Original Article

JHSMR Journal of Health Science and Medical Research

A Preliminary Report on the Outcomes of A Short-Course Intensive Rehabilitation Program for Spinal Cord Injury: A Prospective Observational Study

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Received 19 October 2024 ● Revised 22 February 2025 ● Accepted 9 March 2025 ● Published online 1 July 2025

Abstract:

Objective: To study the effect of a short-course intensive rehabilitation program on functional outcomes in individuals with spinal cord injury (SCI).

Material and Methods: Individuals diagnosed with SCI who met the inclusion and exclusion criteria between January and December 2023 attended a short-course intensive SCI rehabilitation program lasting 1-2 weeks. Participants were assessed for functional outcomes using the Spinal Cord Independence Measure III (SCIM III) and the Modified Barthel Index (MBI) before the program, after the program, and at the 2-, 4-, and 6-month follow-ups. Furthermore, complications such as depression and urinary tract infection (UTI) were evaluated.

Results: The intensive SCI rehabilitation program was performed on 23 patients over 9.61±4.75 days. They demonstrated significant improvements (p-value<0.05) in SCIM III and MBI scores. After completion of the SCI rehabilitation program, mean SCIM III scores rose from 28.43 to 51.26, while MBI scores increased from 5.35 to 10.48 (Cohen's d=1.14 and 1.08, respectively). UTI was the most frequently occurring complication, with an incidence of 48%. During the follow-up phases, the maximum UTI rate was 39.13% at the 2-month follow-up, and the highest depression rate was 8.70% at the 2- and 6-month follow-ups.

Conclusion: The short-course intensive SCI rehabilitation program significantly improved functional outcomes, which were sustained for >6 months. However, UTIs and depression were observed as complications during and after the rehabilitation program.

Keywords: modified barthel index, rehabilitation program, short-course, spinal cord independence measure III, spinal cord injury

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J Health Sci Med Res
doi: 10.31584/jhsmr.20251239
www.jhsmr.org

Introduction

Spinal cord injury (SCI) is a devastating injury that affects the motor, sensory, and autonomic functions, ultimately causing disability and dependency[1]. The incidence and prevalence of SCI vary worldwide. According to the Global Burden of Disease Study 2019, the global incidence rate in 2019 was 0.9 million cases, whereas Southeast Asia's incidence rate was 0.24 million cases[2]. In Thailand, the incidence rate in 1993 was 23 cases per million of population[3]. SCI incidence was lower than other chronic diseases; however, disability and dependency caused burdens. In 2019, the global Age Standardized Years Lived with Disability rate was 12, whereas Southeast Asia's incidence was 7 per 100,000 of population[2].

Rehabilitation is essential in assisting patients to live with their family and community in a manner appropriate to the level of injury by enhancing neurological recovery and averting secondary complications such as pneumonia, urinary tract infection (UTI), thromboembolism, pressure injury, and depression[4–9]. These complications extend hospital stays and increase resource usage. In the United States, the average direct healthcare cost ranged from 40,034 to 132,758 USD per person with SCI for inpatient rehabilitation for all the neurological categories after injury, with a 47.4 hospitalization length of stay in days[10]. The higher treatment cost predictors were age (>70 years), female sex, neurological level of the cervical spine, Charlson index, Injury Severity Score, American Spinal Injury Association (ASIA) grade, traumatic brain injury, additional injury, time to admission to SCI center more than 24 hours, complication development, and accredited hospital in the care pathway[11]. Scivoletto G. et al. found that rehabilitation in the spinal unit of a large rehabilitation hospital in Italy within 30 days, which is the short time-to-admission (TTA) interval group, had higher Barthel Index discharge scores and higher efficiency scores than those of the group with TTA interval of >30 days[12]. The efficiency score was calculated from the length of stay (LOS) divided by the Barthel Index score. The LOS in the short TTA group was an average of 100 days with an efficiency score of 0.8. In Thailand, the mean rehabilitation LOS was 53.2 days within 166.5 days post-injury, and the efficiency score was 1 in the SCI specialized facility[13]. In the non-SCI specialized facilities, the mean rehabilitation LOS was 37.6 days within 288.1 days post-injury, and the efficiency score was 0.7.

With the limitation of SCI specialized-center access in Thailand, the SCI Patient Care Team (PCT) at Songklanagarind Hospital was established in 2017 with the aim of optimizing treatment processes in order to provide quality care to achieve basic functional ability in the post-acute period. The PCT developed a short-course intensive SCI rehabilitation program in response to constraints, such as limited bed availability and the implementation of the diagnosis-related group (DRG) approach, which stipulates a maximum rehabilitation period of 29 days for neurological conditions[14]. Consequently, the hospital prioritizes shorter stays to prevent exceeding reimbursement thresholds. Evaluation of the program's effectiveness is currently hindered by a lack of systematic data, resulting in inadequate retrospective analyses. Therefore, this study aimed to assess the outcomes of this short-course intensive SCI rehabilitation program.

Material and Methods

Study design

Prospective cohort study.

Participants

Patients aged ≥18 years who were first diagnosed with SCI at Songklanagarind Hospital between January 2023 and December 2023, classified as ASIA Impairment Scale (AIS) A to D, with an etiology stemming from traumatic and non-traumatic injuries, and who had undergone the Songklanagarind intensive SCI rehabilitation program were

considered for inclusion in this study. The exclusion criteria were 1) an etiology attributed to malignancy and 2) injury level higher than C4, AIS B.

Informed consent was obtained from all patients, and study approval was granted by the Prince of Songkhla University Human Research Ethics Committee (HREC) (REC: 65-358-41-4). The sample size calculation, derived from n4Studies application version 2.3 (App store, 2024), was based on the significant improvement of functional outcomes after undergoing a short-course intensive SCI rehabilitation program, using the formula for an infinite population mean. The estimated BI score improvement was 14.9±15.7[15]. The calculation considered a 95% confidence interval, 5% acceptable error, and 20% dropout rate. The sample size was 44 patients.

Intensive SCI rehabilitation program

The SCI rehabilitation program included educational sessions, chest, which included breathing exercises and coughing training; neurological physical therapies, which included strengthening exercises of the available muscles and ambulation training with or without a gait aid or wheelchair; occupational therapy, which was based on skills related to the activities of daily living; lower urinary tract and bowel care, pressure injury, and deep venous thrombosis prevention. The program was designed to be performed in three 1-hour sessions each day, 5 days a week, over 1–2 weeks during the patient's hospitalization period. The program was supplemented with an SCI care book and video clips for reference, ensuring that patients could recall the details if necessary. The individualized program was adjusted based on the expected functional outcomes associated with the level of injury.

Ongoing care was documented upon completion of the inpatient intensive rehabilitation program. This included the continuation of a home program facilitated by a caregiver or independently, employing a physical therapist for home therapy, or using the rehabilitative services of a nearby hospital.

Data collection and outcome assessment

Baseline data of parameters, namely, age, sex, underlying disease, injury etiologies, associated injuries, level and completeness of injury, and primary caregiver status, were systematically gathered. The time before rehabilitation was determined from the onset of injury for traumatic etiology and from the postoperative period for non-traumatic etiology to the start of rehabilitation services. Currently, the Thai healthcare system emphasizes the Modified Barthel Index (MBI) as the primary outcome measurement for patients with SCIs[16]. However, the Spinal Cord Injury Independence Measure III (SCIM III) is considered more specific for this patient group[17]. Consequently, this study utilized both SCIM III and MBI in order to enable comprehensive comparisons with other institutions. Additionally, data on complications such as pneumonia, pressure injuries, UTIs, deep vein thrombosis, and depression were collected for analysis[4–6,8,18,19]. The depression assessment instrument employed in this study was the Patient Health Questionnaire-9 (PHQ-9), with a diagnosis of depression assigned a score of ≥9 [20].

Data were collected on 5 occasions: before the program, after the program, and at the 2-, 4-, and 6-month follow-ups. Follow-up assessments were conducted via phone interviews at 2- and 4-month intervals and in person at the hospital at the 6-month follow-up.

Statistical analysis

Quantitative data were reported as means and standard deviations (S.D.s) for parametric data and medians with interquartile ranges (Q1 and Q3) for non-parametric data. Categorical data were presented as frequencies and percentages, and Fisher's exact test was used to evaluate significant differences. Functional outcome scores

measured before and after the program were compared using paired t-tests, while unpaired t-tests were applied to compare scores between groups for parametric data, and the Wilcoxon Rank Sum test was used for non-parametric data. Significant improvements in functional outcome scores during the follow-up periods were assessed using repeated measures ANOVA for parametric data and the Friedman Rank Sum test for non-parametric data. The correlation between SCIM III and MBI was assessed using Pearson's correlation test at each evaluation time point. Cohen's d was used to calculate the effect size when comparing 2 means. p-value<0.05 was considered significant for all tests, and statistical analysis was performed using STATA version 14.2 (StataCorp, College Station, TX, USA).

Results

Baseline characteristics

Of the 44 patients initially recruited, 23 met the inclusion criteria and were enrolled in the study; their baseline demographic information is detailed in Table 1.

Among the enrolled patients, 4 had incomplete tetraplegia (17.4%), 5 had complete paraplegia (21.7%), and 14 had incomplete paraplegia (60.9%). Twenty-one patients were excluded due to the inability to extend their hospital stay, and 1 patient was lost to follow-up after the 2-month assessment. Most patients (44%) were male and diagnosed with non-traumatic incomplete paraplegia. The majority of the patients (87%) had no associated injury; however, 8.7% experienced lung, abdominal, and extremity injuries, and 4.3% had other central nervous system-related injuries. Two patients with traumatic complete paraplegia were enrolled in the intensive program over 30 days after their diagnosis due to their complicated conditions. Caregivers were predominantly identified as partners (60.9%), followed by offspring (30.4%) and siblings (8.7%). After completion of the short-course intensive SCI rehabilitation program, a significant proportion of the patients pursued rehabilitation through a home program (87.0%), whereas others opted for rehabilitation at a nearby hospital (17.4%) or Songklanagarind Hospital (8.7%). In terms of compliance, the majority engaged in rehabilitation 6–7 days per week, accounting for 87.0%, whereas 13.0% adhered to a rehabilitation schedule of 2–3 days per week. For 6 months after discharge, 60.9% underwent follow-up via telephone, whereas 39.1% visited the hospital. The completeness of injuries ratio significantly differed between the early and delayed rehabilitation groups.

Table 1 Demographic characteristics of participants

Characteristics	N=23
Mean age, years (±S.D.)	54.83±11.60
Gender (%)	
Male	13 (56.5)
Female	10 (43.5)
Underlying disease (%)	
None	7 (30.4)
Respiratory disease	1 (4.3)
Cardiovascular disease	7 (30.4)
Musculoskeletal disease	3 (13.0)
Neurodegenerative disease	2 (8.7)
Inflammatory/Auto-immune	1 (4.3)
Others	4 (17.4)
Etiology (%)	
Trauma	4 (17.4)
Traffic accident	1 (4.3)
Falls	2 (8.8)
Violence	1 (4.3)
Non-trauma	19 (82.6)
Degenerative	6 (26.1)
Tumor	9 (39.1)
Infection	2 (8.8)
Inflammatory	1 (4.3)
Others	1 (4.3)
Level of injury (%)	
Cervical	4 (17.4)
Thoracic	11 (47.8)
Lumbar	8 (34.8)
Completeness of lesion (%)	
Complete	5 (21.7)
Sensory incomplete	3 (13.1)
Motor incomplete	15 (65.2)
Median of time before rehabilitation, days (Q1, Q3)	7.0 (5.0, 15.5)
Early (≤30 days) (%)	21 (91.3)
Delayed (>30 days) (%)	2 (8.7)
Median length of hospital stay, days (Q1, Q3)	12 (5, 14)

S.D.=standard deviation

Functional outcomes

Following the Songklanagarind intensive SCI rehabilitation program, all patients demonstrated significant improvements in both SCIM III and MBI scores (p-value<0.001). Table 2 shows that the SCIM III and MBI scores significantly improved during every phase of evaluation (p-value< 0.01) with a large effect size (Cohen's d=1.09 and 1.05, respectively). Before starting the program, patients with incomplete tetraplegia had a mean SCIM III score of 34.75±16.82, and those with paraplegia had a mean score of 27.18±15.73. After completing the program, these scores improved to 63.25±31.36 and 50.77±20.77, respectively. The overall median efficiency from the SCIM III score of this program was 2.29 (IQR: 1.50–5.14).

Additionally, the correlation between SCIM III and MBI ranged from 0.8 to 0.9 at each evaluation time point (p-value<0.05).

Complications

Table 5 presents the complications that occurred during and after the program. The 2 complications observed during the follow-up period were UTIs and depression. The incidence of UTIs was highest at the 2-month follow-up, accounting for 39.13% of cases. In contrast, the highest incidence of depression was recorded at discharge and at the 2- and 6-month follow-ups, with each registering at 8.70%.

Discussion

Our early, short-course intensive rehabilitation program demonstrated significant improvements in the SCIM III and MBI scores, which are consistent with the findings of other studies[12,15,21–23]. Most patients (91.3%) received the program within 30 days of injury onset. The improvement in SCIM scores observed in our study following the program was comparable to the results from a Thai SCI specialized rehabilitation facility, but with a shorter LOS[13]. Mean LOS for rehabilitation at SCI centers from Nepal, Germany, and the United Kingdom ranged from 71.8 to 88.4 days[24–26]. However, the duration from injury onset to the start of rehabilitation in these centers exceeded 2 weeks, whereas the program in this study was completed within 2 weeks, aligning with the 29-day limitation for neurological patients with minimal Cost and Clinical Complexity rehabilitation reimbursement in Thailand[14]. Despite this shorter duration, the study demonstrated a greater median efficiency compared to specialized SCI institutions[13,24,25].

Many studies have reported that factors influencing functional outcome scores included the duration after the onset of SCI, level of injury, severity of lesion, LOS, and the presence of pressure ulcers[13,15,27,28]. Patients with a short duration after the onset of SCI, who had paraplegia and motor incompleteness, experienced longer LOS of rehabilitation, no pressure ulcers, and were more likely to achieve better functional outcome scores. In Thailand, coping strategies,

Table 2 Functional outcomes (Mean±S.D.) categorized by the evaluation phase

Functional outcomes scores	Admission	Discharge	2-month follow-up	4-month follow-up	6-month follow-up	p-value
SCIM III score	28.43±15.39	51.26±23.83	69.30±22.60	76.52±23.08	78.35±23.47	<0.001
Self-care	7.30±3.95	11.87±4.71	15.78±3.20	16.86±2.90	17.18±3.07	<0.001
Respiration & sphincter management	17.48±9.42	24.59±11.06	30.83±10.09	33.09±9.27	33.96±8.45	<0.001
Mobility	4.52±5.79	16.59±9.16	23.91±10.30	27.77±10.81	28.91±11.38	<0.001
MBI score	5.35±3.84	10.48±5.53	13.87±5.71	15.57±5.26	16.22±5.33	<0.001

p-value of Friedman rank sum test of functional outcome scores (SCIM III or MBI), S.D.=standard deviation, SCIM III=spinal cord independence measure III, MBI=the modified barthel index

fighting spirit, and return to work have also been found to be associated with independence outcome scores[29]; however, these factors were not evaluated in this study. Worters R. et al. reported a high recovery rate for patients with incomplete paraplegia, with 76% achieving community ambulation within 1 year[30]. This greater efficiency observed in this study might be attributed to most patients having incomplete paraplegia (60.9%), as per the data represented in Table 3, besides the early rehabilitation program. Since most patients in this study had a non-traumatic etiology (82.6%), Table 4 shows no significant differences in outcomes between etiologies. The impact of SCI etiology on functional outcome scores is being debated. Previous studies have shown significantly greater efficiency in rehabilitation programs for traumatic SCI in rehabilitation hospitals[31,32]. However, studies conducted in Dutch and Flemish rehabilitation centers found no significant differences in efficiency between etiologies[33]. This discrepancy may be attributed to the diverse etiologies and varying conditions of patients with non-traumatic SCI, as observed in this study, highlighting the need for individualized rehabilitation programs tailored to specific patient needs.

Our study found an improvement in functional outcomes after completing the program, with most patients (87%) continuing their rehabilitation at home. This could be from the program, which was designed to be easily understood and was supplemented with an SCI care book and video clips for reference, ensuring that patients could recall the details if necessary. Furthermore, the sustained scores observed during the follow-up period aligned with the existing literature, emphasizing the importance of patient and family education in self-care before discharge, which likely contributes to long-term care benefits. This result could also be attributed to the recovery of most patients who had incomplete paraplegia[30]. Therefore, a well-designed and specific study should be conducted to further evaluate and confirm the long-term outcomes of the program.

Depression is a common condition among patients with SCI, and UTIs are the most frequent complication; our findings aligned with those of previous studies[5,15,34,35]. In our study, UTI incidence peaked during the 2-month follow-up period, predominantly among patients with indwelling and intermittent catheters managed by caregivers. A decline in UTI occurrence was noted after 2 months. The initial peak could have resulted from inadequate training in catheter care before discharge, leading to suboptimal techniques and scheduling issues in bladder emptying[8]. Moreover, some patients change their bladder emptying devices themselves, which can lead to inadequate bladder emptying. More comprehensive education regarding catheter care and bladder emptying methods may be necessary to address the causes of UTI. Pressure injuries were not observed in our study because we focused on new complications, and most patients demonstrated independent bed mobility, thereby mitigating the risk of a pressure injury.

Limitations

First, the small sample size posed a challenge in drawing conclusive findings and limited the evaluation of factors that may influence the outcomes of this intensive rehabilitation program. Second, this study did not consider certain influencial factors, such as coping strategies, socioeconomic status, educational background, and employment status, which could affect the program's effectiveness. Finally, our study did not control for the continuation of rehabilitation programs after completing the short-course intensive rehabilitation. Therefore, the improvements in functional outcome scores observed during the 6-month follow-up cannot be definitively attributed to the short-course intensive rehabilitation program. Therefore, further research should consider these variables and explore additional complications in order to enhance the Songklanagarind SCI intensive rehabilitation program.

Table 3 Functional outcome, length of stay, effectiveness, and efficiency after receiving the Songklanagarind SCI intensive rehabilitation program categorized by completeness of lesion

	Complete N=5	Incomplete N=18	Mean difference (95% CI)	p-value[a]
On admission				
SCIM III	20.2±12.7	31.2±16.1	11.19 (-4.81, 26.91)	0.148
MBI	4.0±3.0	6.1±4.0	2.13 (-1.73, 5.86)	0.250
On discharge				
SCIM III	37.0±16.5	57.6±23.1	20.63 (-0.47, 41.59)	0.054
MBI	7.6±4.5	12.3±4.9	4.81 (-0.83, 10.26)	0.085
Effectiveness				
Δ SCIM III	16.8±8.0	26.3±12.5	9.44 (-19.96, 0.93)	0.070
Δ MBI	3.6±1.8	6.3±3.0	2.69 (-5.02, -0.22)	0.035*
Length of stay (day)	12.0±4.5	9.0±4.6	-3.13 (-5.63, -0.44)	0.220
Efficiency				
Δ SCIM III/LOS	1.5±0.4	4.2±3.8	2.76 (1.14, 4.74)	0.043*
Δ MBI/LOS	0.3±0.2	0.9±0.6	0.60 (-0.94, -0.23)	0.003*

Mean differences=functional outcome scores (SCIM III or MBI) of patients with incomplete lesion, score for those with complete lesion, [a]p-value of independent t-test between patients with incomplete and complete lesion, *significant difference (p-value<0.05), SCI=Spinal cord injury, LOS=length of stay, 95% CI=95% confidence interval, SCIM III=spinal cord independence measure III, MBI=the modified barthel index

Table 4 Functional outcome, length of stay, effectiveness, and efficiency after receiving the Songklanagarind SCI intensive rehabilitation program categorized by etiology

	Trauma N=4	Non-trauma N=19	Mean difference (95% CI)	p-value[a]
Completeness of lesion (%)	Complete 2 (50.0) Incomplete 2 (50.0)	Complete 3 (15.8) Incomplete 16 (84.2)	-	0.194
On admission				
SCIM III	21.0±12.8	29.9±16.2	8.89 (-0.11-18.06)	0.326
MBI	3.3±2.5	5.9±4.0	2.61 (0.67, 4.67)	0.284
On discharge				
SCIM III	45.0±29.6	53.9±22.7	8.94 (-56.69, 74.58)	0.659
MBI	8.7±7.4	11.6±4.9	2.94 (-13.85, 19.73)	0.565
Effectiveness				
Δ SCIM III	24.0±16.8	24.1±11.8	0.06 (-37.87, 37.98)	0.996
Δ MBI	5.3±4.9	5.7±2.8	0.33 (-11.81, 11.14)	0.919
Length of stay (day)	12.7±2.3	9.2±4.8	-3.44 (-5.50, -1.44)	0.311
Efficiency				
Δ SCIM III/LOS	2.1±1.9	3.8±3.7	1.66 (0.09, 3.43)	0.340
Δ MBI/LOS	0.5±0.5	0.8±0.6	0.34 (0.02, 0.68)	0.365

Mean differences=functional outcome scores (SCIM III or MBI) of patients with non-traumatic etiology – score for those with traumatic etiology [a]=p-value of independent t-test between patients with non-traumatic and traumatic etiologies, *significant difference (p-valiue<0.05), SCI=spinal cord injury, LOS=length of stay, 95% CI=95% confidence interval, SCIM III=spinal cord independence measure III, MBI=the modified barthel index

Table 5 Complication incidences (%) categorized by the evaluation phase

	Admission	Discharge	2-month follow-up	4-month follow-up	6-month follow-up
Pneumonia	0.00	0.00	0.00	0.00	0.00
Pressure injury	34.80	0.00	0.00	0.00	0.00
UTI	17.40	8.70	39.13	13.14	4.35
VTE	8.70	0.00	0.00	0.00	0.00
Depression	17.40	8.70	8.70	4.35	8.70

UTI=urinary tract infection, VTE=venous thromboembolism

Conclusion

The functional outcomes of patients with SCI, assessed using SCIM III and MBI, showed significant improvement after participation in the short-course Songklanagarind SCI intensive rehabilitation program. This improvement was sustained during the 2-, 4-, and 6-month follow-ups. Additionally, the incidences of UTIs and depression were noted during and after the program. The implementation of this short-course intensive rehabilitation program should be considered during the early stages of post-SCI. Future research should concentrate on optimizing patient selection criteria and evaluating the long-term outcomes of the program.

Acknowledgement

The authors would like to acknowledge the Rehabilitation Unit at Songklanagarind Hospital for their support. We are grateful to Miss Sripat Ruangpradap, a registered nurse, for her dedicated nursing care and to Dr. Alan Geater for his invaluable contribution to statistical analysis.

Conflict of interest

The authors declare no conflict of interest concerning the research, authorship, and/or publication of this article.

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