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การศึกษาความสัมพันธ์ระหว่าง การควบคุมการเคลื่อนไหวและความสามารถในการเดินในผู้ป่วยโรคหลอดเลือดสมอง

Exploring the Association of Motor Function and Ambulation Capacity in Stroke Patients

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บทคัดย่อ

การฟื้นฟูสมรรถภาพโรคหลอดเลือดสมองมุ่งเน้นไปที่การฟื้นฟูความสามารถในการเดินเป็นอย่างมาก เนื่องจากความบกพร่องของการเคลื่อนไหวภายหลังโรคหลอดเลือดสมองส่งผลกระทบอย่างมีนัยสำคัญต่อการเคลื่อนไหว การทรงตัว และกิจวัตรประจำวัน ทำให้คุณภาพชีวิตลดลง การประเมินความบกพร่องของการเคลื่อนไหวจึงเป็นสิ่งสำคัญสำหรับการพัฒนาวางแผนการรักษาที่เฉพาะเจาะจงในแต่ละบุคคล ซึ่งช่วยเพิ่มประสิทธิภาพในการฟื้นฟูได้ดี

การศึกษานี้มีวัตถุประสงค์เพื่อศึกษาความสัมพันธ์ระหว่างระดับความบกพร่องของการเคลื่อนไหวทันทีหลังเกิดโรคหลอดเลือดสมองและความสามารถในการเดินของผู้ป่วย ณ วันที่ออกจากการฟื้นฟูสมรรถภาพผู้ป่วยใน

การศึกษานี้เป็นการศึกษาแบบติดตามไปข้างหน้าโดยมีผู้ป่วย 24 รายเข้ารับการฟื้นฟูสมรรถภาพผู้ป่วยในหลังจากเกิดโรคหลอดเลือดสมองครั้งแรก ความบกพร่องของการเคลื่อนไหวได้รับการประเมินโดยใช้แบบประเมิน Stroke Rehabilitation Assessment of Movement (STREAM) และประเมินความสามารถในการเดินของผู้ป่วยเมื่อออกจากโรงพยาบาลโดยใช้ Functional Ambulatory Category (FAC) การวิเคราะห์ความสัมพันธ์ระหว่างคะแนน STREAM และ FAC ใช้การวิเคราะห์สหสัมพันธ์ Spearman

จากการศึกษาพบความสัมพันธ์ในระดับสูงระหว่าง FAC และ STREAM total score ($r = 0.884$; $p = 0.0001$) และ STREAM Mobility ($r = 0.878$; $p = 0.0001$) พบความสัมพันธ์ในระดับปานกลางระหว่างคะแนน STREAM Upper Extremity (UE) และ FAC ($r = 0.663$; $p = 0.0004$) พบความสัมพันธ์ระดับสูง

ระหว่างคะแนน STREAM Lower Extremity (LE) และ FAC (r = 0.908; p = 0.0001) ซึ่งบ่งชี้ว่าคะแนน STRTEAM เริ่มต้นที่สูงกว่านั้นสามารถทำนายความสามารถในการเดินของผู้ป่วยได้มากขึ้นเมื่อจำหน่ายออก

จากการศึกษาแสดงให้เห็นถึงความสำคัญของการประเมินความบกพร่องในการเคลื่อนไหวในมีความสัมพันธ์กับความสามารถในการเดิน นำไปสู่การวางแผนการรักษาที่เหมาะสมและมีประสิทธิภาพ ทั้งนักกายภาพบำบัดและคนไข้ให้เป็นแนวทางเดียวกัน เพื่อไปถึงเป้าหมายที่วางไว้

คำสำคัญ: โรคหลอดเลือดสมอง, ความสามารถในการเคลื่อนไหว, STREAM, FAC

ABSTRACT

Stroke rehabilitation focuses intensely on restoring walking ability, as post-stroke motor impairment significantly impacts movement, balance, and daily activities, thereby reducing the quality of life for affected individuals. Accurate assessment of motor impairments is essential for developing precise, individualized treatment plans that can effectively improve outcomes.

This study aimed to investigate the correlation between motor impairment levels immediately following a stroke and the ambulatory capacity at the point of discharge from inpatient rehabilitation.

We conducted a prospective cohort study involving 24 patients admitted for inpatient rehabilitation following their first stroke. Motor impairment was evaluated at admission using the Stroke Rehabilitation Assessment of Movement (STREAM), and ambulatory capacity was assessed at discharge using the Functional Ambulatory Category (FAC). Spearman's correlation analysis was applied to explore the relationships between STREAM and FAC scores.

Analysis revealed a strong correlation between FAC and both STREAM Total Score (r = 0.884; p = 0.0001) and Mobility Score (r = 0.878; p = 0.0001). Moderate correlation was found between STREAM Upper Extremity (UE) scores and FAC (r = 0.663; p = 0.0004). The strongest correlation was found between STREAM Lower Extremity (LE) scores and FAC (r = 0.908; p = 0.0001), indicating that higher initial impairment scores are predictive of greater ambulatory independence at discharge

Our findings demonstrate the importance of these assessments in predicting ambulatory recovery and underline the necessity of integrating comprehensive motor function

evaluations into the treatment planning process. This approach facilitates effective treatment planning, optimal resource allocation, and improved rehabilitation outcomes for stroke survivors.

Keywords: Stroke, STREAM, Ambulation Capacity, FAC

Introduction

The global burden of stroke is huge; in 2020, stroke was the second leading cause of death (6·6 million deaths) and the third leading cause of disability (Feigin et al., 2021). Alarmingly, evidence suggests that the incidence of stroke in younger individuals (i.e., people younger than 55 years) is increasing worldwide (Scott et al., 2022). Stroke often affects the corticospinal tract of the nerve tract, both ascending and descending pathways which is the main pathway that controls the movement of the body on the opposite side. In addition, it also affects the initial thinking of movement planning, and relative functioning of the arms and legs on both sides. The most prevalent impairment resulting from stroke is motor impairment (Langhorne et al., 2009). Research has investigated the temporal trajectory of cerebral recuperation among individuals recovering from stroke. It has been determined that this restorative process commences within the initial one-week to one-month window following the onset of stroke, characterized by discernible improvement within the motor domain. Notably, early rehabilitation during this critical temporal window has been associated with a better prognostic outlook for the condition (Bernhardt et al., 2017).

The findings from the study indicate that motor impairment at three-month post stroke is a "red-flag " and pinpointed that the initial levels of motor and functional impairments play a significant role in forecasting ambulatory outcomes. Post-stroke walking ability affected quality of life, activity of daily living and leading to dependency. Furthermore, Moderate-severe stroke, lower age, and walking disability are important predictors of healthcare utilization after stroke (Minet et al., 2020). The capacity for early ambulation serves as a noteworthy indicator for the likelihood of returning home following acute hospitalization, regardless of the severity of the stroke. Conducting assessments on walking ability soon after a stroke may streamline discharge planning procedures (Verstraeten et al., 2020). To assess

walking ability, Functional Ambulatory Category (FAC) is an acceptable evaluation tool for determining walking ability in clinical practice and research. The study suggests that the FAC can be used in clinical research to measure improvement and outcome in gait performance in primary nonambulatory patients after stroke (Mehrholz et al., 2007). Post-stroke physical therapy has concentrated on rehabilitating motor deficits, aiming to regain optimal movement and enhance functional capacity (Masiero, Avesani, Armani, Verena, et al., 2007).

In today's acute rehabilitation context, there is a pronounced emphasis on evidence-based approaches designed to facilitate early hospital discharges. As a result, clinicians place considerable importance on utilizing objective outcome measures for diagnostic, evaluative, and treatment purposes. Hence, a comprehensive physical assessment is imperative to strategize an optimal and efficacious treatment regimen. Currently, there are a variety of stroke assessments. Among these tools, the Stroke Rehabilitation Assessment of Movement (STREAM) emerges as a notable evaluation method tailored for assessing limb movement and mobility following cerebrovascular events. Widely utilized in research and clinical environments, STREAM has proven its effectiveness across varying degrees of severity, ranging from mild to severe cases (Ward et al., 2011). Therefore, it is common practice to evaluate the impairment to predict functional outcome and to understand a link between functioning and walking ability has been suggest (Hayes et al., 2013). Several factors have been investigated in relation to functional dependency in the context of arterial hypertension, advancing age, sedentary occupation, smoking habits, severity of neuronal injury, and extent of neurological impairment within the initial 24-hour period following the vascular incident. Additionally, a heightened degree of neurological impairment has been found to correlate independently with escalated levels of functional dependence (Oliveira et al., 2024).

Purpose

The aim of this study was to explore the relationship between motor impairment and ambulatory capacity in individuals following an acute stroke. To assess motor impairment, we employed the STREAM, and for evaluating walking ability, the Functional Ambulatory Category (FAC) was utilized.

Hypothesized

We hypothesized that a significant correlation existed between the extent of motor impairment and the ability to walk, suggesting that variations in motor impairment levels directly influenced ambulatory outcomes.

Conceptual framework

A fundamental aim of post-stroke rehabilitation is the restoration of walking ability, which is often compromised due to impaired arm and leg movement, balance deficits, and diminished mobility initiative, significantly impacting the patient's quality of life. It is routinely to assess motor impairment post stroke to estimate ambulatory capacity, thus detection and initiation of rehabilitation following a stroke are imperative. The STREAM assessment emerges as a valuable tool, renowned for its accuracy and reliability in identifying both motor and mobility impairments. Furthermore, FAC used to classified level of walking independent in post stroke patient. Given that the optimal recovery window for stroke spans from one week to a month, immediate recognition of mobility impairment post-stroke and ambulatory level assumes unparalleled importance, as it directly informs the provision of accurate, pertinent, and efficacious treatment strategies.

Research Methodology

This was a prospective cohort study comprised patients hospitalized at Queen Savang Vadhana Memorial Hospital (QSMH), Thailand. QSMH is M2 Mid-Level Referrals Hospital. M2 is a secondary care, high complexity in acute stroke treatment. Stroke treatment encompasses the comprehensive management of all instances of acute stroke admitted to the healthcare institution, prioritizing acute phase intervention, prompt initiation of rehabilitation services such as speech therapy, physiotherapy, and occupational therapy, and thorough investigation into the underlying causes of the stroke. The research was approved by The Institutional Review Board of the Queen Savang Vadhana Memorial Hospital has approved the study (COE. NO.41/2566).

Participants in the study consisted of 24 individuals who were admitted to the hospital for either hemorrhagic or ischemic stroke. The inclusion criteria were as follows: individuals aged between 20 to 80 years, encompassing both males and females, with a diagnosis of their first-ever stroke confirmed by CT (Computed Tomography) scan or MRI (Magnetic Resonance Imaging). Candidates were required to be capable of following one or two commands, demonstrate stability in their medical condition, and either themselves or a responsible relative had to provide signed informed consent. Exclusion criteria were set to omit patients with concurrent orthopedic, cardiovascular, or neurological conditions that might interfere with gait or balance assessment, those who had experienced a recurrent stroke, suffered from a vestibular disorder (e.g., vertigo), had Parkinson's disease, or had undergone lower limb surgery such as knee or hip arthroplasty, which could influence mobility.

Outcome measurement there were two outcome measurements, STREAM and FAC. The STREAM is a detailed tool designed to evaluate the motor functions of both upper and lower limbs in patients who have suffered a stroke. The assessment consists of 30 items and typically requires about 15 minutes to complete. The evaluation is structured as follows: items 1-6 are conducted with the patient in a supine position; items 7-21 in a seated position; items 22 in a standing position without support; items 23-25 in a standing position with support; and items 26-30 are walking tasks. The STREAM includes three domains: Upper Limb Voluntary Movements and Lower Limb Voluntary Movements, each rated on a 3-point ordinal scale (0-2) for a maximum possible score of 20 points per domain; and Basic Mobility, rated on a 4-point ordinal scale (0-3) with a maximum score of 30 points. When an item is not applicable for assessment due to factors such as pain or limited range of motion, it is marked as "X" and is not included in the final score calculation. Each domain score is converted into a percentage, and the overall STREAM score is calculated as the average of these percentages (Daley et al., 1999). The FAC is a validated measure used to assess the level of physical assistance required for safe ambulation following a stroke. This tool categorizes walking ability into six levels, ranging from 0 (nonfunctional ambulation) to 5 (independent ambulation on various surfaces, including level and non-level ground, stairs, and inclines). This scale helps clinicians determine the degree of support a patient needs to walk safely, providing a

straightforward metric to gauge recovery progression and to tailor rehabilitation efforts accordingly (Holden et al., 1986; Kollen et al., 2006).

Procedure Participants were evaluated with the STREAM at first visited to the rehabilitation by researcher, a physical therapist with expertise in stroke rehabilitation. After being discharged from inpatient rehabilitation, participants were evaluated using the FAC. The data were gathered include both demographic and clinical details, such as age, gender, type of stroke, time from stroke onset to assessment, affected body side, the National Institutes of Health Stroke Scale (NIHSS), and the Modified Rankin Scale (mRS).

Statistical Analysis To explore the relationships between the STREAM total scores, its subscale scores, and the Functional Ambulatory Category (FAC) of the participants, Spearman's correlation test was utilized. This non-parametric method was chosen due to its effectiveness in measuring the strength and direction of association between two ranked variables. The correlation coefficients (Spearman's ρ) were interpreted as follows: Values between 0.31 and 0.5 (or -0.31 to -0.5) indicate weak correlations; Values between 0.51 and 0.7 (or -0.51 to -0.7) suggest moderate correlations; Values between 0.71 and 0.9 (or -0.71 to -0.9) denote strong correlations; Values greater than 0.9 (or less than -0.9) are considered very strong correlations. All statistical tests were two-tailed, with a significance level set at $p < 0.05$ (Mukaka, 2012)

Result

Of the 24 participants, 13 were male and 11 were female, with a mean age of 56.3±10.6 years: 20.8% hemorrhagic and 79.2% Ischemic stroke and mean length of stay (LOS) of 6.167±4.478 days. Table 1 describes the clinical characteristics of the participants. Mean and median (IQR) scores for STREAM and their sub scale are shown in Table 2. Severity of stroke as evaluated by the NIHSS was on average 6 (SD 4.22).

Table 1. Patient Characteristics.

Variable	Total (N= 24)
Age, y, mean (SD)	56.292 (10.626)
Sex, n (%)	
Male	13 (54.2%)
Female	11 (45.8%)
Type of stroke	
Ischemic, n (%)	19(79.2%)
Hemorrhagic, n (%)	5(20.8%)
NIHSS, mean (SD)	6(4.22)
mRS, n (%)	
1	6(25.0%)
2	7(29.2%)
3	4(16.7%)
4	7(29.2%)
Length of stay, mean (SD)	6.167(4.479)
Number of rehab, mean (SD)	2.458(1.667)

NIHSS = National Institutes of Health Stroke Scale, FAC = Functional Ambulatory Category, mRS = Modified Rankin Scale

Table 2. Mean and median (IQR) score for STREAM.

	FAC 1 (N = 4)	FAC 2 (N = 7)	FAC 3 (N = 3)	FAC 4 (N = 9)	FAC 5 (N = 1)
STREAM (Total)	4	25	59	60	66
Median (IQR)	(2.50 - 8.00)	(22.75 - 29.25)	(55.25 - 60.50)	(54.75 - 68.25)	(66.00 - 66.00)
STREAM(UE)	0	13	17	15	16
Median (IQR)	(0.00-1.00)	(10.00-13.75)	(15.50-19.25)	(11.75-20.00)	(16.00-16.00)
STREAM(LE)	0	7	14	20	20
Median (IQR)	(0.00-2.50)	(6.25-8.50)	(13.25-17.00)	(17.00 20.00)	(20.00-20.00)
STREA(Mobility)	3.5	5	26	27	30
Median (IQR)	(2.50-4.50)	(5.00-5.00)	(24.50-26.75)	(23.50-28.25)	(30.00-30.00)

FAC; Functional Ambulatory Category, STREAM; Stroke Rehabilitation Assessment of Movement, UE; Upper Extrimity, LE; Lower Extrimity, IQR; Interquartile Range.

The findings from this study elucidated a linear correlation between motor impairment at the initial rehabilitation visit and ambulatory capacity at the time of discharge from inpatient care. These correlations are documented in Table 3 and visually represented in Figure 1. Specifically, the Upper Extremity (UE) score from the Stroke Rehabilitation Assessment of Movement (STREAM) displayed a moderate correlation with the Functional Ambulatory Category (FAC), with a correlation coefficient r=0.663 and a p-value of 0.0004. Furthermore, both the STREAM Total Score and Mobility Score showed strong correlations with FAC, evidenced by r=0.884 (p=0.0001) for the Total Score and r=0.878 (p=0.0001) for the Mobility Score.

Most notably, the STREAM Lower Extremity (LE) Score demonstrated a very strong correlation with FAC (r=0.908, p=0.0001), indicating that a higher initial impairment score is strongly predictive of greater ambulatory independence upon discharge. This result

underscores the importance of early, intensive, and targeted rehabilitation interventions for stroke patients to enhance their functional recovery and independence.

Table 3. The correlation of STREAM score, Sub scale score and FAC.

	Total STREAM	UE	LE	Mobility
Correlation coefficient	0.884	0.663	0.908	0.878
Significance Level P	<0.0001	0.0004	<0.0001	<0.0001

Spearman's rank correlation coefficient, FAC; Functional Ambulatory Category, STREAM; Stroke Rehabilitation Assessment of Movement

Discussion

Existing literature and several studies have established that motor recovery typically occurs within the first three Existing literature and several studies have established that motor recovery typically occurs within the first three months post-stroke (Friedman, 1990; Turani et al., 2004). It is critical to leverage the principle of neuroplasticity during this acute phase to enhance functional recovery (Bitencourt et al., 2020). Our findings indicate that motor impairment and mobility measured at rehabilitation admission were significantly correlated with ambulatory outcomes, as assessed by the FAC at the time of discharge from inpatient rehabilitation. These results highlight the importance of promptly identifying motor impairment and mobility dependence in stroke patients, given their strong associations with overall clinical outcomes.

Ambulatory recovery remains a pivotal goal in stroke rehabilitation. A decline in the ability to perform ADL markedly impacts quality of life. This study has reinforced the strong relationship between the Lower Extremity component of the STREAM-LE and FAC. Supporting literature by Louie D.R. et al. suggests that lower extremity motor impairment and walking ability at admission can predict discharge outcomes (Louie et al., 2021). Additionally, combined assessments of motor impairment, such as the Motricity Index, Trunk Control Test, and Functional Independence Measure (Motor), along with patient age, have been strongly linked to walking recovery metrics measured by FAC (Masiero, Avesani, Armani, & Ermani, 2007).

Previous study described STREAM's utility in assessing both motor and functional impairments(Ward et al., 2011). Our findings corroborate this, showing a strong association between STREAM Mobility scores (STREAM-MO) and FAC, which measures functional capacity. Furthermore, the relationship between functional independence (measured by the Functional Independence Measure or FIM) and the degree of neurological impairment within the first 24 hours post-stroke has been documented (Gath et al., 2021), highlighting that proficient balance and motor control are crucial for achieving independent gait. Regarding upper extremity function, it has been found that the Fugl-Meyer Assessment for Upper Limb (FMA-UL) correlates moderately to well with FIM-Motor scores, particularly in tasks such as dressing (upper body), toileting, and mobility (walking or wheelchair) (Yamamoto et al., 2022). This suggests that upper limb motor function significantly influences lower limb movement and overall mobility. The moderate correlation between STREAM Upper Extremity scores (STREAM-UE) and FAC further underscores the integral role of upper limb function in postural balance and ADL (Moon et al., 2024).

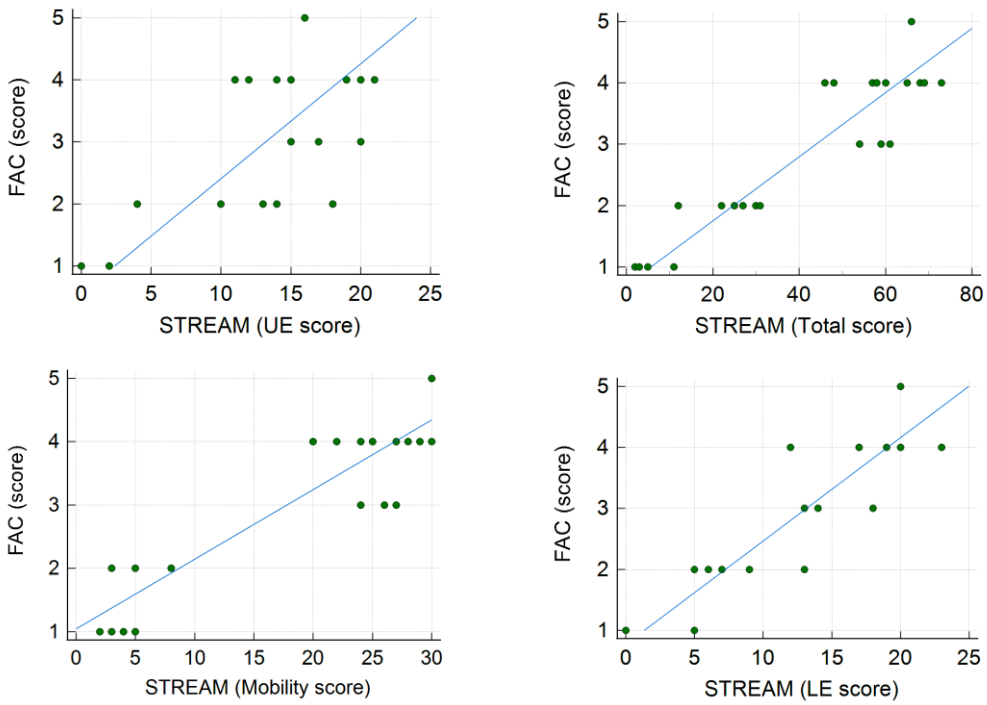

Figure 1. The figure shows the linear correlation between STREAM(Score) and FAC(Score). The X axis indicates the FAC score at discharge from inpatient rehabilitation. The Y axis indicates

the STREAM score at first visit to rehabilitation. FAC; Functional Ambulatory Category, STREAM; Stroke Rehabilitation Assessment of Movement, UE; Upper Extrimity, LE; Lower Extrimity.

This study capitalized on the use of well-established and validated instruments, the STREAM and the FAC, to measure outcomes, which ensured reliable and reproducible results. The adoption of a prospective cohort design further strengthened the causal inferences that could be drawn from the findings. Additionally, the comprehensive assessment of both upper and lower limb functions provided a holistic view of the impact of motor impairments on functional recovery, underscoring the robust nature of the study's methodology.

However, there are several limitations that must be considered. The study being conducted in a single hospital may further limit the applicability of the results to other settings, which might have variations in patient demographics and clinical practices. Moreover, as the study was focused on the acute phase of stroke recovery, it did not assess long-term outcomes and the sustainability of improvements after discharge, which are critical for understanding the full spectrum of recovery and the long-term effectiveness of interventions.

Conclusions

This study underscores the critical importance of early detection and comprehensive evaluation of motor and functional impairments in enhancing post-stroke rehabilitation outcomes. By systematically assessing these impairments at the onset of rehabilitation, clinicians can tailor interventions that maximize recovery potential and facilitate the return to independence. The significant correlations found between STREAM scores and FAC highlight the utility of these measures in predicting and improving ambulatory outcomes, ultimately benefiting stroke patients' overall rehabilitation and quality of life. The findings advocate for the integration of detailed motor function evaluations in stroke care protocols to optimize treatment efficacy and resource allocation.

Recommendations

This study emphasizes the importance of early detection and comprehensive evaluation of motor impairments in stroke rehabilitation. By using STREAM scores and FAC

effectively, clinicians can tailor treatments that improve ambulatory outcomes and overall quality of life. The findings advocate for integrating detailed motor function evaluations into stroke care protocols to enhance treatment efficacy and resource allocation.

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