



Impacts of a Pandemic on Stroke Rehabilitation: Insights from COVID-19

Lipson MR¹, Dai J², Sharma S², Vyas MV³, Cheng A⁴

¹Unity Health Toronto, Canada

²University of Western Ontario, Unity Health Toronto, Canada

³Neurology Department, University of Toronto, Unity Health Toronto, Canada

⁴Physical Medicine and Rehabilitation, University of Toronto, Unity Health Toronto, Canada

ABSTRACT

Background: The COVID-19 pandemic caused widespread disruption to the administration of inpatient post-stroke rehabilitation, and many parameters of this disruption have not been sufficiently examined.

Objective: To explore COVID-19-related impacts on inpatient stroke rehabilitation.

Methods: Chart review of all patients admitted for post-stroke inpatient rehabilitation from March 2020 to March 2024 (n=931). Primary outcome was the Functional Independence Measure (FIM) efficiency (change in FIM/length of stay). Data collected included age, sex, admission/discharge FIM scores, COVID-19 status, vaccination status, and antiviral medication treatment.

Results: No significant difference was identified in FIM efficiency based on COVID-19 infection status (1.35 [0.67-2.08] vs 1.23 [0.65-1.81]). However, the FIM efficiency of COVID-19 positive subjects who received antiviral medications was significantly lower than those who were negative for COVID-19. There was a non-significant trend towards improved FIM efficiency among vaccinated COVID-19 positive subjects.

Conclusion: There was no significant difference in FIM efficiency based on COVID-19 status alone, but those with COVID-19 who received antiviral medication had significantly reduced FIM efficiency. This suggests a relationship between COVID-19 symptom severity and functional recovery. There was a trend towards improved FIM efficiency among vaccinated COVID-19-positive subjects.

KEYWORDS: COVID-19, Stroke rehabilitation, Stroke, Pandemic, Vaccination

INTRODUCTION

The COVID-19 pandemic was disruptive to inpatient post-stroke rehabilitation care pathways. Those infected with COVID-19 (COVID+) experience symptoms that may diminish their engagement in stroke rehabilitation, such as headaches, fatigue/malaise, nausea/vomiting, diarrhea, myalgias, arthralgias, confusion/delirium, fever, and respiratory symptoms.¹ Additionally, isolation precautions and personal protective

*Correspondence:

Melissa Lipson
3276 St Clair Ave E, Toronto, ON, M1L 1W1
Canada.
Email: melissarose.lipson@gmail.com

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equipment (PPE) also interfered with the delivery of post-stroke rehabilitation. Isolation restrictions limit a patient's ability to leave their room and participate in therapeutic exercises in shared spaces (such as a physiotherapy gym). The requirement for PPE limits nonverbal communication cues between therapists and patients. PPE also creates communication challenges, as it is much harder for patients to hear therapists using face masks and shields, and limits compensatory lip reading. One study by Taketa et al. (2024) found that functional outcomes of those in stroke rehabilitation were negatively affected by the pandemic, but this occurred irrespective of the infection status of the rehabilitation participants.²

Only 3 studies to date examined the impact of COVID-19 on functional recovery in post-stroke inpatient rehabilitation. These studies had inconsistent findings and were conducted under notably different circumstances.²⁻⁴ None of these studies examined the impacts of vaccination or post-infection antiviral medication administration when exploring functional recovery, yet many COVID-19 vaccines approved for use have been demonstrated to significantly mitigate the symptomatic severity of COVID-19 infection.⁵ Remdesivir has been demonstrated to reduce the severity and/or duration of the clinical presentation of COVID-19 infection.⁶ Nirmatrelvir and ritonavir combination drug (Paxlovid) has been found to reduce the risk and length of hospitalization.⁷ Both remdesivir and Paxlovid have been shown to reduce mortality.^{6,7}

Although the pandemic has waned, COVID-19 is still affecting hospitalized patients and can disrupt the course of their inpatient post-stroke rehabilitation. Fear and skepticism regarding the risk/benefit balance of vaccinations remains an issue. It is important to be able to provide evidence-based information when counseling patients during their post-stroke inpatient stay when addressing issues such as vaccination and antiviral treatments. At present, there is too little data published on these issues in a post-stroke rehabilitation setting to guide clinicians on these issues. This study seeks to improve the knowledge gap by exploring differences in post-stroke functional outcomes due to COVID-19, along with the impact of vaccination and antiviral medication administration amongst COVID+ subjects.

METHODS

Data was extracted from charts of all inpatients admitted to Providence Healthcare, a tertiary care facility in Toronto, Ontario, Canada, from March 1, 2020, to March 1, 2024. Inclusion criteria were those who suffered a stroke within 3 months prior to their admission date. The study was approved by the Research Ethics Board (REB) of Unity Health Toronto, REB #24-202, with waiver of consent granted for chart review. The data collected included age, sex, admission and discharge FIM scores (motor, cognitive, and total), length of stay (LOS) in inpatient rehabilitation, identification of post-stroke COVID-19 infection, COVID-19 vaccination status, and administration of antiviral medication (either remdesivir or Paxlovid). FIM efficiency was determined by the change in the FIM score (from admission to discharge) divided by the LOS (in days).

Exclusion criteria included LOS less than 1 week or over 3 months (to eliminate outliers who left rehabilitation early or stayed

excessively long due to discharge planning barriers), those who were under 18 years of age, and those who were discharged to acute care due to medical instability.

Statistical analysis compared demographic data of post-stroke COVID+ subjects with those who were not infected with COVID-19 during their hospital stay (COVID-). T-tests were used for continuous data. Outcome measures of FIM scores and FIM efficiency were analyzed using the Mann-Whitney U test. Categorical nominal data were analyzed using the chi-squared test. Statistical significance was set at $p < 0.05$, and SAS software (version 9.4) was used.

The Mann-Whitney U test was used to compare FIM and FIM efficiency of COVID+ subjects who received antiviral medication (COVID+Antiviral+) to those who did not (COVID+Antiviral-). This same analysis was used to compare COVID+ who received vaccination (COVID+Vaccine+) those who did not (COVID+Vaccine-). Initial results prompted further analyses using the Mann-Whitney U test to assess whether FIM efficiency of COVID+ who received antiviral medication differed from those who were COVID-. Additionally, a linear regression analysis was performed to examine the extent to which age and vaccination status influenced FIM efficiency among COVID+ subjects.

All data were reported in a manner conforming with STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

RESULTS

In total, 931 subjects were included in this study. 70 (7.5%) subjects were COVID+. Comparing COVID- to COVID+, there was no baseline difference in age (71.1 [13.9] vs. 69.1 [13.9]), sex (43% females vs. 37% female), or admission FIM scores (59 [46-72] vs 55 [45-70]) (Table 1). There was also no difference in the outcomes of the FIM discharge scores or FIM efficiency between COVID+ and COVID- subjects. The median discharge FIM score was 100 [76-112] vs 99 [80-109], and the median FIM efficiency was 1.35 [0.67-2.08] vs 1.23 [0.65-1.81] (Table 1).

The COVID+Vaccine+ group had a greater FIM efficiency than the COVID+Vaccine- group, but this trend did not reach statistical significance. There was a significant difference in the age amongst these two groups, with vaccinated subjects having a significantly higher mean age (Table 2). The vaccination status of 27 COVID+ subjects (39%) was not discernable on retrospective chart review.

In the age-adjusted linear regression model, vaccination status among patients with COVID-19 infection was not significantly associated with FIM efficiency (beta estimate = 0.52, 95% CI -0.10 to 1.14, $P = 0.11$).

FIM efficiency scores were lower in the COVID+Antiviral+ group as compared to the COVID+Antiviral- group; (0.78 [0.52-1.26] vs 1.29 [0.73-1.88]), but this was just above statistical significance ($p=0.0648$) (Table 3). Subjects in these groups had similar baseline characteristics, including age, sex, and admission FIM scores, but there was a difference in discharge cognitive FIM scores (24 [19-29] vs 28 [24-31] $p=0.0348$) (Table 3).

Table 1: Comparison of COVID- to COVID+ Groups. Adm = admission, Dis = discharge

	COVID- Group	COVID+ Group	p-value
	(n = 861)	(n = 70)	
Age	71.1 (13.9)	69.1 (13.9)	0.245
Sex (Female)	n = 372 (43.2%)	n = 26 (37.1%)	0.324
Adm FIM (Total)	59 (46-72)	55 (45-70)	0.285
FIM Cognitive	23 (19-28)	24 (18-28)	0.748
FIM Motor	35 (23-48)	34 (21-42)	0.196
Dis FIM (Total)	100 (76-112)	99 (80-109)	0.493
FIM Cognitive	27 (23-31)	28 (23-31)	0.901
FIM Motor	73 (54-83)	71 (57-80)	0.333
FIM Efficiency	1.35 (0.67-2.08)	1.23 (0.65-1.81)	0.165

Table 2: Comparison of COVID+Vaccination- to COVID+Vaccination+. Adm = admission, Dis = discharge

	COVID+ Vaccination-	COVID+Vaccination+	p-value
	(n = 17)	(n = 26)	
Age	58.0 (10.9)	76.1 (11.4)	<.001
Sex (Female)	n = 5 (29.4%)	n = 15 (57.7%)	0.069
Adm FIM (Total)	59 (46-67)	55 (47-70)	0.833
FIM Cognitive	23 (17-29)	25 (18-28)	0.737
FIM Motor	34 (24-39)	38 (21-41)	0.765
Dis FIM (Total)	98 (86-106)	104 (83-109)	0.559
FIM Cognitive	25 (21-28)	28 (23-31)	0.156
FIM Motor	74 (61-79)	72 (63-80)	0.823
FIM Efficiency	1.29 (0.85-1.48)	1.61 (0.96-2.06)	0.101

Table 3: Comparison of COVID+Antiviral- to COVID+Antiviral+ Groups. Adm = admission, Dis = discharge

	COVID+Antiviral-	COVID+Antiviral+	p-value
	(n = 58)	(n = 12)	
Age	68.7 (14.2)	71.3 (13.0)	0.563
Sex (Female)	n = 21 (36.2%)	n = 5 (41.7%)	0.722
Adm FIM (Total)	58 (45-70)	50 (39-67)	0.21
FIM Cognitive	25 (18-28)	21 (17-27)	0.325
FIM Motor	36 (22-42)	25 (18-38)	0.141
Dis FIM (Total)	101 (83-110)	80 (53-104)	0.061
FIM Cognitive	28 (24-31)	24 (19-29)	0.035
FIM Motor	72 (60-81)	56 (35-78)	0.121
FIM Efficiency	1.29 (0.73-1.88)	0.78 (0.52-1.26)	0.065

As there were only 12 subjects who were COVID+Antiviral+, this group was compared against the entire COVID- population (n=861), identifying a statistically significant reduction in FIM efficiency. These groups had similar baseline characteristics, but

FIM efficiency of the COVID- group was 1.35 [0.67-2.08], vs the COVID+Antiviral+ group FIM efficiency, which was 0.78 [0.52-1.26], p=0.0415 (Table 4).

Table 1: Comparison of COVID+Antiviral+ to COVID- Groups. Adm = admission, Dis = discharge

	COVID+Antiviral+ (n = 12)	COVID- (n = 861)	p-value
Age	71.3 (13.0)	71.1 (13.9)	0.938
Sex (Female)	n = 5 (41.7%)	n = 372 (43.2%)	0.915
Adm FIM (Total)	50 (39-67)	59 (46-72)	0.13
FIM Cognitive	21 (17-27)	23 (19-28)	0.413
FIM Motor	25 (18-38)	35 (23-48)	0.089
Dis FIM (Total)	80 (53-104)	100 (76-112)	0.055
FIM Cognitive	24 (19-29)	27 (23-31)	0.085
FIM Motor	56 (35-78)	73 (54-83)	0.077
FIM Efficiency	0.78 (0.52-1.26)	1.35 (0.67-2.08)	0.042

DISCUSSION

COVID-19 symptoms such as low-grade fever, malaise, lethargy, myalgias/arthralgias, headache, and nausea¹ would be expected to limit one’s participation in post-stroke rehabilitation. In this study, COVID+ and COVID- groups had similar baseline characteristics, with no significant change in FIM efficiency between groups. These findings would indicate that despite the potential for significant disruption, COVID-19 infection was not detrimental to the functional gains made in post-stroke rehabilitation. However, this may have been influenced by relatively less symptomatic cases of COVID-19 infection included in this study. Although those with symptomatic illness and fever remained on the rehab ward, those with threatening respiratory instability were sent out to acute care and were excluded from the study. Additionally, the robust screening program on the inpatient rehabilitation ward would have detected minimally symptomatic cases of COVID-19 more readily. This may have produced a COVID+ group of milder clinical severity than would typically be identified in the community. Those with milder symptoms would reasonably be expected to experience less disruption in their participation in rehabilitation and their post-stroke functional recovery, making changes in FIM efficiency less detectible.

The COVID+Antiviral+ group was relatively small for statistical analysis (n=12), remdesivir (n=9), or Paxlovid (n=3), so those receiving either antiviral medication were combined and analyzed as one group. It was anticipated that these medications would mitigate the adverse effects of COVID-19 infection that would be detrimental to functional restoration in rehabilitation.^{6,7} However, the COVID+Antiviral+ group displayed a lower FIM efficiency than the COVID+Antiviral- group, although this trend did not reach statistical significance. The COVID+Antiviral+ group had a median FIM efficiency that was only 62% that of the COVID+Antiviral- group,

but the p-value was just above statistical significance (p=0.0648). This suggested that antiviral medications administration may be disadvantageous for those who were COVID+. As the COVID+ group was only n=70, it was decided to compare COVID+Antiviral+ against the COVID- group [n=861] to increase the power of the analysis. This demonstrated that the COVID+Antiviral+ had a FIM efficiency that was only 58% that of the COVID- group, with a p-value that did reach statistical significance. This revealed an association between antiviral administration and a worse functional outcome.

Remdesivir is known to cause some undesirable side effects, but these are typically mild⁸. Paxlovid mainly causes gastrointestinal side effects such as abdominal pain, nausea, diarrhea (5.4%), with serious side effects being rare.⁹ Paxlovid is used less often due to its many drug interactions. Side effects of these antiviral medications are typically transient, and protocols (at the study site) are only for 5 days of administration of either antiviral medication. The average length of stay was 34 days in the COVID+ group, so antiviral medication would only have been provided for 15% of the rehabilitation stay, and no serious adverse effects were reported to those who received antiviral medications in this study. It is unlikely that the administration of antiviral medications accounted for worse functional outcomes in this study. Rather, the symptom severity caused by the COVID-19 infection likely accounted for this association. It is these associated symptoms that would be expected to disrupt participation in rehabilitation, and antiviral medication administration would be reserved for those with relatively more symptomatic infections. Accordingly, the administration of antiviral medication likely acted as a surrogate measure for more symptomatic/disruptive COVID-19 clinical presentations. This would support the assumption that COVID-19 infection does disrupt functional recovery in post-stroke

rehabilitation, but only when associated symptoms reach a minimal threshold of severity.

In this study, there was also a notable trend towards improved FIM efficiency amongst COVID+Vaccination+ subjects as compared to COVID+Vaccination- subjects. However, this difference did not reach statistical significance. The median FIM efficiency of the vaccinated subjects was 25% higher, but the p-value was 0.101. Smaller sample size was a challenge in this analysis, as there were only 70 COVID+ subjects, and the vaccination status of 27 of those subjects was unknown. The COVID+Vaccination+ group (age [years] 76.1 [11.4]) was also significantly older than the COVID+Vaccination- group (age [years] 58 [10.9]), $p < 0.001$. Since advanced age is known to reduce post-stroke functional recovery,¹⁰ a linear regression analysis was performed to explore the age-adjusted relationship between COVID+ and FIM efficiency. This found that adjustment for age did not alter the statistical significance of the finding.

As previously noted, there are only three identified studies to date exploring the functional impacts of COVID-19 in inpatient stroke rehabilitation.²⁻⁴ The findings amongst these studies have been mixed, with some demonstrating a detrimental effect COVID-19 infection, while others did not. The results of this study suggest that symptom severity of COVID-19 infection may be the primary factor that determines the impact on post-stroke recovery. This is a factor that has not been directly examined in any study to date, likely because COVID-19 severity scales focus primarily on distinguishing between broader symptomatic changes (community management, hospitalization, respiratory support, organ failure). Such scales are not well suited to classify COVID-19 symptom severity on a stroke rehab ward, where participants are medically stable.

CONCLUSIONS

Although the data from this study did not find a significant difference in functional outcome between the post-stroke COVID+ and COVID- groups, the subgroup analysis of those who required/received antiviral medication administration had a lesser functional recovery based on FIM efficiency. This suggested symptom severity was the factor that determined the impact on functional recovery. This study also identified a trend towards better outcomes among vaccinated subjects compared to those who were unvaccinated.

DISCLOSURE STATEMENT

There are no disclosures to be made, as there were no grants, funding, donations, or any remuneration to researchers for the completion of this study. There are no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

Data may be provided upon written request from the corresponding author.

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