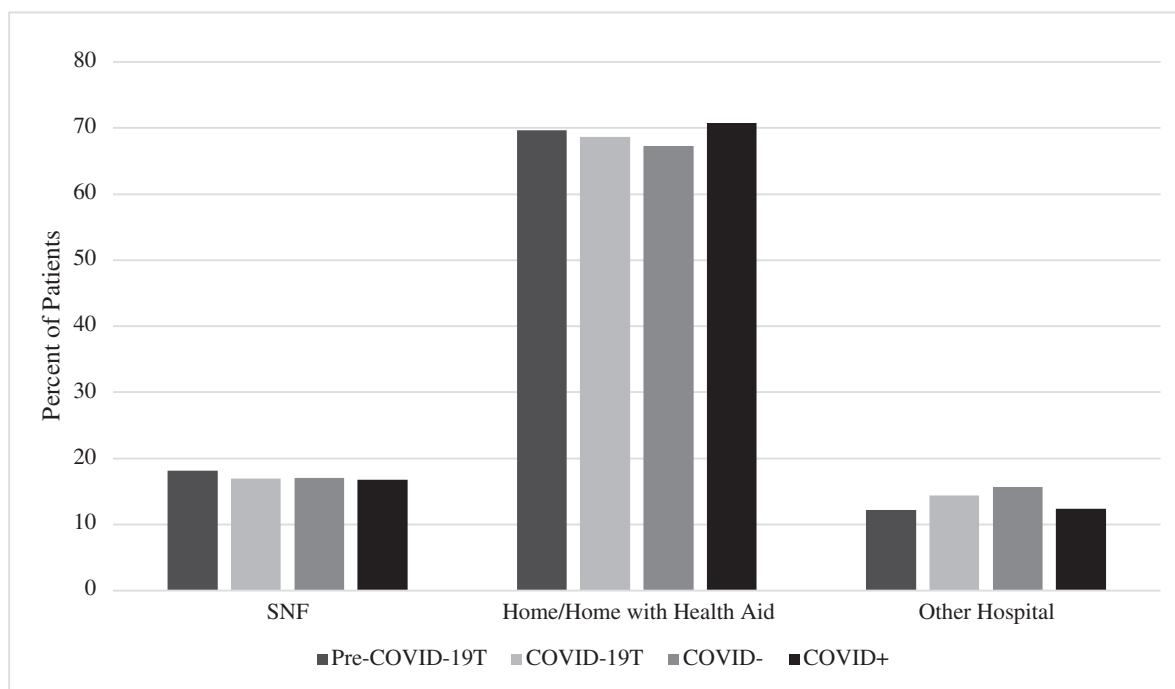
Pre-COVID-19T: Patients admitted from January 1, 2020 to February 19, 2020
COVID-19T: Patients admitted from April 1, 2020 to May 9, 2020.
COVID+: Patients tested Positive for COVID-19 who were admitted from April 1, 2020 to May 9,2020.
COVID-: Patients tested Negative for COVID-19 who were admitted from April 1, 2020 to May 9,2020.
SNF: Skilled Nursing Facility

Fig 1 Discharge disposition by time period and COVID-19 status.

Table 2 Discharge outcomes by time point and COVID-19 status

Discharge Destination (n)	Pre—COVID-19T	COVID-19T	P Value	COVID-19T/COVID—	COVID-19T/COVID+	P Value
SNF, % (n)	18.1 (134)	17.3 (58)	.75	17.9 (35)	16.5 (23)	.74
Home/home with health aid, % (n)	69.7 (515)	69.0 (231)		67.3 (132)	71.2 (99)	
Other hospital, % (n)	12.2 (90)	13.7 (46)		14.8 (29)	12.2 (17)	

the differences in discharge disposition between COVID− and COVID+ patients was not statistically significant within COVID-19T (P=.74) (see table 2).

Table 3a outlines the multiple linear regression analysis for pre−COVID-19T and COVID-19T using SNF as the null discharge category. When controlling for other variables, patients who were younger (age: P<.01, odds ratio [OR]=0.66), had shorter IRH LOS (IRH LOS: P<.01, OR=0.66), had a higher change in functional ADL score (change in functional ADL score: P<.01, OR=4.17), and were less medically complex (CMI: P<.01, OR=0.57) were more likely to be discharged to home than SNF. Similarly, when controlling for other variables, patients who stayed longer in acute care (ACH LOS: P=.01, OR=1.72), had shorter IRH LOS (IRH LOS: P<.01, OR=0.24), had a smaller change in functional ADL score (change in functional ADL score: P<.01, OR=0.04), and were more medically complex (CMI: P<.01, OR=3.40) were more likely to be discharged to a hospital other than SNF.

Table 3b identifies variables affecting likelihood of discharge disposition within the COVID-19T time period using SNF as the null discharge category. Patients who had a higher change in functional ADL scores (change in functional ADL score: P<.01, OR=3.49) and who were less medically complex (CMI: P<.01,

OR=0.39) had a higher probability of being discharged to home than to SNF when controlling for other variables. Likewise, patients who were older (age: P=.02, OR=5.24), had a longer ACH LOS (ACH LOS: P<.01, OR=6.02), had a shorter IRH LOS (IRH LOS: P<.01, OR=0.09), had less of a change in functional ADL score (change in functional ADL score: P<.01, OR=0.02), and who were more medically complex (CMI: P<.01, OR=4.51) had a higher probability of being discharged to a hospital other than SNF when controlling for other factors. Notably, COVID status was not found to be correlated with the likelihood of discharge disposition to home (COVID+: P=.06, OR=0.49) or to hospital other than SNF within COVID-19T (COVID+: P=.30, OR=0.41).

Inpatient rehabilitation hospital length of stay

Average IRH LOS during pre−COVID-19T was found to be significantly shorter compared with the average IRH LOS during COVID-19T (16.7±12.8d [median of 14d] vs 18.8±10.9d [median of 17d], P<.01). IRH LOS differences were not significant when stratifying for COVID status within COVID-19T. (COVID+ average LOS of 17.7±9.50d [median of 17d] vs COVID− average LOS of 19.6±11.8d [median of 17d], P=.12) (see table 1).

Table 3a Multiple linear regression analysis model on discharge disposition in pre−COVID-19T and COVID-19T

Discharge Disposition	Variables	B	SE	P Value	Odds Ratio	95% CI
Home/home with health aid	Intercept	1.17	0.25	1.74e-06*	3.24	2.00-5.24
	COVID-19T/COVID−	0.43	0.26	.10	1.53	0.93-2.54
	COVID-19T/COVID+	−0.15	0.30	.62	0.86	0.48-1.54
	Age	−0.42	0.12	.00*	0.66	0.52-0.83
	BMI	−0.13	0.10	.17	0.88	0.73-1.06
	Race-NHW	0.17	0.27	.54	1.18	0.70-2.00
	Race-other	0.70	0.44	.11	2.02	0.85-4.77
	ACH LOS	0.04	0.11	.75	1.04	0.83-1.29
	IRH LOS	−0.42	0.14	2.44e-03*	0.66	0.50-0.86
	Change in mobility score	1.43	0.15	.00*	4.17	3.12-5.58
	CMI	−0.57	0.12	3.93e-06*	0.57	0.44-0.72
Other hospital	Intercept	−4.81	0.77	5.18e-10*	0.01	0.00-0.04
	COVID-19T/COVID−	0.005	0.50	.99	1.00	0.38-2.69
	COVID-19T/COVID+	−0.39	0.61	.53	0.68	0.20-2.25
	Age	0.009	0.27	.97	1.01	0.59-1.72
	BMI	−0.29	0.21	.17	0.75	0.49-1.14
	Race-NHW	0.43	0.57	.45	1.53	0.51-4.65
	Race-other	1.20	0.84	.16	3.30	0.63-17.3
	ACH LOS	0.54	0.20	.01*	1.72	1.18-2.52
	IRH LOS	−1.42	0.29	1.19e-06*	0.24	0.14-0.43
	Change in mobility score	−3.20	0.41	3.55e-15*	0.04	0.02-0.09
	CMI	1.22	0.29	2.69e-05	3.40	1.92-6.01

NOTE. Null categories for regression analysis included discharge to SNF, race: Black.
Abbreviations: CI, confidence interval; NHW, non-Hispanic White.
∗ Indicates statistical significance, P<.05.

Table 3b Multiple linear regression analysis model on discharge disposition in COVID-19T

Discharge Disposition	Variables	B	SE	P Value	Odds Ratio	95% CI
Home/home with health aid	Intercept	1.59	0.45	.00*	4.9	2.04-11.8
	COVID +	−0.72	0.39	.06	0.49	0.23-1.04
	Age	−0.23	0.20	.27	0.80	0.54-1.19
	BMI	−0.11	0.17	.51	0.89	0.64-1.25
	Race-NHW	0.20	0.45	.65	1.22	0.50-2.97
	Race-other	1.23	0.77	.11	3.41	0.75-15.5
	ACH LOS	0.14	0.26	.60	1.15	0.69-1.90
	IRH LOS	−0.02	0.25	.93	0.98	0.60-1.60
	Change in mobility score	1.25	0.24	1.54e-07*	3.49	2.19-5.56
	CMI	−0.95	0.23	5.56e-05*	0.39	0.24-0.61
Other hospital	Intercept	−5.30	1.94	.01*	0.01	0.00-0.23
	COVID +	−0.90	0.87	.30	0.41	0.07-2.24
	Age	1.66	0.68	.02*	5.24	1.37-20.0
	BMI	−0.11	0.38	.77	0.89	0.43-1.87
	Race-NHW	−0.82	1.32	.54	0.44	0.03-5.84
	Race-other	1.27	1.65	.44	3.55	0.14-90.9
	ACH LOS	1.79	0.64	.01*	6.02	1.71-21.2
	IRH LOS	−2.36	0.73	.00*	0.09	0.02-0.40
	Change in mobility score	−3.90	0.97	6.26e-05*	0.02	0.00-0.14
	CMI	1.51	0.57	6.16e-03	4.51	1.48-13.8

NOTE. Null categories for regression analysis included discharge to SNF, race: Black.
Abbreviations: CI, confidence interval; NHW, non-Hispanic White.
∗ Indicates statistical significance, P<.05.

Table 4a reports the results of multiple linear regression analysis between IRH LOS and other variables in pre−COVID-19T and COVID-19T. Patients who had longer acute care LOS (ACH LOS: P<.01, B=2.08), higher change in functional ADL score (change in functional ADL score: P<.01, B=2.34), and higher medical complexity (CMI: P<.01, B=5.11) were more likely to have longer IRH LOS in pre−COVID-19T and COVID-19T when controlling for other variables. Notably, patients who had a diagnosis of hypertension (hypertension diagnosis: P<.01, B=−2.85) were correlated with a shorter IRH LOS for pre−COVID-19T and COVID-19T.

Table 4a Multiple linear regression analysis model on IRH LOS in pre−COVID-19T and COVID-19T

Variables	B	SE	P Value	t Value	95% CI
Intercept	19.4	0.82	<2e-16*	23.6	17.8-21.0
COVID-19T/COVID−	0.40	0.84	.63	0.48	−1.25 to 2.05
COVID-19T/COVID+	−1.23	0.97	.20	−1.27	−3.1 to 0.66
Age	−0.80	0.36	.03	−2.23	−1.50 to −0.10
ACH LOS	2.08	0.35	2.58e-09*	6.01	1.40-2.74
Change in mobility score	2.34	0.32	6.62e-13*	7.28	1.71-2.97
Neurologic diagnosis	0.55	0.67	.42	0.81	−0.77 to 1.86
Hypertension diagnosis	−2.85	0.87	.00*	−3.28	−4.55 to −1.14
CMI	5.11	0.34	<2e-16*	14.94	4.44-5.78

NOTE. Null categories for regression analysis included discharge to SNF, race: Black.
Abbreviation: CI, confidence interval.
* Indicates statistical significance, P<.05.

Table 4b Multiple linear regression analysis model on IRH LOS in COVID-19T

Variables	B	SE	P Value	t Value	95% CI
Intercept	17.2	1.34	<2e-16*	12.87	14.6-19.8
Age	−0.98	0.52	.06	−1.89	−2.00 to 0.04
COVID+	−0.64	1.0	.53	−0.63	−2.64 to 1.36
ACH LOS	1.08	0.67	.11	1.62	−0.23 to 2.40
Change in mobility score	2.14	0.47	6.85e-06*	4.57	1.22-3.05
Neurologic diagnosis	0.25	1.03	.81	0.24	−1.78 to 2.27
Hypertension diagnosis	−0.06	1.29	.96	−0.05	−2.59 to 2.47
CMI	6.23	0.54	<2e-16*	11.7	5.19-7.28

Abbreviation: CI, confidence interval.
* Indicates statistical significance, P<.05.

Table 4b outlines factors found to be associated with IRH LOS solely within COVID-19T. When controlling for other factors, patients with a higher change in functional ADL score (change in functional ADL score: P<.01, B=2.14) and who were more medically complex (CMI: P<.01, B=6.23) were more likely to have longer IRH LOS in COVID-19T. COVID+ status was not found to be a significant predictor of IRH LOS (P=.53).

Functional ADL score at discharge

Overall, patients admitted in pre−COVID-19T had a statistically greater functional ADL score at discharge than patients admitted in COVID-19T (44.0±17.4 vs 41.0±18.0; P<.01). When

stratifying COVID-19T for COVID status, COVID+ patients had statistically greater discharge functional ADL scores than COV-ID− patients (44.9±18.3 vs 38.3±17.4; P<.01) (see table 1).

Table 5a showcases the results of multiple linear regression analysis on factors that correlate with discharge functional ADL scores in pre−COVID-19T and COVID-19T. Patients who were younger (age: P<.01, B=−3.33) and who were less medically complex (CMI: P<.01, B=−7.09) were more likely to have a higher discharge functional ADL score in pre−COVID-19T and COVID-19T when controlling for other factors. Patients with a neurologic diagnosis were found to have, on average, a discharge functional ADL score 3.6 points lower than those without a neurologic diagnosis (neurologic diagnosis: P<.01).

Table 5b outlines variables that were found to correlate with discharge functional ADL scores in COVID-19T. Patients who were younger (age: P<.01, B=−3.92) and less medically complex (CMI: P<.01, B=−6.40) were more likely to have higher discharge functional ADL scores in COVID-19T when controlling for other variables. Patients with a neurologic diagnosis were found to have, on average, a discharge functional ADL score 4.06 points lower than those without a neurologic diagnosis (neurologic diagnosis: P<.05). COVID+ status was not found to be significantly correlated with discharge functional ADL scores (COVID+: P=.06, B=3.51).

Discussion

Given that COVID-19 has been a great cause of morbidity and neurologic impairment worldwide,[36,37] the need for IRH and

Table 5a Multiple linear regression analysis model on discharge functional ADL score in pre−COVID-19T and COVID-19T

Variables	B	SE	P Value	t Value	95% CI
Intercept	45.0	0.72	<2e-16*	32.2	43.6-46.4
COVID-19T/COVID−	−2.17	1.27	.09	−1.70	−4.66 to 0.33
COVID-19T/COVID+	1.32	1.46	.37	0.90	−1.54 to 4.17
Age	−3.33	0.50	5.33e-11*	−6.63	−4.31 to −2.34
ACH LOS	−0.96	0.52	.068	−1.83	−1.98 to 0.07
Neurologic diagnosis	−3.57	1.00	.00*	−3.58	−5.53 to −1.61
CMI	−7.09	0.52	<2e-16*	−13.7	−8.10 to −6.07

NOTE. Null categories for regression analysis included discharge to SNF, race: Black.
Abbreviation: CI, confidence interval.
* Indicates statistical significance, P<.05.

Table 5b Multiple linear regression analysis model on discharge functional ADL score in COVID-19T

Variables	B	SE	P Value	t Value	95% CI
Intercept	42.8	1.55	<2e-16*	27.5	39.7-45.8
Age	−3.92	0.93	3.09e-05*	−4.23	−5.73 to −2.10
COVID+	3.51	1.91	.06	1.84	−0.23 to 7.25
ACH LOS	−0.69	1.26	.58	−0.55	−3.16 to 1.77
Neurologic diagnosis	−4.06	1.92	.04*	−2.11	−7.83 to −0.29
CMI	−6.40	1.0	4.45e-10*	−6.43	−8.35 to −4.45

Abbreviation: CI, confidence interval.
* Indicates statistical significance, P<.05.

rehabilitation services increased during this time frame.[9,13] This study sought to measure how the early COVID-19 time period influenced discharge outcomes, LOS, and functional ADL scores from IRHs given the need to discharge severely debilitated patients from acute care[7-12] as well as the disruption to the discharge process.[18,19]

Demographic characteristics

Patients admitted during COVID-19T were found to be significantly younger, less likely to be White, have longer acute care LOS, and be more medically complex. The differences in racial background were statistically significant in COVID-19T between COVID+ and COVID− patients. This finding is consistent with studies that report a higher age- and sex-standardized incidence rate of COVID-19 and higher mortality rates in patients who identify as Black as well as Latino and "Other" racial groups in comparison to those who identify as White.[38-40] BMI and sex showed no significant differences among all comparisons. Unsurprisingly, COVID+ patients were found to have longer acute care LOS compared to their COVID− counterparts.

Perhaps one of the most intriguing findings was the significantly higher CMI in COVID− patients during COVID-19T. We postulate that those who were COVID− in acute care were likely discharged home if at all possible, as opposed to discharged to a facility given the higher risk of COVID-19 transmission. This would create a self-selecting population of more medically complex COVID− patients who were unable to be discharged home from acute care. Another possible explanation was that IRHs had a limited number of beds available for COVID− patients because many beds required specific COVID isolation precautions reserved for COVID+ patients. Therefore, only the most medically complex COVID− patients (possibly indicating the highest "need" for IRH bed) were admitted to IRH.

Discharge disposition

There were no statistically significant differences in discharge disposition between pre−COVID-19T and COVID-19T or between COVID+ and COVID− patients during COVID-19T. Several factors at baseline, such as age, CMI, change in functional ADL score, ACH LOS, and IRH LOS, were significantly related to discharge outcomes in various comparisons. However, the sentinel finding was that COVID status alone was not correlated with the likelihood of any discharge disposition during COVID-19T. This finding indicates that COVID status was not a barrier to home discharge despite the numerous obstacles it posed to overall rehabilitation and the discharge process.

IRH length of stay

Overall, the average and median IRH LOS were significantly increased during the pandemic. However, there were no statistically significant differences in IRH LOS between the COVID+ and COVID− cohorts within COVID-19T. During COVID-19T, patients who were more medically complex were found to have a longer IRH LOS. Additionally, there was a significant relationship between longer IRH LOS and larger change in functional ADL score. These findings were intuitive; patients who require a longer LOS in IRH will have lower baseline functional ADL score as well as larger gains in functional ADL score given the additional rehabilitation. (Previous studies have showed similar findings in stroke patients.[41]) Yet again, the sentinel finding with IRH LOS was that COVID status was not found to be a significant correlate.

Functional ADL score at discharge

Functional status as a strong predictor of discharge location has been established for other medical populations, including studies on patients with COVID-19.[42] On average, COVID-19T patients had significantly lower functional ADL scores at both admission and discharge compared with pre−COVID-19T. COVID− patients had lower functional ADL scores compared with their COVID+ counterparts at discharge, again likely indicating the higher medical complexity and overall more debilitated population that comprised COVID-19T COVID− patients. Variables such as age and CMI were predictive of a higher functional ADL score at discharge between pre−COVID-19T and COVID-19T. Patients with a neurologic diagnosis had significantly lower functional ADL scores at discharge; lower functional scores within neuorological diagnosis groups was consistent with similar findings in the literature.[43,44] Within COVID-19T, age and CMI remained significant predictors of higher discharge scores and neurologic diagnosis predicted lower functional ADL scores at discharge. Although it was initially hypothesized that COVID+ status would decrease functional ADL scores, COVID+ status was not a significant predictor of discharge functional ADL score.

Although the initial hypotheses were not correct, the findings are positive. Despite the pandemic leading to an overall more medically complex patient population as indicated by higher CMI and lower functional ADL scores on admission during COVID-19T, COVID status did not play a role in discharge disposition or IRH LOS. Therefore, an important aspect of this article is that more impaired individuals admitted during the pandemic did not have increased discharge rates to an ACH and/or SNFs/subacute rehabilitation facilities. Although there are limited data regarding the effectiveness of IRH in functional recovery in patients affected during the COVID-19 time frame,[12] IRHs are known to support a comprehensive integrated model along the continuum of patient

care, with studies advocating for thorough rehabilitation plans and intervention during the ACH stay[42,45] and for leveraging technology to assist in delivering care in the time of the COVID-19 pandemic.[46] Given the prioritization of COVID-19 vaccination in health care workers, acute care and IRH should begin to see an increase in small group and bedside physical therapy allowing for increased intervention.[47] Our findings serve as a testament to the success of IRHs in restoring function and maintaining the ability to discharge patients to their homes, even in the face of a global crisis.

This study identifies candidates for predictors of discharge destination, LOS, and discharge functional ADL score from IRHs during a global pandemic. In addition, it reaffirms the ability for IRHs to discharge patients safely despite a debilitated and medically complex patient population. Moving forward, research to assess how COVID-19 has affected the continuum of care post-IRH is the next step in evaluating how the disruption of postdischarge rehabilitation services,[15,48] such as telehealth appointments and virtual therapy, have affected discharge outcomes once patients have arrived home.[13,49,50]

Study limitations

A limitation within the system meant that we were unable to examine racial background more closely, leading to only the categories of White, Black, and other. Another limitation lies in the fact that this study was solely conducted within 1 IRH system, which affects generalizability. Lastly, the total number of patients for pre−COVID-19T and COVID-19T and by COVID status differed, although this is attributed to the admission restrictions in place secondary to COVID-19.

Conclusions

Our IRH system admitted a more debilitated patient population during the height of the COVID-19 pandemic, yet there was no significant change in discharge disposition. Additionally, COVID status was not found to be significantly correlated with discharge outcome, LOS, or functional ADL score at discharge. This supports the importance of IRHs in restoring function and discharging patients to home at analogous rates despite the limitations imposed by COVID-19 at the height of the pandemic.

Supplier

a. R Studio, version 1.3.1056; The R Foundation.

Keywords

Activities of daily living; COVID-19; Functional status; Length of stay; Patient discharge; Physical and rehabilitation medicine; Rehabilitation; SARS-CoV-2

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