Japanese Journal of Comprehensive Rehabilitation Science (2024)

Original Article

Impact of a Nosocomial COVID-19 Outbreak on Convalescent Rehabilitation Outcomes of Post-Stroke Patients

Tomoyo Taketa, MD,[1,2] Yuki Uchiyama, MD, PhD,[1] Yoko Sakamoto, MD,[2] Yushi Tanaka, MD,[2,3] Takafumi Suehiro, MD,[2] Shinichi Nakagawa, MD, PhD,[2] Ko Sakata, MD,[2] Kazuhisa Domen, MD, PhD[1]

[1]Department of Rehabilitation Medicine, School of Medicine, Hyogo Medical University, Nishinomiya, Hyogo, Japan
[2]Department of Rehabilitation Medicine, Yuseikai Midorigaoka Hospital, Takatsuki, Osaka, Japan
[3]Department of Rehabilitation Medicine, Sasayama Medical Center, Hyogo Medical University, Tamba-Sasayama, Hyogo, Japan

ABSTRACT
Taketa T, Uchiyama Y, Sakamoto Y, Tanaka Y, Suehiro T, Nakagawa S, Sakata K, Domen K. Impact of a Nosocomial COVID-19 Outbreak on Convalescent Rehabilitation Outcomes of Post-Stroke Patients. Jpn J Compr Rehabil Sci 2024; 15: 79−87.
Objective: This study aimed to elucidate the impact of a nosocomial COVID-19 outbreak on convalescent rehabilitation outcomes of post-stroke patients.
Methods: This retrospective observational study included post-stroke patients who were hospitalized in convalescent rehabilitation wards of our hospital during a COVID-19 outbreak between July 22, 2022 and August 13, 2022 (outbreak group). The control group consisted of patients hospitalized in convalescent rehabilitation wards from October 1 to December 31, 2022 (non-outbreak group). The two groups were compared in terms of motor Functional Independence Measure (FIM) effectiveness at discharge, Brunnstrom Recovery Stage, length of stay, and duration of rehabilitation therapy. Furthermore, within the outbreak group, outcomes were compared according to whether patients were infected with SARS-CoV-2. The impact of the outbreak on motor FIM effectiveness at discharge was also evaluated.
Results: There were 30 patients in the outbreak group (COVID-19, $n = 18$; close contacts, $n = 12$) and 33 patients in the non-outbreak group. Motor FIM effectiveness at discharge was significantly lower in the outbreak group, but there was no significant difference in outcomes according to SARS-CoV-2 infection status. After adjusting for SARS-CoV-2 infection, the nosocomial outbreak was significantly associated with lower motor FIM effectiveness at discharge.
Conclusion: A nosocomial COVID-19 outbreak affected motor FIM effectiveness in convalescent rehabilitation for post-stroke patients, regardless of SARS-CoV-2 infection status.
Key words: COVID-19, Isolation, Nosocomial infection, Close contact, Motor FIM effectiveness

Correspondence: Yuki Uchiyama, MD, PhD
Department of Rehabilitation Medicine, School of Medicine, Hyogo Medical University, 1−1 Mukogawa-cho, Nishinomiya, Hyogo 663−8501, Japan.
E-mail: yutti@hyo-med.ac.jp
Accepted: October 26, 2024
Conflicts of interest: The authors declare that there are no conflicts of interest.

Introduction

The COVID-19 pandemic, which began in late 2019 and became a global public health issue for nearly 3 years, has been particularly problematic in terms of outbreaks at care facilities and hospitals [1]. Due to the high contagiousness of SARS-CoV-2, nosocomial outbreaks have persisted even after the World Health Organization declared the end of the public health emergency in May 2023 [1]. Rehabilitation facilities, in particular, have a high risk for the spread of infection due to the close contact between healthcare staff and patients [2−4].

Many post-stroke patients in convalescent rehabilitation wards are elderly and often have comorbidities such as diabetes, cardiovascular disease, or chronic kidney disease, placing them at high risk for severe illness in the event of a nosocomial COVID-19 outbreak [5]. However, the clinical impact of such outbreaks on post-stroke patients in rehabilitation facilities has not yet been reported.

Previous studies on nosocomial outbreaks of infectious diseases other than COVID-19 have demonstrated that outbreaks negatively affect rehabilitation outcomes, resulting in extended hospital stays and reduced Functional Independence Measure (FIM) scores at discharge [3, 4]. In the event of a nosocomial COVID-19 outbreak, the provision of appropriate rehabilitation therapy may be hindered by several challenges, including ward closures, isolation measures, restrictions on training spaces and content, staff shortages due to infection, and a decline in patient motivation for rehabilitation [3, 4]. These issues are expected to impact not only infected individuals but also close contacts and non-infected patients. This poses a significant challenge, especially for post-stroke patients in the convalescent phase, for whom optimizing functional recovery is crucial. To date, no studies have investigated the impact of COVID-19 outbreaks on rehabilitation outcomes for infected patients and close contacts in rehabilitation facilities.

The aim of this study was to examine the clinical characteristics of post-stroke patients during a nosocomial COVID-19 outbreak in convalescent rehabilitation wards (Kaifukuki rehabilitation wards) and to clarify the impact of the outbreak on the rehabilitation outcomes of both infected patients and close contacts.

Methods

1. Patients

We retrospectively collected data of post-stroke patients hospitalized during a COVID-19 outbreak that occurred between July 22, 2022 and August 13, 2022 in two convalescent rehabilitation wards of our hospital (one with 53 beds and the other with 50 beds, with only one private room in total). Patients diagnosed with COVID-19 were those who tested positive for SARS-CoV-2 by PCR testing using a nasopharyngeal swab. Uninfected patients who shared a room with COVID-19 patients were considered close contacts. As a control group, we selected post-stroke patients admitted to the same two wards between October 1, 2022 and December 31, 2022, during which no COVID-19 outbreaks were observed. We excluded patients with an impaired understanding of instructions due to disorders of consciousness, severe aphasia or other higher brain dysfunction, or severe cognitive impairment (Revised Hasegawa's Dementia Scale score ≤ 10 [6]), those with head trauma or subarachnoid hemorrhage, those with a pre-admission modified Rankin Scale score of ≥ 2 [7], and those who experienced recurrent stroke. Patients hospitalized during the outbreak were classified into the outbreak group, and those hospitalized after the end of the outbreak were classified into the non-outbreak group.

The study protocol was approved by the Ethics Committee of our hospital (approval number 23012), and informed consent was obtained using an opt-out method.

2. Infection Control Measures and Rehabilitation Treatment Before the Outbreak

During the study period, global pandemic-related precautions were in place, including mandatory mask-wearing for patients, standard infection control measures for staff, and restrictions on family visits, even outside the outbreak period. Rehabilitation therapists wore full personal protective equipment (PPE) during treatment sessions. Post-stroke patients received physical therapy, occupational therapy, and speech therapy for a total of 120 to 180 min per day. Walking training using parallel bars and ball exercises were conducted in a rehabilitation room separate from the wards, while activities of daily living (ADL) training was conducted within the wards.

3. COVID-19 Outbreak and Infection Control Measures During the Outbreak

On July 22, 2022, 3 patients in two rehabilitation wards were diagnosed with COVID-19. Symptomatic patients and close contacts underwent PCR testing with nasopharyngeal swabs. Over the next 8 days, additional cases emerged, resulting in 32 staff members (22 nurses and 10 therapists) testing positive for COVID-19. Infected patients were placed in either single-room isolation or cohort isolation. All ward staff underwent PCR testing, wore full PPE, and strictly adhered to hand hygiene and environmental disinfection protocols. Patients were released from isolation after testing negative by PCR between 13 and 18 days after symptom onset. Close contacts underwent PCR testing the day after their initial test and on day 5, and were released from isolation after testing negative on day 14. Infected staff members stayed home for 10 days after symptom onset, and close contacts stayed home for 7 days after contact, both returning to work after testing negative by PCR.

4. Rehabilitation Therapy During the Outbreak

During the isolation period, occupational therapy and speech therapy were suspended for both infected patients and close contacts, and only physical therapy was provided. Dedicated COVID-19 physical therapists performed rehabilitation therapy once or twice daily for 20 to 60 min in the patient's room, adjusting intensity based on the severity of illness and providing guidance on self-training. Infected patients received training to address respiratory symptoms, including positioning and exercises to improve thoracic mobility. After isolation was lifted, occupational and speech therapies were resumed, but rehabilitation therapy was conducted exclusively in the wards until the outbreak ended. After the end of the outbreak, patients resumed therapy in the rehabilitation room, with infection control and therapy measures returning to those in place before the outbreak.

5. Measurements

Patient data, including demographic (age, sex, BMI) and clinical (e.g. comorbidities, time from stroke onset to admission, length of stay) information, were extracted from medical records for both the outbreak and non-outbreak groups. For infected patients, we collected information on clinical symptoms, severity, treatments, and vaccination status. The proportion of post-stroke patients with COVID-19 who died of COVID-19 during the outbreak period was calculated as the hospital-acquired infection mortality rate due to COVID-19 among post-stroke patients. FIM scores were assessed at both admission and discharge from the rehabilitation wards. The FIM consists of 18 items, including 13 motor and 5 cognitive tasks, with a maximum of 91 points for motor tasks and 35 points for cognitive tasks, for a total of 126 points [8]. Rehabilitation outcomes were evaluated using motor FIM gain (difference in motor FIM scores between admission and discharge) and total FIM gain (difference in total FIM scores) [9]. To account for ceiling effects in FIM gain, motor FIM effectiveness (motor FIM gain / [91 − motor FIM score on admission]) and total FIM effectiveness (FIM gain / [126 − admission total FIM score]) were calculated [9, 10]. The Brunnstrom Recovery Stage (BRS) of the paralyzed side [11] and the duration of rehabilitation therapy (total and daily) during the convalescent rehabilitation ward stay were also assessed. In the outbreak group, the duration of rehabilitation therapy during and outside the isolation period was also evaluated. Comparisons were made between the outbreak and non-outbreak groups, as well as between infected and non-infected patients within the outbreak group.

Finally, to examine whether the COVID-19 outbreak was associated with motor FIM effectiveness at discharge, while controlling for the impact of SARS-CoV-2 infection, we conducted multiple linear regression analysis with age, motor and cognitive FIM scores at admission, stroke type (ischemic or hemorrhagic), and SARS-CoV-2 infection status during the outbreak as explanatory variables and motor FIM effectiveness as the dependent variable.

6. Discharge Criteria

In Japan, post-stroke patients can stay in convalescent rehabilitation wards for up to 150 days, extended to 180 days if higher brain dysfunction is present [12]. Discharge was determined based on functional improvement and the ability to manage daily life within these time limits. Discharge during the outbreak period was permitted.

7. Statistical Analysis

Patient characteristics are reported as percentages for categorical data and medians (interquartile ranges) for continuous data. The Mann–Whitney U test or Fisher's exact test was used for comparisons between two groups. The impact of the COVID-19 outbreak on motor FIM effectiveness at discharge was assessed using multiple linear regression analysis. Covariates included factors previously reported to be associated with motor FIM effectiveness and clinically relevant factors (age, admission motor and cognitive FIM scores, stroke type, and SARS-CoV-2 infection) [13−15]. The number of covariates and their selection were based on sample size and multicollinearity considerations. Multicollinearity was considered absent if the variance inflation factor (VIF) was between 1 and 10. All statistical analyses were performed using JMP 16.0 (SAS Institute Japan, Tokyo, Japan), and statistical significance was set at $p < 0.05$.

Results

Figure 1 shows the flow of patients in the study population. During the outbreak period, 83 patients were admitted to our hospital's rehabilitation ward, including 47 post-stroke patients. Among them, 31 were infected with COVID-19, while 16 were not infected. One infected patient died due to exacerbation of chronic heart failure triggered by COVID-19. After excluding 16 patients, 30 patients were classified into the outbreak group. All non-infected patients in the outbreak group were considered close contacts as they were housed in the same room as infected patients. The hospital-acquired infection mortality rate due to COVID-19 among post-stroke patients during the outbreak was approximately 3.2% (1/31 cases). Among the 31 infected post-stroke patients, 5 (16.1%) developed COVID-19-related pneumonia, with 2 of these patients requiring oxygen therapy. No patients required ventilator management. Clinical symptoms included fever (n = 25; 80.6%), sore throat (n = 11; 35.4%), cough (n = 10; 32.2%), and difficulty in moving (n = 1; 3.2%). One infected patient (3.2%) was asymptomatic. The median isolation period for COVID-19 patients was 16 days. Remdesivir was administered to 25 patients (80.6%), and 6 patients (19.4%) were kept under observation. In the control group, 59 post-stroke patients were admitted during the corresponding period, with 26 patients excluded, leaving 33 patients in the non-outbreak group. There were no new COVID-19 infections outside of the outbreak period in either group.

Table 1 presents the patient characteristics in the outbreak and non-outbreak groups. There were no significant differences in patient backgrounds between the two groups. Table 2 shows the discharge outcomes of the outbreak and non-outbreak groups. No patients from the outbreak group were discharged during the outbreak period. Although there were no significant differences between the two groups in motor FIM

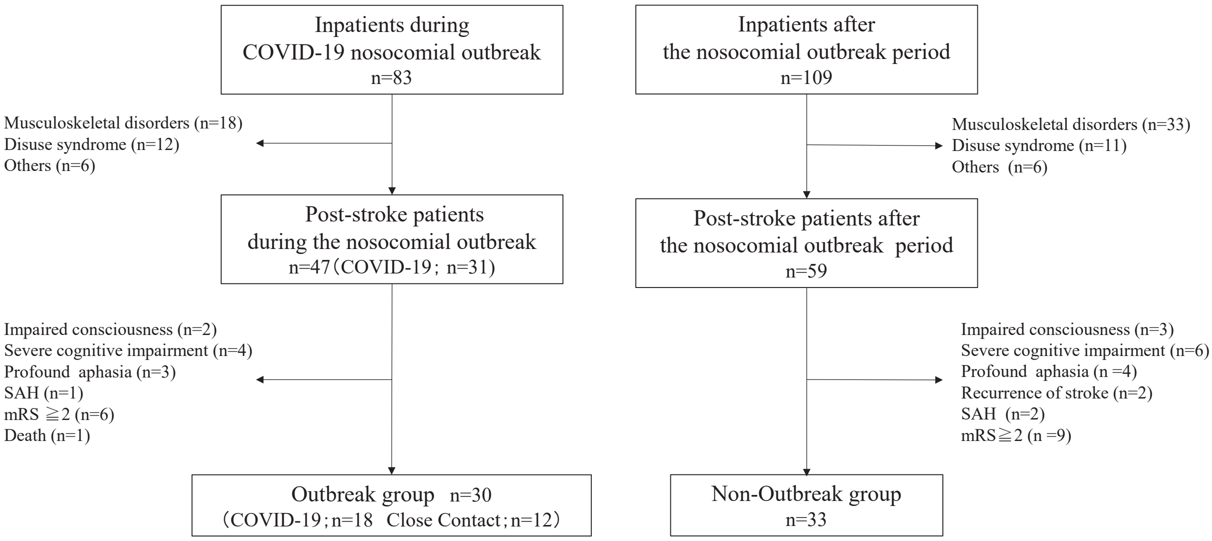

Figure 1. Study Participants in Outbreak and Non-Outbreak Groups.
Flow of patients through the study. Abbreviations: COVID-19, coronavirus disease 2019; mRS, modified Rankin Scale; SAH, subarachnoid hemorrhage.

Table 1. Patient Characteristics in Outbreak and Non-Outbreak Groups.

Variables	Outbreak group (*n*=30)	Non-Outbreak group (*n*=33)	*p*-value
Age, years	74.0 (70.3, 83.0)	79.0 (69.0, 86.0)	0.57
Male sex, %	53.3	48.5	0.80
Body mass index, kg/m^2	21.9 (20.7, 22.6)	21.6 (20.4, 22.3)	0.31
Comorbidities, %			
Diabetes	33.3	27.3	0.78
Hypertension	63.3	81.8	0.15
Chronic kidney disease	16.7	27.3	0.37
Hyperlipidemia	40.0	33.3	0.61
Infarction/Hemorrhage, %	53.3/46.7	72.7/27.3	0.13
BRS I/II/III/IV/V/VI, %			
Upper limb	3.3/23.8/10.0/16.7/30.0/16.7	9.1/24.2/6.1/9.1/42.4/9.1	0.66
Hand/finger	10.0/11.1/16.7/20.0/30.0/13.3	15.2/12.1/3.0/18.2/39.4/12.1	0.53
Lower limb	3.3/16.7/16.7/10.0/43.3/10.0	6.1/24.2/9.1/12.1/39.4/9.1	0.91
HDS-R	20.0 (12.5, 24.0)	19.0 (15.0, 25.5)	0.48
MMSE	21.0 (16.0, 24.0)	20.0 (14.5, 25.0)	0.97
Interval between onset and admission, days	21.5 (17.8, 43.0)	20.0 (12.0, 33.5)	0.10
FIM score at admission			
Motor score	25.0 (18.0, 42.8)	30.0 (17.5, 41.0)	0.78
Cognition score	19.5 (13.0, 25.0)	23.0 (16.5, 26.0)	0.15
Total score	42.5 (36.0, 67.0)	48.0 (41.0, 66.5)	0.48

Data are presented as the median (interquartile range) or as a percentage. *P*-values represent comparisons between the Outbreak and the non-Outbreak groups. Abbreviations: BRS, Brunnstrom recovery stage; FIM, Functional Independence Measure; HDS-R, Hasegawa Dementia Scale-Revised; MMSE, Mini-Mental State Examination.

scores or total FIM scores, the cognitive FIM scores were significantly lower in the outbreak group (p = 0.04). Motor FIM gain and total FIM gain were also significantly lower in the outbreak group (both $p < 0.01$). Furthermore, motor FIM effectiveness and total FIM effectiveness were significantly lower in the outbreak group (outbreak group vs. non-outbreak group: motor FIM effectiveness, median 0.27 vs. 0.44, p = 0.04; total FIM effectiveness, 0.22 vs. 0.41, p = 0.02). There were no significant differences between the two groups in terms of discharge BRS or the length of stay in the rehabilitation ward. The total duration of rehabilitation therapy and daily duration were both significantly shorter in the outbreak group (outbreak group vs. non-outbreak group; median 172.2 h vs. 253.0 h, p = 0.04; 116 min/day vs. 160 min/day, p <

Table 2. Rehabilitation Outcomes at Discharge in Outbreak and Non-Outbreak Groups.

Variables	Outbreak group (*n*=30)	Non-Outbreak group (*n*=33)	*p*-value
FIM score			
Motor score	40.5 (27.0, 69.5)	61.0 (44.0, 74.5)	0.11
Cognition score	20.5 (13.0, 26.3)	24.0 (20.5, 30.0)	**0.04**
Total score	59.0 (45.8, 91.0)	84.0 (66.0, 103.0)	0.09
Motor FIM gain	14.0 (9.0, 24.0)	25.0 (15.5, 35.0)	**<0.01**
FIM gain	16.0 (9.0, 24.0)	31.0 (19.0, 38.5)	**<0.01**
Motor FIM effectiveness	0.27 (0.13, 0.51)	0.44 (0.32, 0.71)	**0.04**
FIM effectiveness	0.22 (0.11, 0.36)	0.41 (0.30, 0.63)	**0.02**
BRS I/II/III/IV/V/VI, %			
Upper limb	0/3.3/23.3/13.3/50.0/10.0	9.1/9.1/3.0/12.1/48.5/18.2	0.09
Hand/finger	3.3/6.7/10.0/16.7/53.3/10.0	9.1/9.1/0/9.1/51.5/21.2	0.19
Lower limb	0/3.3/13.3/23.3/50.0/10.0	3.0/9.1/12.1/12.1/33.3/30.3	0.17
LOS in convalescent rehabilitation ward, days	95.0 (66.0, 126.0)	95.0 (51.0, 141.0)	0.93
Total duration of rehabilitation therapy, h	172.2 (129.9, 249.5)	253.0 (142.3, 379.7)	**0.04**
Daily duration of rehabilitation therapy, min	116.0 (104.0, 122.0)	160.0 (152.0, 167.0)	**<0.01**

Data are presented as the median (interquartile range). *P*-values represent comparisons between the Outbreak and the non-Outbreak groups. Statistically significant *p*-values (<0.05) are in bold. Abbreviations: BRS, Brunnstrom recovery stage; COVID-19, coronavirus disease 2019; FIM, Functional Independence Measure; LOS, length of stay.

0.01).

Next, we compared the outcomes of COVID-19 and close contact patients within the 30 cases of the outbreak group. The outbreak group consisted of 18 COVID-19 patients and 12 close contacts. Table 3 shows the patient characteristics of COVID-19 patients and close contacts. There were no significant differences in patient backgrounds between the COVID-19 patients and close contacts. The rehabilitation outcomes at discharge are shown in Table 4. There were no significant differences between these two groups in motor FIM gain, total FIM gain, motor FIM effectiveness, or total FIM effectiveness. During the isolation period, the daily duration of rehabilitation therapy was significantly reduced in COVID-19 patients relative to close contacts (42.1 min/day vs. 77.1 min/day, $p < 0.01$). Additionally, the daily duration during the total hospitalization period in the rehabilitation ward was decreased in COVID-19 patients (111.0 min/day vs. 119.0 min/day, $p = 0.04$). There were no significant differences in the daily duration of rehabilitation therapy outside the isolation period or in the total duration of rehabilitation therapy.

Table 5 shows the results of the multivariate linear regression analysis on motor FIM effectiveness at discharge in the context of the nosocomial COVID-19 outbreak. After adjusting for age, FIM motor and FIM cognition scores at admission, types of stroke, and nosocomial SARS-CoV-2 infection, three factors were found to be associated with motor FIM effectiveness at discharge: FIM motor score ($\beta = 0.553$, $p < 0.01$), FIM cognition score at admission ($\beta = 0.241$, $p = 0.011$), and nosocomial COVID-19 outbreak ($\beta = -0.275$, $p = 0.019$).

Discussion

The occurrence of a nosocomial COVID-19 outbreak in a convalescent rehabilitation ward was shown to result in reduced rehabilitation outcomes at discharge. Furthermore, the outbreak had a significant impact on the outcomes of post-stroke patients at discharge, regardless of whether they contracted SARS-CoV-2 during the outbreak period.

To our knowledge, this is the first study to evaluate the impact of a nosocomial COVID-19 outbreak on the rehabilitation outcomes of post-stroke patients at discharge from a convalescent rehabilitation ward. In addition, the novelty of this study lies in the fact that it assessed the outcomes of both infected patients and close contacts during the outbreak. Post-stroke patients were chosen as the focus of this study because rehabilitation therapy is critical for functional improvement, particularly in the convalescent phase, where the quality of rehabilitation therapy has a significant impact on functional outcomes of patients. It is known that functional recovery after stroke typically reaches a plateau at 3 to 6 months after onset [16, 17], and it has been reported that increasing the duration of rehabilitation therapy improves FIM gain [18]. We believed that examining the impact of the nosocomial outbreak during this limited period would contribute to improving the quality of rehabilitation therapy and strengthening infection control measures.

The risk of nosocomial infection in rehabilitation facilities had been reported even before the COVID-19 pandemic [19, 20]. Hospital-acquired infection mortality due to COVID-19 and severity rates are higher than those of community-acquired infections [21], and the

Table 3. Patient Characteristics of COVID-19 Patients and Close Contacts in the Outbreak Group.

Variables	Outbreak group (*n*=30)		*p*-value
	COVID-19 (*n*=18)	Close Contact (*n*=12)	
Age, years	77.5 (72.0, 83.5)	72.5 (67.3, 76.3)	0.09
Male sex, %	62.5	50.0	0.77
Body mass index, kg/m^2	21.5 (20.4, 22.4)	22.1 (21.5, 23.1)	0.26
Comorbidities, %			
Diabetes	38.9	25.0	0.69
Hypertension	61.1	66.7	0.76
Chronic kidney disease	11.1	25.0	0.59
Hyperlipidemia	44.4	33.3	0.36
Infarction/Hemorrhage, %	66.7/33.3	33.3/66.7	0.13
BRS I/II/III/IV/V/VI, %			
Upper limb	0/22.2/5.6/27.8/27.8/16.7	8.3/25.0/16.7/0/33.3/0	0.16
Hand/finger	11.1/5.6/16.7/27.8/27.8/11.1	8.3/16.7/16.7/8.3/33.3/16.7	0.75
Lower limb	0/11.1/16.7/16.7/50.0/5.6	8.3/25.0/16.7/0/33.3/16.7	0.22
HDS-R	18.5 (11.0, 24.0)	21.0 (18.0, 24.0)	0.15
MMSE	19.5 (15.0, 24.0)	22.0 (18.0, 24.0)	0.33
Interval between onset and admission, days	28.5 (15.0, 64.0)	21.5 (19.0, 25.0)	0.36
FIM score at admission			
Motor score	25.5 (18.8, 40.5)	24.0 (17.3, 61.8)	0.58
Cognition score	19.0 (13.0, 25.0)	21.5 (12.0, 24.8)	0.83
Total score	45.5 (36.8, 61.3)	41.0 (35.0, 85.3)	0.71
COVID-19 Vaccinated within 6 months, %	88.2	88.9	0.96

Data are presented as the median (interquartile range) or as a percentage. *P*-values represent comparisons between the Outbreak and the non-Outbreak groups. Abbreviations: BRS, Brunnstrom recovery stage; FIM, Functional Independence Measure; HDS-R, Hasegawa Dementia Scale-Revised; MMSE, Mini-Mental State Examination.

Table 4. Rehabilitation Outcomes at Discharge of Patients with COVID-19 and Close Contacts in the Outbreak Group.

Variables	Outbreak group (*n*=30)		*p*-value
	COVID-19 (*n*=18)	Close Contact (*n*=12)	
FIM score at discharge			
Motor score	44.5 (27.0, 61.5)	35.5 (26.5, 88.5)	0.51
Cognition score	19.5 (13.8, 26.5)	24.0 (12.3, 26.8)	0.75
Total score	68.0 (44.5, 86.8)	51.5 (46.3, 116.3)	0.67
Motor FIM gain	17.5 (8.0, 24.0)	12.0 (9.5, 24.5)	0.87
FIM gain	21.0 (8.5, 26.8)	12.5 (9.5, 26.0)	0.42
Motor FIM effectiveness	0.31 (0.11, 0.43)	0.17 (0.14, 0.94)	0.46
FIM effectiveness	0.26 (0.10, 0.35)	0.15 (0.11, 0.66)	0.97
BRS at discharge I/II/III/IV/V/VI, %			
Upper limb	0/0/16.7/22.2/55.6/5.6	0/8.3/33.3/0/41.7/16.7	0.10
Hand/finger	0/11.1/5.6/16.7/61.1/5.6	8.3/0/16.7/16.7/41.7/16.7	0.29
Lower limb	0/0/5.6/27.8/61.1/5.6	0/8.3/25.0/16.7/33.3/16.7	0.18
LOS in convalescent rehabilitation ward, days	97.5 (64.0, 142.8)	83.0 (66.3, 121.3)	0.32
Isolation period, days	16.0 (13.8, 17.3)	14.0 (14.0, 14.0)	**0.02**
Total duration of rehabilitation therapy, h	157.8 (133.0, 237.6)	191.0 (85.0, 301.0)	0.63
Daily duration of rehabilitation therapy, min			
Total hospitalization period	111.0 (80.0, 119.0)	119.0 (113.0, 124.0)	**0.04**
During isolation period	42.1 (30.5, 53.5)	77.1 (62.9, 80.3)	**<0.01**
Outside isolation period	119.6 (103.0, 129.3)	129.8 (121.2, 134.8)	0.06

Data are presented as the median (interquartile range). Statistically significant *p*-values (<0.05) are in bold. Abbreviations: BRS, Brunnstrom recovery stage; COVID-19, coronavirus disease 2019; FIM, Functional Independence Measure; LOS, length of stay.

Table 5. Multivariate Linear Regression Analysis of Motor FIM Effectiveness at discharge.

Variables	B	β	95% CI	*p*-value
Age	–0.004	–0.151	–0.0079–0.0006	0.094
FIM motor score at admission	0.009	0.553	0.0062–0.0126	**<0.01**
FIM cognition score at admission	0.008	0.241	0.0018–0.0135	**0.011**
Nosocomial SARS-Cov-2 infection	–0.009	–0.003	–0.072–0.0697	0.979
Types of Stroke (Infarction; 0 Hemorrhage; 1)	0.041	0.138	–0.0110–0.0922	0.121
Nosocomial COVID-19 outbreak	–0.077	–0.275	–0.1412– –0.0128	**0.019**

R^2=0.63

Statistically significant *p*-values (<0.05) are in bold. Abbreviations: CI, confidence interval; COVID-19, coronavirus disease 2019; FIM, Functional Independence Measure; SARS-Cov-2, Severe Acute Respiratory Syndrome Coronavirus 2.

hospital-acquired infection mortality rate of the Omicron variant, which was prevalent during the study period, is reported to be between 0% and 4.5% [21−23], whereas the mortality rate for community-acquired infections in Japan is < 1% [1]. In this study, the hospital-acquired infection mortality rate among post-stroke patients was approximately 3.2% (1 of 31 cases), which is consistent with previous reports of the mortality rate of the Omicron variant. Furthermore, in this study, approximately 16.1% of the cases (5 of 31) were classified as moderate severity, (i.e., requiring oxygen therapy or developing pneumonia), which is higher than the proportion observed in community-acquired moderate Omicron infections in Japan (4.0% to 6.0%) [1]. The U.S. Centers for Disease Control and Prevention (CDC) lists cerebrovascular disease as an underlying condition associated with severe COVID-19 [24]. Therefore, post-stroke patients in convalescent rehabilitation wards should continue to be regarded as a high-risk group for SARS-CoV-2 infection, even after the end of the pandemic.

Additionally, during the outbreak, the duration of rehabilitation therapy was significantly restricted, which is believed to have greatly impacted rehabilitation outcomes. Thus, it is reasonable to conclude that the decrease in motor FIM effectiveness at discharge in the outbreak group was inevitable. On the other hand, a key point emphasized in the results of this study is that, despite a significant reduction in daily rehabilitation hours among COVID-19 patients relative to close contacts, there was no significant difference in outcomes between them. Furthermore, after adjusting for the effect of SARS-CoV-2 infection, the nosocomial outbreak was still associated with rehabilitation outcomes at discharge. This suggests that the experience of the nosocomial outbreak during the hospitalization period, rather than the SARS-CoV-2 infection itself, had an impact on patients' functional recovery.

Factors contributing to the lack of significant differences in discharge outcomes between COVID-19 patients and close contacts may include the effects of isolation, ward closures, and the impact on the training environment and content due to infection of medical staff. Luker et al. pointed out that isolation during COVID-19 outbreaks could lead to a shortage of rehabilitation resources and space, potentially restricting activities that promote social engagement and independence [25]. In this study, although COVID-19 patients experienced significantly restricted training time, particularly during isolation, both COVID-19 patients and close contacts were limited to physical therapy in their rooms during isolation. As a result, they could not participate in walking training in larger spaces, ADL training, or social skills training, nor could they engage in appropriately challenging tasks tailored to their individual needs. Even after isolation was lifted, training during the outbreak period remained restricted to within the ward. Reports prior to the COVID-19 pandemic indicated that isolation measures and contact precautions reduced the amount of time healthcare staff spent with patients [25−28]. In addition, the staff shortage caused by numerous infections among ward personnel led to difficulties in nursing care and delays in rehabilitation therapy schedules. These factors likely had a significant impact on the rehabilitation outcomes of not only COVID-19 patients but also close contacts during the post-stroke convalescent period.

This study was associated with some limitations. First, the single-facility design and limited sample size may limit the generalizability of the results. Second, because infection prevention measures during the COVID-19 pandemic (e.g., isolation periods and rehabilitation treatment protocols) varied from facility to facility, it is challenging to generalize the results. Third, we did not investigate the psychological effects of the outbreak on patients and the relationship of those effects with outcomes. Fourth, the study period coincided with the global COVID-19 pandemic, during which factors such as delays in the certification process for long-term care insurance, the occurrence of COVID-19 outbreaks in our acute care ward, and delays in transfer to care facilities affected both the length of hospitalization and the time from onset to admission to the recovery phase ward. These factors were not examined in this study. However, the results of this study highlight the significant impact of a nosocomial COVID-19 outbreak on clinical presentation and rehabilitation therapy for post-stroke patients in convalescent rehabilitation settings and underscore the importance of addressing these issues. Even as infection control measures in healthcare facilities are being relaxed following the end of the COVID-19 pandemic, the impact of nosocomial outbreaks in inpatient rehabilitation facilities remains significant. Moving forward, it is essential to strengthen risk management during outbreaks in rehabilitation environments and implement measures to maximize functional recovery of patients.

Acknowledgments

This research was supported by JSPS KAKENHI Grant Number JP 22K11329.

We extend our sincere appreciation to the Director of Midorigaoka Hospital for their continuous support and guidance throughout this study. We also gratefully acknowledge the dedicated staff of the convalescent rehabilitation wards for their invaluable assistance in conducting this research.

References

1. Ministry of Health, Labor and Welfare (2023, May 8): Visualizing the data: information on COVID-19 infections. https://covid19.mhlw.go.jp/en/
2. Japanese Society for Infection Prevention Control (2023, Jan 17): Guidelines for Responding to COVID-19 in Healthcare Institutions 5th Edition (In Japanese) http://www.kankyokansen.org/
3. Jasper NR, Cifu DX, Edinger JM, Edmunds M, Ketchum JM. The effect of contact isolation on inpatient rehabilitation outcomes. PM R 2010; 2: S34.
4. Berdale C, Del Toro D, Sergey T. Impact of contact isolation on FIM score change, FIM efficiency score, and length of stay in patients in acute inpatient rehabilitation facility. PM R 2014; 6: 988−91.
5. The Japanese Association of Rehabilitation Medicine (2023, Feb 18): Infection Prevention Guidelines (In Japanese) https://www.jarm.or.jp/document/guideline_jarm_infection.pdf
6. Kato S, Shimogaki H, Onodera A, Ueda H, Oikawa K, Ikeda K, et al. Development of the revised version of Hasegawa's Dementia Scale (HDS-R). Jpn J Geriatr Psychiatry. 1991; 2: 1339−47.
7. Van Swieten JC, Koudstaal PJ, Visser MC, Schouten HJ, Van Gijn J. Interobserver agreement for the assessment of handicap in stroke patients. Stroke 1988; 19: 604−7.
8. Keith R, Granger C, Hamilton B, Sherwin F. The Functional Independence Measure: a new tool for rehabilitation. Adv Clin Rehabil 1987; 1: 6−18.
9. Koh GC-H, Chen CH, Petrella R, Thind A. Rehabilitation impact indices and their independent predictors: a systematic review. BMJ Open. 2013; 3: e003483
10. Tokunaga M, Ugai S, Ise M, Nagata T, Miyakoshi K. ADL Improvement in Kaifukuki Rehabilitation. Jpn J Rehabil Med 2018; 55: 305−8. Japanese.
11. Brunnstrom S. Motor testing procedures in hemiplegia: based on sequential recovery stages. Phys Ther 1966; 46: 357−75.
12. Ministry of Health, Labor and Welfare (2024, May 11): https://www.mhlw.go.jp/
13. Meyer MJ, Shelialah P, Andrew M, Robert T, Amardeep T, John K, et al. A systematic review of studies reporting multivariable models to predict functional outcomes after post-stroke inpatient rehabilitation. Disabil Rehabil 2015; 37: 1316−23.
14. Spielmanns M, Pekacka-Egli AM, Cecon M, Witassek F, Schoendorf S, Lutz D, et al. COVID-19 Outbreak During Inpatient Rehabilitation: Impact on Settings and Clinical Course of Neuromusculoskeletal Rehabilitation Patients. Am J Phys Med Rehabil 2021; 100: 203−8.
15. Tokunaga M, Watanabe S, Sonoda S. A Method of Calculating Functional Independence Measure at Discharge from Functional Independence Measure Effectiveness Predicted by Multiple Regression Analysis Has a High Degree of Predictive Accuracy. J Stroke Cerebrovasc Dis 2017; 26: 1923−8.
16. Duncan PW, Lai SM, Keighley J. Defining post-stroke recovery: implications for design and interpretation of drug trials. Neuropharmacology 2000; 39: 835−41.
17. Verheyden G, Nieuwboer A, De Wit L, Thijs V, Dobbelaere J, Devos H, Severijns D, Vanbeveren S, De Weerdt W: Time course of trunk, arm, leg, and functional recovery after ischemic stroke. Neuro Rehabil Neural Repair 2008; 22: 173−9.
18. Kondo K. Convalescent Rehabilitation Medicine: The Past 20 Years, the Future 20 Years. Jpn J Rehabil Med 2021; 58: 468−81. Japanese.
19. Boonstra MB, Spijkerman DCM, Voor In't Holt AF, Van Der Laan RJ, Bode LGM, Van Vianen W, et al. An outbreak of ST307 extended-spectrum betalactamase (ESBL)-producing Klebsiella pneumoniae in a rehabilitation center: An usual source and route of transmission. Infection Control Hosp Epidemiol 2020; 41: 31−6.
20. Warnke P, Köller T, Kreikemeyer B, Barrantes I, Mach H, Podbielski A. Molecular epidemiology study of a nosocomial Moraxella catarrhalis outbreak in a neurological rehabilitation unit. J Hosp Infect 2019; 103: 27−34.
21. Hawkins LPA, Pallett SJC, Mazzella A, Anton-Vazquez V, Rosas L, Jawad SM, et al. A. Transmission dynamics and associated mortality of nosocomial COVID-19 throughout 2021: A retrospective study at a large teaching hospital in London. J Hosp Infect 2023; 133: 62−9.
22. Leal J, O'Grady HM, Armstrong L, Dixit D, Khawaja Z, Snedeker K, et al. Patient and ward related risk factors in a multi-ward nosocomial outbreak of COVID-19: Outbreak investigation and matched case–control study. Antimicrob Resist Infect Control 2023; 12: 21.
23. Sohn YJ, Shin PJ, Oh WS, Kim E, Kim Y, Kim YK. Clinical Characteristics of Patients Who Contracted the SARS-CoV-2 Omicron Variant from an Outbreak in a Single Hospital. Yonsei Med J 2022; 63: 790−3.

24. Centers for Disease Control and Prevention (2023, Feb 9). Underlying Medical Conditions Associated with Higher Risk for Severe COVID-19: Information for Healthcare Prfessionals. https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-care/underlyingconditions.html
25. Luker S, Laver K, Lane R, Potter E, Harrod AM, Bierer P, et al. 'Put in a room and left': a qualitative study exploring the lived experiences of COVID-19 isolation and quarantine among rehabilitation inpatients. Ann Med 2023; 55: 198−206.
26. Abad C, Fearday A, Safdar N. Adverse effects of isolation in hospitalised patients: a systematic review. J Hosp Infect 2010; 76: 97−102.
27. Evans HL, Shaffer MM, Hughes MG, Smith RL, Chong TW, Raymond DP, et al. Contact isolation in surgical patients: a barrier to care? Surgery 2013; 134: 180−8.
28. Fan PEM, Aloweni F, Lim SH, Ang SY, Perera K, Quek AH, et al. Needs and concerns of patients in isolation care units-learnings from COVID-19: a reflection. World J Clin Cases 2020; 8: 1763−66.