Original Article

Comparative Analysis of Functional Outcomes in Stroke Patients: First Admission Versus Readmission to Inpatient Rehabilitation

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ABSTRACT

Objectives: To explore potential differences in functional outcomes of stroke patients undergoing inpatient rehabilitation between their first admission and readmission to the rehabilitation ward.

Study design: Observational study design: retrospective chart review

Setting: A tertiary care hospital, Thailand. The inpatient ward (25 beds) of the Department of Rehabilitation Medicine, which has a limited admission period of up to 3 weeks.

Participant: Stroke patients over 18 years of age who were admitted between January 1, 2015, and December 31, 2020.

Methods: Using matched demographics, a comparison of functional outcomes between the first admission and readmission of stroke patients were conducted. Functional outcomes were evaluated based on changes in the Modified Barthel Index (MBI), rehabilitation efficiency (average increase in MBI scores per day), and rehabilitation effectiveness (potential improvement) comparing patients after their first admission and those following readmission.

Results: The demographic characteristics of patients at their first admission and readmitted patients showed no significant differences in age, sex, underlying disease, stroke classification, hemineglect, aphasia, dysphagia, motor power of the upper extremities, onset-to-admission interval, length of stay, or admission MBI score ($p > 0.05$). Functional outcomes were calculated and are presented as follows: The median of MBI changes were 2 (1, 5) for the first admission and 2 (1, 4) at readmission, with $r = 0.09$, $p = 0.19$; rehabilitation efficiency was 11 (6, 27) for the first admission and 10 (3, 18) at readmission, with $r = 0.14$, $p = 0.05$; and rehabilitation effectiveness was 25 (9, 50) for the first admission and 20 (5, 37) at readmission, with $r = 0.12$, $p = 0.10$.

Conclusions: The improvement in functional outcomes of stroke patients upon readmission to the rehabilitation ward showed no statistically significant difference compared to the improvement during their first admission when the length of stay was limited to 3 weeks. This suggests that in hospitals with a short length of stay, readmitting patients for further rehabilitation may be warranted. However, the results may not generalize to settings with a longer average length of stay. A study investigating the prognostic factors for functional outcome improvement in readmitted stroke patients is warranted.

Keywords: readmission, stroke, rehabilitation, length of stay, treatment outcome

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Introduction

Stroke is caused by inadequate vascular supply due to either blockage (ischemic stroke) or bleeding (hemorrhagic stroke), resulting in cell death from the disruption of oxygen and nutrients supplied by the blood. This leads to sudden weakness and numbness on one side of the body. The treatment consists of two phases. The first phase involves acute stroke therapies that aim to stop the progression of the disease, such as thrombolysis, mechanical thrombectomy, or surgery. However, patients still face many chronic or permanent disabilities after a stroke, despite rapid management.[1] As evidenced by statistical data in Thailand and around the world, stroke remains the leading cause of death and disability among patients over 60 years of age.[2] For that reason, the next phase of treatment, post-stroke rehabilitation, is crucial for reducing impairment and maximizing function as much as possible in stroke patients.[3]

Neurological recovery following a stroke involves two primary mechanisms. The first mechanism is natural recovery, which occurs as cerebral edema decreases and blood circulation is restored in the penumbra region. The second mechanism involves neural plasticity, where neurons undergo repair and reorganization; this process is enhanced through practice and learning during rehabilitation. Research indicates that the month following the onset of a stroke is the most critical period for neurological recovery. The typical duration of the recovery process is 3 to 6 months, beyond which there are few notable changes in neurological outcomes.[4-6]

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Post-stroke rehabilitation is generally divided into three phases. The first phase is the acute phase, which begins 24 hours post-stroke, during which patients are encouraged to engage in early mobilization, such as bed mobility and sitting, to prevent immobilization syndrome. Once the medical conditions are stable, the rehabilitation phase begins. This period focuses on the restoration and compensation for diminished physical abilities. After the patients' functions are improved, the final phase, the community phase, begins. Patients need to be prepared before returning to their daily routines.[3, 7, 8]

Numerous studies demonstrate that rehabilitation initiated within the first month after a stroke yields the most favorable functional outcomes.[9, 10] However, at Siriraj Hospital, the number of patients exceeds the capacity of the medical staff, leading to long waiting times for patients to receive initial intensive rehabilitation.[11] As a result, the average time from stroke onset to rehabilitation in our rehabilitation ward has increased to 30 days. In addition to the delayed onset of rehabilitation, a longer length of stay is also associated with better outcomes.[12] According to Bindawas et al., the length of stay for stroke patients in inpatient rehabilitation facilities shows significant variation across countries. For instance, the average length of stay for stroke patients in the United States is approximately 16.5 days. In contrast, Canada's average length of stay ranges widely from 23 to 49 days, Australia averages 28 days, and New Zealand averages 30 days. The average length of stay in Saudi Arabia was notably higher at 45 days during the 2005-2008 period. Studies suggested that these differences in length of stay across settings and countries are largely attributable to systemic factors, including insurance models, healthcare coverage policies, and the quantity and quality of available inpatient rehabilitation facilities.[13, 14] The results of these studies are in line with the situation in Siriraj Hospital, where the length of stay in the rehabilitation ward is limited to under three weeks due to insufficient resources. Hospital staff at Siriraj additionally have to manage a large number of referral patients from secondary care hospitals. Due to limited beds and staff, the length of stay is restricted to 3 weeks to allow opportunities for other patients who are in the golden period of rehabilitation. This situation forces some patients to be discharged from the hospital before achieving their rehabilitation goals. As a consequence, these patients require readmission to the rehabilitation ward to reach their original goals. Additionally, several patients are initially admitted with severe neurological deficits, necessitating a wait for improved neurological status before they can be readmitted to begin rehabilitation programs again to achieve higher goals. In addition to patients being readmitted to reach previous or stepped-up goals, those with deconditioning can also be readmitted to restore function. According to the statistics from our hospital, we found that 1 in 5 stroke patients requires readmission.

It is evident that the issue of limited resources and strict length-of-stay policies is not unique to our facility, many healthcare systems worldwide encounter similar constraints. These challenges can significantly affect patient outcomes and underscore the need for effective rehabilitation strategies that optimize functional improvement within a limited timeframe.

Since no research studies have examined the outcomes following readmission, this study aims to evaluate the functional improvement in readmitted patients by comparing their pre- and post-admission functional scores with the outcomes of first-time admitted patients. The rationale for this comparison is to determine whether readmission provides significant benefits to patients. Understanding the implications of readmissions and rehabilitation efficacy in this context will contribute to the ongoing dialogue about resource allocation and patient care across various healthcare systems globally. We hypothesized that readmitted patients would demonstrate less functional improvement compared to those who were admitted for the first time, as these patients are likely to have already undergone substantial rehabilitation. If the outcomes following readmission are significantly inferior to those of first-time admission, outpatient rehabilitation should be considered instead. In contrast, if the study demonstrates that rehabilitation outcomes for our readmitted patients are not significantly different from those of first-time admitted patients, the length-of-stay limitation of three weeks should be reconsidered, and the importance of readmission should be emphasized.

Methods

Study design

The study design was single-center retrospective chart review and was reported following the STROBE 2025 guidelines for observational studies. The Siriraj Hospital Institutional Review Board approved this study, SIRB Protocol Number 274/2565, COA no.SI455/2022 (IRB4).

The study utilized a comparative analysis to assess differences in functional outcomes between stroke patients admitted for the first time and those who were readmitted. We hypothesized that patients in the first admission group would exhibit greater functional improvement compared to those who were readmitted. The reporting of this study adheres to the STROBE guideline for descriptive studies.

Participants

We conducted a single-center retrospective study on stroke patients who were admitted to the rehabilitation ward at Siriraj Hospital in Bangkok, Thailand, between 2015 and 2020. Siriraj Hospital has approximately 25 beds in the rehabilitation ward. The inpatient rehabilitation team comprises 30 rehabilitation residents, five physiatrists, 20 rehabilitation nurses, 20 physiotherapists, 20 occupational therapists, two speech therapists, three psychotherapists, and two social workers. During their admission, patients received physical therapy and occupational therapy for 1 hour per session,

once or twice a day throughout the week. If patients had language or psychiatric problems, speech therapy and psychotherapy were added as needed.

Intervention

We collected medical records of 923 stroke patients who were admitted to the rehabilitation ward between 2015 and 2020, all of whom were over 18 years old and diagnosed with stroke according to WHO criteria.[15] However, among these medical records, there may be instances of the same patients being admitted at different times. For example, if a patient was first admitted on February 3, 2016, and readmitted on May 18, 2016, there would be two separate medical records for that patient. Patient demographic data were recorded according to their status at the time of each admission. Medical records were excluded if the patients had: 1) unstable medical conditions during their hospital stay, 2) other neurologic complications (e.g., cervical myelopathy, meningioma), 3) admission Modified Barthel Index scores greater than 18 out of 20 (to avoid a ceiling effect), 4) disapproval of discharge (e.g., the patient declined to stay at the hospital), and 5) incomplete medical records regarding the Modified Barthel Index score. Patients with admission scores above 18 were excluded to prevent the ceiling effect, which occurs when a high initial score limits the ability to observe further improvements. This ensures that we analyzed individuals who still had potential for significant functional enhancement.[16, 17] Only one individual reviewed the medical records. A total of 842 medical records were included after exclusions. (Figure 1)

Outcome measurements

This study employed the modified version of the Barthel Index (MBI), introduced by Collin and Wade in 1988 as an outcome measurement tool. It consists of 10 items designed to assess the activities of daily living of patients with neuromuscular or musculoskeletal disorders. The MBI demonstrates good reliability and validity in post-stroke patients, with scores ranging from 0 to 20, where a score of 20 indicates full independence.[18-20] The scores also classify patients into four groups: 0-4 indicates total dependence, 5-12 indicates severe dependence, 13-18 indicates moderate dependence, and 19-20 indicates slight dependence.[17]

Patients' MBI scores were evaluated by physiatrists at both admission and discharge. Study outcomes were measured by 1) MBI change = discharge MBI score - admission MBI score, 2) Rehabilitation efficiency,[21] average increase in MBI scores per day = (discharge MBI score - admission MBI score) ÷ LOS, and 3) rehabilitation effectiveness,[21] potential improvement = [(discharge MBI score - admission MBI score) ÷ (20 - admission MBI score)] x 100.

To evaluate the functional outcomes of stroke readmissions in our rehabilitation ward, we compared data in the records of first admissions and readmissions to assess the significant improvements in readmitted patients, either due to continuing their rehabilitation to reach previous goals or stepping up to higher goals in subsequent admissions, or refreshing their programs for those who experienced deconditioning. However, established evidence indicates that age, upper limb motor power, and the interval from stroke onset to rehabilitation have significant effects on the outcomes of the Barthel Index score in post-stroke patients. Patients with a younger age and better upper limb motor power tend to have better outcomes on the Barthel Index Score.[9, 10, 22]

To control for these confounding factors, we matched the first admission and readmission groups by age (within a 2-year range),[23] upper limb motor power (MRC grade ≤ 2 and MRC grade > 2),[24] stroke onset to rehabilitation (≤ 30 days, 31-90 days, > 90 days) and admission MBI score (scores of 0-4, scores of 5-12 and scores of 13-18) before comparing the functional outcomes.[9, 10] (Figure 2)

We also identified the causes of readmission and deconditioning, which were recorded by rehabilitation residents in the medical records.

Statistical methods

All statistical analyses were performed using IBM SPSS Statistics for Windows version 26.0 (IBM Corp, Armonk, NY). A p-value of less than 0.05 was considered statistically significant. Quantitative data were represented as mean (SD) for normal distributions and the median with interquartile range (IQR) for non-normal distributions, while qualitative data were represented by frequency and percentage. Case-control matching was conducted using MedCalc Statistical Software version 19.2.6 (MedCalc Software bv, Ostend, Belgium; https://www.medcalc.org; 2020). Patients were matched based on age, upper limb motor power, time from stroke onset to rehabilitation, and the admission Barthel Index score.

Descriptive statistics in Table1 were compared using the independent t-test and chi-square test. For changes in MBI, rehabilitation efficiency, and rehabilitation effectiveness be-

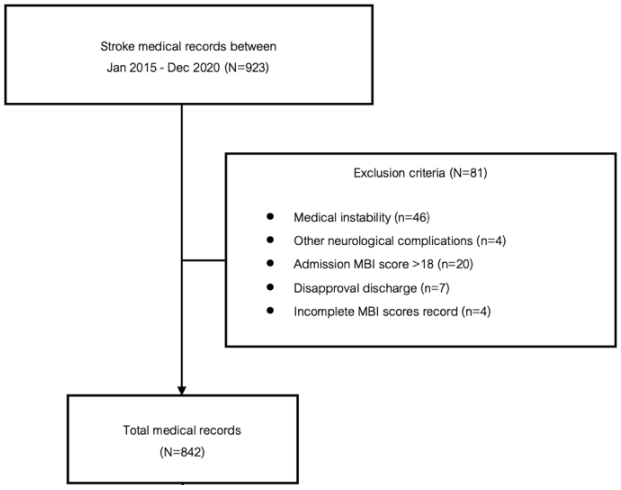


Figure1. Flow chart of participants in this study

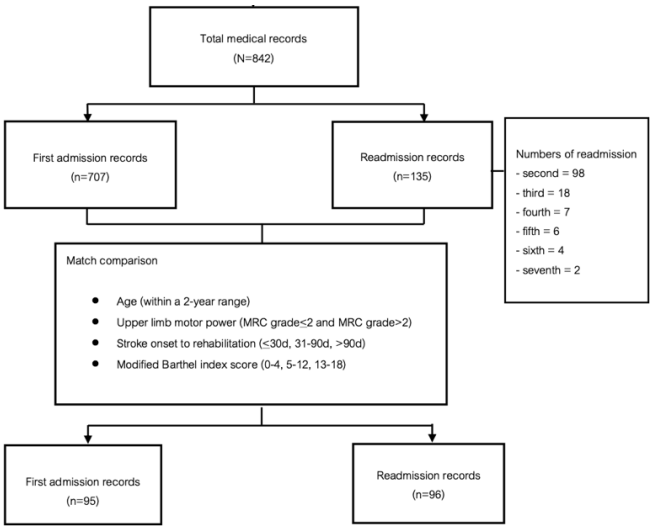


Figure 2. Flow of match comparison

Table 1. Demographic characteristics

	First admission n = 95	Readmission n = 96	[4]*p*-value
Age[1]	67.6 (11.3)	67.9 (11.2)	0.86
Female Gender[2]	36 (37.9)	43 (44.8)	0.33
Stroke classification[2]			
Ischemic	64 (67.4)	60 (62.5)	0.48
Hemorrhagic	31 (32.6)	36 (37.5)	0.48
Hemineglect[2]	12 (12.6)	15 (15.6)	0.55
Aphasia[2]	26 (27.4)	16 (16.7)	0.07
Dysphagia[2]	47 (49.5)	42 (43.8)	0.43
Motor power [2]			
UE3 proximal > [2]	35 (36.8)	36 (37.5)	0.93
UE3 distal > [2]	29 (30.5)	28 (29.2)	0.84
Onset to admission interval[2]			
< 30 days	2 (2.1)	2 (2.1)	0.99
31-90 days	17 (17.9)	17 (17.7)	0.99
> 90 days	76 (80.0)	77 (80.2)	0.99
Length of stay[1]	18.8 (6.4)	20.6 (6.8)	0.64
MBI score at admission[1]	7.78 (5.13)	8.02 (5.07)	0.74

[1]Mean (SD), [2]Number (percentage), [3]Upper extremities, [4]Statistical comparisons are shown for transparency; groups were matched on these variables by design

tween these two groups, the study employed the Mann-Whitney U-test. We hypothesized that readmitted patients would demonstrate less functional improvement compared to those who were admitted for the first time. If the *p*-value obtained for the functional outcomes between the two groups is not < 0.05, outpatient rehabilitation should be considered as an alternative to readmission.

We also calculated the 95% confidence intervals (CIs) for the descriptive data in Table 3. Effect size was calculated using the correlation effect size (*r*) derived from the z-value obtained through the Mann-Whitney U test. The interpretation of the effect size was referenced from Cohen, who categorized effect sizes as small (*r* = 0.1), medium (*r* = 0.3), and large (*r* = 0.5).[25] As no research on readmission outcomes has been published, we calculated the sample size based on the methodology of Wattanapan et al., who also collected data from rehabilitation wards in Thailand.[26] The sample size was estimated using n4Studies: an application for sample size calculation in health science research, version 2.2 (App Store; 2023).[27] Based on a statistical power of 0.8 and an alpha level of 0.05, the estimated sample size was determined to be at least 55 medical records per group.

Results

A total of 842 eligible stroke medical records (Figure 1) were divided into first admissions (n = 707) and readmissions (n = 135). After matching and comparison, only 191 records were included, comprising first admission charts (n = 95) and readmission charts (n = 96). In the readmission group, the timing of readmissions ranged from the second to the seventh admission. (Figure 2)

Table 2. Readmission characteristics

	Readmission N = 96
Numbers of readmissions[1]	
2	74 (77.1)
3	14 (14.6)
4	2 (2.1)
5	4 (4.2)
6	1 (1.0)
7	1 (1.0)
Cause of readmission[1]	
Improve function	57 (59.4)
Deconditioning	32 (33.3)
Others	7 (7.3)

[1]Number (percentage)

Table 1 presents the demographic characteristics of the patients. There were no significant differences in age, sex, underlying disease, stroke classification, hemineglect, aphasia, dysphagia, motor power of the upper extremities, onset-to-admission interval, length of stay, and admission MBI score. Because first-time admission patients had to match their waiting time with that of the readmission patients, the majority of participants in this study had a waiting time to admis-sion of more than 90 days, which contrasts with the average onset-to-admission interval mentioned above. These first-time admission patients experienced delays in admission due to a complicated patient referral system and issues related to medical rights.

In this study, the groups were matched based on relevant demographic and clinical characteristics to control for confounding variables. It is important to note that statistical comparisons of matched variables were intentionally designed to be equivalent on these parameters.

Table 2 provides details about readmission. The causes of readmission were classified based on a thorough review of resident notes. After matched comparison, the records indicate that readmissions occurred between two to seven times, with the highest percentage (77.1%) occurring during the second readmission. The majority of patients were readmitted to improve function (59.4%), continuing from their last admission. The second most common reason for readmission was deconditioning (33.3%). (Figure 3) The remaining patients (7.3%) were readmitted to relieve caregiver stress, which emerged as a leading cause of high readmission rates for patients with more than three readmissions, as shown in Table 2.

In patients with deconditioning (n = 32), the majority of cases were attributed to post-stroke complications (34.4%), such as pneumonia and urinary tract infections, followed by caregiver neglect and lack of social support (28.1%). Although these patients required caregivers to facilitate ambulation and exercise, some caregivers reported being too fatigued and lacking the time to engage in these activities. Additionally, some caregivers were too frail to assist patients with exercise, compounded by financial issues that made it difficult to involve therapists. All of these factors were identified as contributing to caregiver neglect and insufficient social support. Other issues included family-related difficulties (18.7%), such as fear of pain or falling during home exercises or avoiding community ambulation due to the COVID-19 pandemic, as well as a lack of motivation among patients (9.4%) and fall accidents (9.4%). (Figure 4)

Table 3 presents a comparison of outcomes between first admission and readmission. No significant differences were observed in MBI change (r = 0.09, p = 0.19) or rehabilitation effectiveness (r = 0.12, p = 0.10). For rehabilitation efficiency, the comparison yielded a p-value of 0.05, which is considered the borderline level of statistical significance. However, when interpreted in conjunction with the effect size (r = 0.14), we conclude that there is no clear evidence of a significant difference.

When examining the MBI change, it was observed that the median value was 2 for both first-admission and readmission patients. This value exceeds the minimal clinically important difference (MCID) of the MBI score, which is 1.85.[28] Therefore, this change can be interpreted as having clinical significance for the patients.

Discussion

In this study, the results do not align with the hypothesis we established. No significant differences were observed in MBI change, rehabilitation efficiency, or rehabilitation effec-

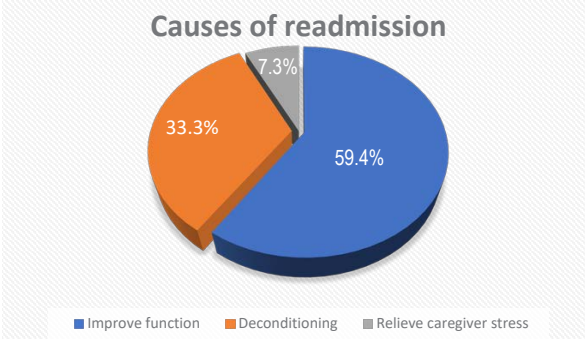


Figure 3. Causes of readmission

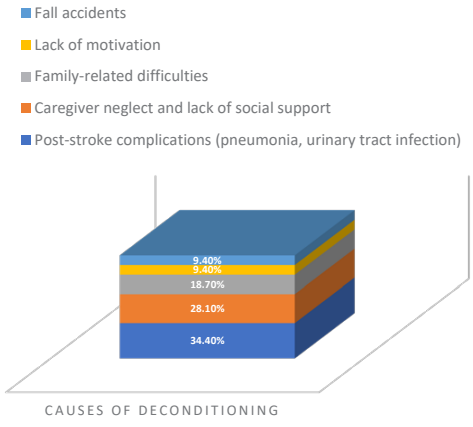


Figure 4. Causes of deconditioning

Table 3. Outcomes comparison

Outcome measures	First admission	Readmission	Effect size	*p*-value
MBI change	2 (1, 5)[1] 95%CI (2, 3)	2 (1, 4)[1] 95%CI (1, 3)	0.09	0.19[a]
Efficiency[2]	11 (6, 27)[1] 95%CI (10, 19)	10 (3, 18)[1] 95%CI (7, 14)	0.14	0.05[a]
Effectiveness[3]	25 (9, 50)[1] 95%CI (18, 33)	20 (5, 37)[1] 95%CI (13, 27)	0.12	0.10[a]

[1]Median (Q1, Q3), [a]Mann-Whitney U-test

$$^{2}\left(\frac{\text{discharge MBI score}-\text{admission MBI score}}{\text{length of stay}}\right)\times 100,\ ^{3}\left(\frac{\text{discharge MBI score}-\text{admission MBI score}}{20-\text{admission MBI score}}\right)\times 100$$

tiveness between first admissions and readmissions. Given these findings, it is essential to reassess the three-week length-of-stay limitation and to highlight the significance of readmission. Since there are no published studies on the functional outcomes of readmitted patients, the factors contributing to this equivalence in outcomes cannot be clearly determined. However, according to Table 2, most patients were readmitted to improve function, continuing from their previous admissions. It can be inferred that due to the limited three-week stay, some patients had not yet achieved their goals before discharge, leading to readmission for the continuation of their rehabilitation programs to reach their original targets. This finding aligns with the observations of O'Brien et al., who noted that a shorter length of stay correlated with a higher rate of failing to reach goals before discharge.[29] That study also demonstrated that a length of stay of 18 days, which is similar to ours, was associated with lower discharge Functional Independence Measure (FIM) scores than the predicted discharge FIM scores.[29] That is, readmitted patients were able to achieve greater functional improvement toward their original goals or to step up to higher goals in subsequent admissions.

According to Jørgensen et al., 80.0% of patients reached their best function within 3 weeks in mild strokes, within 7 weeks in moderate strokes, and within 12 weeks in severe strokes.[6] Therefore, some readmitted patients may have been initially admitted too early, resulting in only minimal functional improvement. In comparison, by the time of their readmission, their neurological and functional status had improved naturally, making them more suitable for rehabilitation than at the time of their first admission. Thus these patients still had the potential to improve their functional abilities, even after undergoing rehabilitation previously. This explanation is further supported by O'Brien et al., who stated that higher admission FIM scores are associated with greater functional improvement after inpatient rehabilitation.[29] Additionally, research supporting the idea that higher-dose repetitive task training yields significantly better rehabilitation outcomes compared to lower-dose training suggests that patients can continue to achieve improved functional outcomes during the readmission period.[30]

Some patients who were readmitted due to deconditioning from either post-stroke complications or caregiver neglect also had the capacity to restore their baseline functions and could still gain significant benefits from rehabilitation, which correlates with the findings of Kortebein and Suriyaarachchi et al.[31, 32]

This current study also examined the causes of deconditioning. We found that the majority of patients were affected by post-stroke complications such as urinary tract infections and pneumonia. Another significant cause to be aware of is caregiver neglect and low social support. Additionally, lack of motivation or depression was associated with deconditioning. These findings corroborate previous studies.[33, 34]

To address these complications, implementing proactive infection prevention strategies is essential. This action includes regular monitoring for signs of infection, early intervention, and education for both patients and caregivers about hygiene practices. Another significant cause to be aware of is caregiver neglect and low social support. To address this issue, structured caregiver support programs should be established, providing caregivers with training and resources; moreover, the lack of motivation or depression associated with deconditioning highlights the need for psychological support. Implementing routine mental health screenings and providing access to counseling and support groups can help address these emotional barriers. Furthermore, both extrinsic and intrinsic factors related to falling should be explored in greater detail.

Our study has two main strengths. The first is the use of matched comparison, which allowed us to eliminate most confounding factors that could affect the MBI score. Furthermore, there were no differences in other patient characteristics between the two groups. The second strength is that only one person was responsible for data collection, which helps reduce the risk of misclassification bias.

Regarding the limitations of the study, due to the small number of patients who were readmitted more than twice, we were unable to clarify and interpret the relationship between the number of readmissions and functional outcomes. Further studies should be conducted to understand these associations better. Additionally, because this was a retro-

spective chart review, MBI scores were evaluated by different assessors. However, the interobserver reliability of the Barthel Index is excellent, with a weighted kappa of 0.93.[35] It is also important to note that the results may not generalize to settings with a longer average length of stay, as our findings are particularly relevant to hospitals with limited bed capacity that typically necessitate a stay of three weeks or less. Moreover, the delayed admission group may negatively affect neural plasticity.[4-6] As a result, the rehabilitation outcomes for the first delayed admission may be lower than usual and may closely resemble those in the readmission group. Therefore, this study may not be applicable for interpreting results for patients in the early readmission group.

In hospitals where the rehabilitation length of stay is limited to three weeks, readmission is recommended to maximize functional outcomes and achieve rehabilitation goals. In that case, the hospital should establish a readmission policy to ensure that sufficient beds are available for both first-time patients and those who have been readmitted. Additionally, to enhance cost-effectiveness, the hospital should evaluate and implement a tiered reimbursement strategy that incentivizes outpatient rehabilitation and reduces the financial burden on the facility. Moreover, it is important to implement an outpatient rehabilitation program as an alternative option for readmitted patients in situations where bed availability is limited, ensuring they receive ongoing support that promotes further recovery and independence. Stroke patients with deconditioning should also be readmitted to restore function, provided that the causes of deconditioning can be addressed. Further investigations into the determinants of deconditioning should be conducted to reduce the rates of readmission in these patients. These implications should be viewed as preliminary evidence rather than practice-changing findings, underscoring the need for further validation and investigation.

Conclusions

The improvement in functional outcomes of stroke patients upon readmission to the rehabilitation ward showed no statistically significant difference compared to the improvement during their first admission, when the length of stay was limited to 3 weeks. This finding indicates that the limited three-week rehabilitation length of stay necessitates a reevaluation of current hospital policies regarding readmission.

The results suggest that some readmitted patients may benefit from the opportunity to continue their rehabilitation after not reaching their goals during their initial admission, particularly when their neurological status has improved. This finding underscores the importance of ongoing rehabilitation programs and suggests that readmission can be a valuable option for enhancing patient recovery.

The study further identifies common causes of deconditioning among patients, including post-stroke complications and caregiver neglect, underlining the need for proactive strategies in infection prevention and caregiver support.

In light of these findings, hospitals should establish comprehensive and flexible readmission policies to accommodate both first-time and readmitted patients. However, the findings may not be generalizable to settings with longer lengths of stay or to patients who are readmitted early.

Future research should focus on understanding the determinants of deconditioning to reduce readmission rates and to validate these preliminary findings, which are vital for informing better practices in the rehabilitation of stroke patients.

Conflict of interest disclosure

The authors declare that they have no potential conflicts of interest regarding the research, authorship, or publication of this article.

Generative AI declaration

The authors acknowledge the use of OpenAI's ChatGPT (version 4.0) to assist in language and grammar improvement throughout the manuscript. This tool was utilized solely for the purpose of enhancing clarity, coherence, and overall quality of the text, and no content generation or material alteration beyond linguistic refinement was conducted with the assistance of AI.

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Data availability

The data that support the findings of this study cannot be shared publicly and are available upon request from the corresponding author, Chayaporn Chotiyarnwong. The data are confidential and contain information that could compromise the privacy of the patients involved in the research.

Author contributions

Supitcha Tassatarn: data curation, formal analysis, funding acquisition, investigation and writing,

Chayaporn Chotiyarnwong: conceptualization, methodology, project administration, supervision and writing.

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