ORIGINAL ARTICLE

The effectiveness of inpatients rehabilitation for spinal cord patients in Siriraj hospital

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Study design: Retrospective study.

Objectives: To study the effectiveness of inpatient rehabilitation in spinal cord injury (SCI) patients.

Setting: Rehabilitation Medicine Department, Faculty of Medicine Siriraj Hospital.

Subjects: SCI patients admitted from 2006 to 2010.

Methods: Medical records of SCI patients including baseline characteristic, functional score using Barthel index (BI), length of stay (LOS) and complications were reviewed. The effectiveness and efficiency were calculated by difference of BI admission and BI discharge (Δ BI) and Δ BI/LOS, respectively. The factors associated with the effectiveness were then determined by multivariate linear regression analysis.

Results: There were 201 admissions with complete data. There were 164 (81.6%) admissions that had objective for intensive rehabilitation. The average LOS was 39.8 days (s.d. = 23.6). BI score was significantly increased after inpatient rehabilitation with the effectiveness of 13.0 (s.d. = 15.2) and BI efficiency of 0.37 score per day (s.d. = 0.47). SCI patients admitted for intensive rehabilitation goal had significantly better BI effectiveness and efficiency compared with other objective group. Only the objective of admission for intensive rehabilitation, the shorter duration of onset before admission, lower BI score on admission and absence of comorbidity were found to associate with the change of BI score.

Conclusion: Inpatient rehabilitation is considered as important part for improving SCI patients' functional abilities. The shorter duration between SCI and rehabilitation, a lower BI score on admission, the absence of comorbidity and the ability to undertake an intensive rehabilitation program were positively associated with the effectiveness of rehabilitation. These factors should be taken care during inpatient rehabilitation program.

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INTRODUCTION

Spinal cord injury (SCI) is a devastating medical condition that disrupts the lives of the injured and their families. The SCI patients mostly result in disability, loss of independence in performing activities and possible psychological issues. The following impact does not only limit to the patients but also to their families, communities and the health-care systems in the life-long period. Many of previous studies about SCI inpatient rehabilitation demonstrated the functional improvement of SCI patients after admission for rehabilitation^{1–10} and it is mostly necessary for both acute and chronic SCI patients. The outcomes and factors associated with the outcomes of SCI inpatients rehabilitation, therefore, are significant to be determined.

Barthel index (BI) instrument is a standard tool that is widely used for assessment of the functional outcome of inpatient rehabilitation.^{11,12} Even BI was demonstrated in some studies that it had minimal evidence on validity; many of the studies of SCI inpatient rehabilitation setting still used BI as the main tool for determination of the functional outcome.^{2,13,14} Our previous study of the epidemiology of SCI patients demonstrated the significant change in functional outcome between the BI scores on admission and discharge for all neurological levels of SCI patients.¹⁵ These studies addressed the

significance of using BI as the tool for assessing functional outcome of SCI inpatient rehabilitation.

There were many of previous studies focused on the factors associated with the effectiveness of rehabilitation in SCI patients. Those factors included age,^{4–6,8} level of spinal cord lesion,^{6,8,16} the completeness of spinal cord lesion,^{3,16} the characteristic of lesion,^{3,4} American Spinal Injury Association (ASIA) impairment scale,⁶ the duration after onset of spinal cord lesion,^{9,10} the causes of SCI,^{1,4,7,8} functional status on admission,^{3,8,10} and the length of stay (LOS) during rehabilitation.^{8,10,16}

Otherwise, there were also the previous studies in our country about SCI inpatient rehabilitation^{15,17,18} but all those studies focused on the epidemiological data. There was only a study performed by Kuptniratsaikul V¹⁵ that demonstrated BI score on admission and at discharge after SCI inpatient rehabilitation. However, none of previous studies in our country focused on the factors associated with effectiveness of SCI inpatient rehabilitation. Therefore, the objectives of this study are as following: (1) to determine the effectiveness of rehabilitation for SCI patients at rehabilitation inpatient ward, Siriraj hospital using functional outcome assessed by changes of BI score; (2) to determine the factors associated with the effectiveness of the SCI inpatient rehabilitation by using the multivariate analysis.

MATERIALS AND METHODS

Retrospective medical records of SCI patients that admitted to the rehabilitation inpatient ward, Siriraj hospital from 2006 to 2010 were included in this study. After correction of surgical and/or medical conditions from acute SCI, patients who had potential for rehabilitation or could co-operate all provided programs were transferred for rehabilitation in our inpatient ward. Because this study

recruited medical records of SCI patients for 5 years, there were some health-care provider changes throughout the study. However, the program provided was performed on the basis of clinical presentation of the patients. In addition, the chronic SCI patients who had spinal injuries for a period and readmitted for improving functions were also included in the study. Patients were discharged when they reached goals of admission. The medical records of SCI patients

Table 1 Demographic characteristics of patients admitted for rehabilitation for spinal cord injury

Characteristic	No (n = 201)	Proportion (%)
Mean age, years ($\pm$ s.d.)	44.4 $\pm$ 17.7	
Age range, years	8–89	
Male sex	118	58.7
<i>Marital status</i>		
Single	77	38.3
Married	96	47.8
Divorced	16	8.0
Widow	10	5.0
<i>Career before injury</i>		
Unemployed	25	12.4
Employed	166	82.5
<i>Caregiver</i>		
Yes	186	91.1
No	10	5.0
<i>Comorbidity^b</i>		
Present	82	40.8
Absent	119	59.2
<i>Surgery before admission</i>		
Yes	22	10.9
No	179	89.1
Mean time until rehabilitation (months $\pm$ s.d.)	2.4 $\pm$ 3.9	
Median (min, max)	1 (0–30)	
LOS (mean $\pm$ s.d.) (days)	39.8 $\pm$ 23.6	
Median (range)	35 (3–140)	
<i>Objective of admission^a</i>		
Intensive rehabilitation	164	81.6
Bladder investigation/training	33	16.4
Treatment of complications	1	0.5
Caregiver training	3	1.5
<i>Neurological classification</i>		
Complete tetraplegia	11	5.5
Incomplete tetraplegia	61	30.3
Complete paraplegia	34	16.9
Incomplete paraplegia	95	47.3
<i>Level of injury</i>		
C1–T1 tetraplegia	72	35.8
T2–T12 paraplegia	92	45.8
L1–S5 paraplegia	37	18.4
<i>ASIA impairment scale on admission</i>		
A	45	22.4
B	34	16.9
C	43	21.4
D	73	36.3
<i>Cause of injury</i>		
Traumatic	85	42.4
Road traffic collision	(44)	(21.9)
Fall from height	(14)	(7.0)
Gunshot wound	(16)	(8.0)
Others	(11)	(5.5)
Non-traumatic	115	57.6
Tumor	(25)	(12.4)
Degenerative	(33)	(16.4)
Vascular	(15)	(7.5)
Others	(42)	(20.9)

Abbreviation: LOS, length of stay.

^aEach admission may have had more than one objective, only the main objective is represented.

^bComorbidities included diabetes mellitus, hypertension, dyslipidemia, stroke, cancer, heart disease, visual impairment, and musculoskeletal and neurological disorders.

were excluded if the data of BI score on admission and/or discharge were missing. According to the goal to evaluate the effectiveness of SCI inpatient rehabilitation at each visit, this study also included readmission visits. Totally, 201 admissions with 25% readmission were included.

The demographic data and clinical features included ASIA impairment scale, neurological classification, level of injury, cause of SCI, BI score on admission and at discharge, objectives of admission, LOS, duration after onset of SCI and complications during admission. Goals of admission were categorized into intensive rehabilitation program and others. Patients admitted for intensive rehabilitation program means they can tolerate program >3 h per day and 7 days per week. The program was usually ~30–45 min per round of physical therapy or occupational therapy depending on the programs for each patient. All subjects admitted in our rehabilitation ward would be assessed for functions twice using BI within 2 days of admission and again a week prior to discharge date. The score ranged from 0 to 100 with the higher score represents the better outcomes. BI was used routinely in evaluation of functions for every diagnosis in rehabilitation wards in Thailand because of its simplicity and no license. We do not use other specific instruments as Spinal Cord Independence Measure or Walking Index for Spinal Cord Injury for additional evaluation.

The main outcome of this study was the effectiveness of SCI inpatient rehabilitation, which was determined by the change of BI score from admission to BI discharge (Δ BI). BI efficiency was also calculated by divided Δ BI with average LOS. In addition, factors that were determined for the association with the effectiveness of SCI rehabilitation included demographic characteristics, LOS, duration after onset of SCI, presence of comorbidities, presence of complications, causes of SCI, level of injury and completeness of cord injury.

Statistical methods

The quantitative data were presented by mean $\pm$ s.d., and categorical data were presented in number (*n*) and percentage (%). Paired *t*-test was used to compare within group and unpaired *t*-test to compare between groups. The factors associated with Δ BI were identified by Mann–Whitney *U* test and Kruskal–Wallis H-test for categorical data, that is, gender, caregiver, level of injury. Pearson's correlation was applied for the quantitative data, that is, age, duration after onset of SCI and LOS. The univariate analysis was performed. Subsequently, stepwise multiple linear regression was then applied for the effect of several independent variables simultaneously for Δ BI to determine for the factors that strongly associated with rehabilitation outcome (Δ BI). The statistical significance was determined at *P*-value <0.05.

RESULTS

There were total of 238 chart review of SCI admissions in rehabilitation ward, Siriraj hospital from 2006 to 2010. From total of 238 chart review, 37 admissions were excluded because of the referred case (10 cases), death case (1 case) and incomplete BI data (26 cases). The reasons for refer patients to Department of Medicine were unstable medical conditions during admission including sepsis and acute

gastrointestinal bleeding. In Thailand, we had only three specialized rehabilitation centers. Our hospital serves as a rehabilitation center in university hospital, so we do not transfer patients to other specialized rehabilitation centers.

Only 201 SCI admissions (85%) had the complete data of BI score both on admission and at discharge in which only 25% were readmission. Because the objective of this study is to determine the effectiveness of rehabilitation in each admission, we then applied total of 201 admissions for further analysis. Table 1 shows demographic characteristics of patients at admission. The mean age was 44.4 years (s.d. = 17.7) with range from 8 to 89 years and 58.7% were males. Most of the SCI patients had their own caregiver (91.1%) of which 81.6% were family member. Some patients (10.9%) underwent surgery before admission to rehabilitation unit. However, the admission in our study did not include the surgical phase. Most of the patients suffered from paraplegic (64.2%) and incomplete (77.6%). The ASIA impairment scales on admission were 22.4, 16.9, 21.4 and 36.3% for ASIA A, B, C and D, respectively. There were 85 patients (42.4%) with traumatic SCI. The duration after onset ranged from 0 to 30 months with the median about 1 month before admission. The patients were mostly chronic SCI in which the duration after onset is >3 months (57.7%). There were 164 of 201 patients (81.6%) admitted for intensive rehabilitation, whereas others were admitted for other purposes, that is, bladder training and/or investigation (16.4%) or caregiver training (1.5%).

After rehabilitation, 141 (70.1%) patients had BI improvement, whereas 60 (29.9%) had no change in BI. Table 2 presents the functional outcomes of SCI patients categorized by objectives of admission. For all patients, the average BI score on admission and discharge were 48.9 (s.d. = 26.7) and 61.6 (s.d. = 27.0) out of 100 score, respectively. The BI effectiveness or Δ BI was 13.0 (s.d. = 15.2). The LOS of all admissions had a mean of 39.8 days (s.d. = 23.6). The average of change in functional score (BI efficiency or Δ BI/day) was 0.37 points per day (s.d. = 0.47). To assess for effectiveness of rehabilitation in subgroup that were admitted for intensive rehabilitation, total of 164 admissions had average of BI score on admission 47.5 (s.d. = 25.9). After inpatient rehabilitation, BI score at discharge was significantly different from BI admission (*P* < 0.001). The BI effectiveness was 14.9 (s.d. = 15.7) and BI efficiency was 0.41 score (s.d. = 0.48). For patients who were admitted for other purposes (*N* = 37), BI effectiveness and BI efficiency were significantly lower than the group admitted for intensive rehabilitation (*P* < 0.001 and *P* = 0.010). Moreover, the average LOS in the group admitted for

Table 2 Functional outcome, length of stay and effectiveness rehabilitation in patients with spinal cord injury categorized by admission objectives

	All patients on admission mean $\pm$ s.d. (<i>n</i> = 201)	Admission for intensive rehabilitation mean $\pm$ s.d. (<i>n</i> = 164)	Admission for other objectives mean $\pm$ s.d. (<i>n</i> = 37)	Mean difference (95% confidence intervals)	<i>P</i> -value ^a
Barthel index on admission	48.9 $\pm$ 26.7	47.5 $\pm$ 25.9	55.2 $\pm$ 29.8	-7.7 (-17.3, 1.8)	0.113
Barthel index on discharge	61.6 $\pm$ 27.0*	62.0 $\pm$ 25.9**	59.5 $\pm$ 31.6***	2.5 (-8.7, 13.7)	0.656
Barthel index effectiveness (Δ BI)	13.0 $\pm$ 15.2	14.9 $\pm$ 15.7	4.3 $\pm$ 8.4	10.2 (6.6, 13.8)	< 0.001 ^b
Length of stay (day)	39.8 $\pm$ 23.6	41.7 $\pm$ 22.6	31.6 $\pm$ 26.1	10.1 (1.8, 18.5)	0.018 ^b
Barthel index efficiency (Δ BI/LOS)	0.37 $\pm$ 0.47	0.41 $\pm$ 0.48	0.19 $\pm$ 0.37	0.22 (0.05, 0.39)	0.010 ^b

Abbreviations: Δ BI, BI discharge; LOS, length of stay.

Mean difference = BI score of those admitted for intensive rehabilitation – score for those admitted for other objectives.

****Paired *t*-test comparing Barthel index (BI) on admission and at discharge: **P* < 0.001, ***P* < 0.001, ****P* = 0.003.

^a*P*-value of independent *t*-test between patients with spinal cord injury admitted for intensive rehabilitation and those admitted with other objectives.

^bSignificant difference.

intensive rehabilitation (41.7 ± 22.6 days) was significantly longer than the group admitted for other objectives (31.6 ± 26.1 days) ($P=0.018$).

Table 3 shows the comparison between rehabilitation of SCI from different etiologies; traumatic and non-traumatic. There was no significant difference of the BI effectiveness, BI efficiency and LOS between traumatic and non-traumatic SCI. However, there was significant improvement of BI score on admission and at discharge ($P<0.001$) within each group. Table 4 presents the comparison between acute (onset ≤ 3 months) and chronic (onset > 3 months) SCI groups. BI effectiveness revealed the significant difference between groups ($P<0.001$) as well as the BI efficiency ($P=0.024$). The effectiveness and efficacy of patients with acute onset were significantly more than those of chronic cases. There was also significant improvement of BI score on admission and at discharge within each group ($P<0.001$ and $P=0.003$).

The factors associated with Δ BI were demonstrated in Table 5. Those factors included several baseline characteristics of SCI patients and classification of SCI itself. After using stepwise multivariate linear regression analysis, the factors that associated with improvement of BI score (effectiveness) included (1) the group of patients who was admitted for intensive rehabilitation ($P=0.001$), (2) the shorter duration after onset of SCI ($P=0.018$), (3) the lower BI score on admission ($P=0.017$) and (4) the absence of comorbidity ($P=0.007$). In this study, the neurological level of SCI, completeness of injury, ASIA classification and other baseline characteristics of SCI patients did not appear to have any association with Δ BI after inpatient rehabilitation.

We also analyzed the medical complications that occurred during inpatient rehabilitation process (Table 6). The top three complications in SCI inpatients were urinary tract infection, urinary incontinence and neuropathic pain with the frequency of 58.7, 33.8 and 13.9%,

respectively. No one had deep vein thrombosis. In this study, complications during admission did not relate to Δ BI score.

DISCUSSION

In our setting, the patients who immediately suffer from SCI would be admitted, underwent supportive or surgical management and then stabilized in 'orthopedic spinal cord unit'. In the old days, our rehabilitation team joined with spinal unit and provided rehabilitation service until patients were independent and could be discharged home. Nowadays, we do have our own rehabilitation ward and patients were transferred to our ward to receive rehabilitation programs. Those who have potential for improving functions were admitted into our specialized rehabilitation unit. In addition, the chronic cases could also be readmitted if their clinical status or function was declined.

Our study revealed the significant improvement of BI score regarding the intensive rehabilitation objectives, traumatic etiologies and acute onset of SCI patients (Tables 2–4). This finding addresses that inpatient rehabilitation is necessary for the improvement of functional status of all subgroup of SCI patients. The higher BI effectiveness of intensive rehabilitation group comparing with other purposes could be due to readiness and the better potential of SCI patients to receive training programs including mobility, ambulation and self-care training. BI effectiveness of acute SCI group (onset ≤ 3 months) is also better than chronic SCI group, which could result from the better neurological recovery in earlier phase after SCI injury. Our results were in line with the study of Sumida *et al.*¹⁰

Similar to previous studies,^{2–4,15,16} our study demonstrate the significant improvement of SCI patients who were admitted for intensive rehabilitation. However, comparison of results with previous studies is rather difficult because most of studies on the effectiveness of

Table 3 Functional outcome, length of stay and effectiveness of inpatient rehabilitation categorized by cause of spinal cord injury

	All patients on admission mean $\pm$ s.d. (n = 201)	Traumatic etiology mean $\pm$ s.d. (n = 85)	Non-traumatic etiology mean $\pm$ s.d. (n = 116)	Mean difference (95% confidence interval)	P-value ^a
Barthel index on admission	48.9 $\pm$ 26.7	48.4 $\pm$ 28.1	49.3 $\pm$ 25.8	-0.9 (-8.4, 6.7)	0.820
Barthel index on discharge	61.6 $\pm$ 27.0*	61.9 $\pm$ 28.8**	61.3 $\pm$ 25.8***	0.6 (-7.0, 8.2)	0.876
Barthel index effectiveness (Δ BI)	13.0 $\pm$ 15.2	13.5 $\pm$ 15.3	12.6 $\pm$ 15.2	0.9 (-3.3, 5.2)	0.661
Length of stay (day)	39.8 $\pm$ 23.6	37.8 $\pm$ 25.8	41.3 $\pm$ 21.7	-3.5 (-10.1, 3.2)	0.304
Barthel index efficiency (Δ BI/LOS)	0.37 $\pm$ 0.47	0.44 $\pm$ 0.53	0.32 $\pm$ 0.42	0.12 (-0.02, 0.25)	0.089

Abbreviations: Δ BI, BI discharge; LOS, length of stay.

Mean difference = BI score of patients with traumatic spinal cord injury – score for those with non-traumatic injuries.

*–***Paired *t*-test comparing Barthel index (BI) on admission and at discharge: * $P<0.001$, ** $P<0.001$, *** $P<0.001$.

^aP-value of independent *t*-test between patients with traumatic spinal cord injury and those with non-traumatic injuries.

Table 4 Functional outcome, length of stay and effectiveness of inpatient rehabilitation categorized by duration since spinal cord injury

	All patients on admission mean $\pm$ s.d. (n = 201)	Acute injury (≤ 3 months) mean $\pm$ s.d. (n = 52)	Chronic injury (> 3 months) mean $\pm$ s.d. (n = 149)	Mean difference (95% confidence intervals)	P-value ^a
Barthel index on admission	48.9 $\pm$ 26.7	40.1 $\pm$ 25.6	52.0 $\pm$ 26.5	-11.9 (-20.3, -3.6)	0.005 ^b
Barthel index on discharge	61.6 $\pm$ 27.0*	61.6 $\pm$ 27.8**	61.6 $\pm$ 26.8***	0.07 (-8.5, 8.7)	0.987
Barthel index effectiveness (Δ BI)	13.0 $\pm$ 15.2	22.7 $\pm$ 19.5	9.6 $\pm$ 11.6	13.1 (7.4, 18.9)	<0.001 ^b
Length of stay (day)	39.8 $\pm$ 23.6	50.5 $\pm$ 26.1	36.1 $\pm$ 21.5	14.4 (7.2, 21.6)	<0.001 ^b
Barthel index efficiency (Δ BI/LOS)	0.37 $\pm$ 0.47	0.49 $\pm$ 0.53	0.32 $\pm$ 0.44	0.17 (0.02, 0.32)	0.024 ^b

Abbreviations: Δ BI, BI discharge; LOS, length of stay.

Mean difference = BI score of patients with acute spinal cord injury – score for those with chronic injuries.

*–***Paired *t*-test comparing Barthel index (BI) on admission and at discharge: * $P<0.001$, ** $P<0.001$, *** $P=0.003$.

^aP-value of independent *t*-test between patients with acute spinal cord injury and those with chronic injuries.

^bSignificant difference.

Table 5 Factors associated with change in Barthel index score (Δ BI): univariate and stepwise multiple linear regression analyses

Factor	n	Univariate analysis		Stepwise regression analysis		
		Δ BI		b	s.e. (b)	P-value
		Mean (s.d.)	P-value			
		Median (range)				
Age (years)	201	$r = 0.012$	0.868			
Sex						
Male	118	13.0 ± 15.0	0.952			
Female	83	12.8 ± 15.5				
Length of stay (days)	201	$r = 0.173^a$	0.014 ^a			
Duration between injury and rehabilitation (months)	201	$r = 0.226^a$	0.001 ^a	-0.621	0.261	0.018 ^a
BI score on admission	201	$r = -0.216^a$	0.002 ^a	-0.092	0.380	0.017 ^a
Objective of admission						
Intensive	164	11 (-3, 85)	<0.001 ^a	8.840	2.634	0.001 ^a
Others	37	9 (0, 85)				
Comorbidity						
Present	82	11 (0, 85)	0.012 ^a	-5.539	2.032	0.007 ^a
Absent	119	5 (-3, 60)				
Complications						
Present	175	10 (-3, 85)	0.085			
absent	26	3.5 (0, 47)				
ASIA impairment on admission						
A	45	10 (0, 47)	0.748			
B	34	7 (0, 60)				
C	43	6 (0, 39)				
D	73	9 (-3, 85)				
Completeness of injury						
Complete	45	10 (0, 47)	0.475			
Incomplete	156	9 (-3, 85)				
Level of injury						
C1-T1 tetraplegia	72	7.5 (-3, 66)	0.602			
T2-T12 paraplegia	92	9.5 (0, 85)				
L1-S5 paraplegia	37	10 (0, 52)				
Causes of injury						
Traumatic	85	10 (0, 66)	0.680			
Non-traumatic	16	9 (-3, 85)				
Caregiver						
No	10	19.5 (0, 85)	0.080			
Yes	184	9 (-3, 66)				
Marital status						
Single	77	8 (0, 85)	0.105			
Married	96	10 (0, 66)				
Divorced/widowed	26	4 (-3, 60)				
Pre-injury employment						
Unemployed	25	10 (0, 52)	0.528			
Employed	166	9 (-3, 85)				

Abbreviations: ASIA, American Spinal Injury Association; BI, Barthel index; Δ BI, difference between Barthel index at admission and discharge; s.e., standard error.

^aSignificant difference.

Table 6 Medical complications arising during inpatient rehabilitation for spinal cord injury

	Number (n = 201)	%
No complications	26	12.9
Complications	175	87.1
Urinary tract infection	118	58.7
Urinary incontinence	68	33.8
Neuropathic pain	28	13.9
Musculoskeletal problem	27	13.5
Spasticity	23	11.4
Fecal incontinence	16	8.0
Pressure ulcer	16	8.0
Orthostatic hypotension	13	6.5
Autonomic dysfunction	3	1.5
Deep vein thrombosis	0	0

functional rehabilitation used other functional measures including Functional Independent Measure,^{1,3,6,7,9,10} Rivermaid Mobility Index,⁴⁻⁶ Walking Index for Spinal Cord Injury.⁴⁻⁶ In addition, some studies focused only traumatic or non-traumatic causes of SCI.^{6,15} Certain studies aimed to compare between traumatic and non-traumatic SCI.^{4,5} Our study did not aim as those studies.^{4-6,15} The populations in this study recruited both traumatic and non-traumatic causes.

The BI effectiveness of our study is lower than previous study. This finding could possibly relate with early acute phase of SCI in most previous studies. The average of BI admission score was then extremely lower and there was room for BI improvement during rehabilitation phase. However, our study revealed comparable improvement of BI score per day with previous studies. This result could be due to relatively shorter LOS in our study. This could result from difference in criteria of admission for rehabilitation compared with previous studies. The previous studies counted the days of LOS beginning from acute injury then underwent supportive and/or surgical management and subsequent rehabilitation in the same admission that makes LOS longer. In our study, the LOS counted only during rehabilitation phase. Therefore, it appeared to have comparable BI efficiency when we calculated for the change of BI score per day during admission.

Our study demonstrates that the factors significantly associated with the effectiveness of SCI inpatient rehabilitation include (1) the group of patients who was admitted for intensive rehabilitation, (2) the shorter duration after onset of SCI, (3) the lower BI score on admission and (4) the absence of comorbidity. Van der putten *et al.*⁹ in 2001 demonstrated that the change of Functional Independent Measure motor score directly associated with the earlier duration after SCI onset in non-traumatic SCI patients. Although in traumatic SCI patients, the ability to do self-care function was better in the group that has received early rehabilitation after SCI onset.¹⁰ Therefore, our study reveals the consistent results with previous studies in which improvement of BI score associates with the shorter duration after SCI onset.^{9,10} Moreover, from subgroup analysis of acute and chronic SCI groups, the acute SCI group (onset ≤ 3 months) demonstrates the significant better effectiveness of rehabilitation ($P = 0.001$).

Concerning the role of patients' families, almost all have caregivers who could be either family member or hired caregivers. In our setting, the family or caregivers could follow the patients during physical therapy/occupational therapy sessions and learn how to assist or guide the patients at home. They could also standby with the patients at their

own bed at ward. Patients mostly feel mentally secure with the presence of their families or caregivers. This situation could psychologically affect the patient training and subsequent the outcome of care. SCI patients included in this study are mostly in working age group with employed status before SCI. Those social background data imply that most of the patients in our studies are functionally independent with decent supporting system to facilitate continuing rehabilitation care. However, multivariate analysis revealed that those factors on social background did not associate with the effectiveness of rehabilitation.

The previous studies showed that SCI patients who had higher functional score on admission got significant improvement of functional outcome score.³ In contrast, our study demonstrates that the lower BI score on admission leads to better increase of Δ BI score. The explanation of this finding could be possibly because of the higher number of SCI patients who were admitted for intensive rehabilitation ($n = 164$, 81.6%) from total of 201 admissions. This group of patients had lower BI admission score, whereas the patients who were admitted for other purposes, that is, bladder training, had higher BI admission score and lesser Δ BI as admission focused in only bladder training.

Our study is the first study demonstrating that the absence of comorbidity strongly associates with the improvement of BI score. The comorbidities in our study included diabetes mellitus, hypertension, dyslipidemia, stroke, cancer, cardiac condition, visual problem, musculoskeletal problem and neurological disease. The presence of comorbidity could reflect the health condition of patients for rehabilitation and could affect the continuity of rehabilitation during admission. Therefore, the effectiveness of rehabilitation is worse than the group that has absence of comorbidity.

There are several limitations in our study including (1) some parts of data were missing because of the retrospective study design. Therefore, the total number of subjects recruited was only 201; (2) this study mainly used BI score as the functional outcome measure for effectiveness of rehabilitation. Other functional measurement tools including Functional Independent Measure, Rivermaid Mobility Index or Walking Index for Spinal Cord Injury were not applied in this study according to several limitations of usage of those functional measurement tools in our country; (3) because of the limitation from retrospective study design, there was lack of psychological data, especially depression, that could affect the effectiveness of rehabilitation. However, depression is a common condition that could be detected in SCI patients.^{19,20} In addition, depression was demonstrated to associate with longer LOS, poor social integration and increasing of SCI medical complications.²⁰ This factor should then be considered in further studies. (4) We could not demonstrate changes in SCI development over the rehabilitation course. Reviewing of medical records did not provide the complete data set of neurological physical examination of these patients before and after admission to demonstrate in the study. (5) The numbers that are used in the calculations include patients admitted and then discharged on more than one occasion (201 admissions, 150 patients). The rate of change is then per admission rather than per person, therefore there was potential to overestimate the real rate of change. In addition, there was also potential to underestimate the average time spent in rehabilitation as the actual LOS in rehabilitation for a patient with an interrupted program is necessarily divided.

CONCLUSION

The effectiveness of rehabilitation for SCI inpatients was better in acute cases who were admitted for intensive rehabilitation program. The average LOS was 40 days. In addition, the factors that are addressed to associate with effectiveness of SCI inpatient rehabilitation

include the objective of admission for intensive rehabilitation, the shorter duration after SCI onset, the lower BI score on admission and the absence of comorbidity.

DATA ARCHIVING

There were no data to deposit.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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