Original Article

Demographics, Clinical Characteristics and Functional Outcome of Non-Traumatic Spinal Cord Injury Undergoing Inpatient Rehabilitation in University Malaya Medical Centre

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ABSTRACT

Objectives: To describe the demographics and functioning of patients with non-traumatic spinal cord injury (NTSCI) undergoing inpatient rehabilitation.

Study design: Retrospective study.

Setting: A tertiary hospital in Malaysia.

Subjects: Patients (N = 141) with NTSCI who had undergone initial inpatient rehabilitation between 1st January 2015 to 31st December 2019.

Methods: This was a retrospective study design where information was obtained from patients' electronic medical records. The etiology of NTSCI, demographic information, length of stay in rehabilitation, American Spinal Injury Association Impairment Scale (AIS) grade at initial rehabilitation and discharge, and Spinal Cord Injury Independence Measure Version III (SCIM III) score at initial rehabilitation and discharge, were recorded and analyzed.

Results: A total of 141 patients with NTSCI were referred for inpatient rehabilitation. The mean age was 58.1 years (range 20-88), and 59.6% were men. The mean duration of inpatient rehabilitation was 32.3 days (range 7-198). The top three etiology were spine degeneration (34.0%), spine neoplasms (30.5%), and infection (23.4%). The commonest neurological impairment was incomplete paraplegia (52.5%). Most patients were classified as AIS D (n=84, 60.4%); only 14 (10.1%) patients were found to be AIS A. The mean difference of SCIM III score between initial and completion of rehabilitation all NTSCI etiologies achieve clinical significance, with mean score ranges from 12.7 to 21.9 points.

Conclusions: Spine degeneration and spine neoplasm were the most common etiology of NTSCI in this study. Regardless of the etiology of NTSCI, all patients benefited from inpatient rehabilitation program, and had similar functional gain.

Keywords: etiology, demography, functional outcome, spinal cord injury, rehabilitation

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Introduction

Spinal cord injury (SCI) is a chronic condition which affects patients' physical, psychological health and social well-being, as well as causes heavy burden on families, communities, and health care systems.[1] The prevalence of SCI was from 440 to 526 per million people.[1] A recent survey in Malaysia where 298 people with SCI participated, 14.6% were non-traumatic spinal cord injury (NTSCI).[2] The incidence of NTSCI is reported to be higher than traumatic SCI in Australia and Canada.[3,4] The number of people with NTSCI is increasing due to aging populations. Therefore, it is anticipated that the incidence of NTSCI will increase with the aging global population.[3] Patients with NTSCI are older than those with traumatic SCI (TSCI), with the typical median age of 60 to 65 years old[2-5] and could possibly have worse functional outcome.

The common etiology of NTSCI are degenerative spinal conditions, benign or malignant neoplasm, vascular disorders, inflammatory disorders, and infection.[2,5,6] NTSCI in developed countries are commonly caused by degenerative conditions and neoplasms, while in developing countries caused by infections and neoplasms.[7]

Clinical characteristics and functional outcome of NTSCI is less often reported compared to traumatic SCI. When compared to NTSCI, TSCI group had a higher proportional of patients who were male (68-76%), tetraplegic (32.1-60.6%), and complete lesion (23-74%).[8-10] Tetraplegia occurred more commonly in patients with degenerative disorder of the spine, as compared to other etiologies.[5,11] Patients with vertebral infection were more likely to have incomplete paraplegia[6] whilst patients with malignant spinal cord compression had similar age and gender distribution compared to other causes of non-traumatic spinal cord injury.[13] Functioning of patients with NTSCI improved following inpatient rehabilitation, but patients with malignant neoplasm have lesser improvement.[5,11,12] Nevertheless, most patients with malignant neoplasms met their inpatient rehabilitation goals.[13]

There is scarce study on the functional outcome among different etiologies in patients with NTSCI in Malaysia. It is important to understand the characteristics of the different etiologies of NTSCI and their functioning changes following rehabilitation, as it might help to facilitate optimal rehabilitation and anticipated outcome of the patients. Thus, the purpose of this study is to describe the demographics, clinical characteristics and functioning profile of patients with NTSCI according to the etiology.

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Methods

This is a retrospective study of patients with NTSCI who were referred to the SCI rehabilitation team for initial inpatient rehabilitation in University Malaya Medical Centre (UMMC), between 1st January 2015 to 31st December 2019. The study was approved by the UMMC Medical Research Ethics Committee (MREC ID Number: 2020628-8831).

The inclusion criteria were patients with NTSCI, 18 years old and above, and referred for initial rehabilitation after the onset of NTSCI, and had Spinal Cord Independence Measure III (SCIM III) scores before and after rehabilitation were included. Those who were diagnosed as Guillain-Barre´ syndrome, multiple sclerosis, spina bifida, Friedreich ataxia, or a conversion syndrome were excluded. The information was gathered from UMMC electronic medical records. Age, gender, date of onset of SCI, duration of inpatient rehabilitation, etiology of NTSCI, level of spinal cord injury (tetraplegia vs paraplegia), and completeness of injury (complete vs incomplete). American Spinal Cord Injury Association Impairment Scale (AIS) grade and SCIM III score at the start of rehabilitation and discharge were collected.

The etiology of NTSCI was classified according to the classification used in the International Nontraumatic Spinal Cord Injury Data Set.[14] According to this classification system, the etiologies in this study were categorized as degenerative, neoplasms, infection and others. The duration of SCI was the date of onset of SCI to the date of initiation of rehabilitation, and were recorded as acute (≤ 1 day), subacute (> 1 day but ≤ 7 days), prolonged (> 7 days but ≤ 1 month), and lengthy (> 1 month).[14] The duration of rehabilitation stay was defined as the date of initiation of inpatient rehabilitation to the date of discharge.

The SCI Rehabilitation service in UMMC routinely uses SCIM III to document functional outcomes of patients with spinal cord injuries at the start and end of inpatient rehabilitation. The SCIM III covers three major domains: self-care (score 0-20), respiration and sphincter management (score 0-40) and mobility (score 0-40). The total score ranges from 0 to 100, where 0 indicates total dependence and 100 indicates complete independence.[15] SCIM III is a reproducible and valid functional outcome measure in patients with NTSCI.[16] The difference between initial rehabilitation and discharge was documented as the functional gain during the inpatient rehabilitation.

Statistical Package for the Social Sciences (SPSS) version 23 was used for data analysis. The chi square test was used to detect significant differences of demographic (gender and pattern of onset) and characteristics of SCI with etiology. One way ANOVA was used to compare age with etiology while Kruskal-Wallis rank sum test was used to compare duration of rehabilitation stay with etiology. Association between SCIM III score and subdomain SCIM III scores with etiology and characteristic of SCI were also analyzed. Kruskal-Wallis rank sum test and Mann-Whitney test was used because of the skewed distribution of the scores. *P* values of less than 0.05 were considered significant.

Results

A total of 141 patients were referred for rehabilitation during the study period (Table 1). The mean (SD) age was 58.1 (14.2) years old (range 20-88), and majority were men (n = 84, 59.6%). A total of 109 patients were admitted to the rehabilitation ward for rehabilitation, while the rest received rehabilitation in the primary ward. The mean duration of inpatient rehabilitation was 32.3 days (median 27, IQR 18-42, range 7-198). The commonest neurological impairment was incomplete paraplegic (52.5%). The top three etiologies were spine degeneration (n = 48, 34.0%), spine neoplasms (n = 43, 30.5%), and infection (n = 33, 23.4%).

At initial rehabilitation, most patients were classified as AIS D (n = 84, 60.4%), only 14 (10.1%) patients were found to be AIS A. At discharge, 36 (25.9%) patients showed improvement in the AIS classification, 102 (73.4%) remained the same, and one (0.7%) deteriorated.

Table 2 shows the comparison of demographic and characteristics of NTSCI between the etiologies. Patients with spine degeneration had a higher mean age (p = 0.07), were mainly men (p = 0.027), and had incomplete tetraplega (p = 0.00) compared to others. Patients with spine infection had the longest rehabilitation length of stay.

Out of the 141 patients with NTSCI who were referred for rehabilitation, only 65 patients had complete informa-

Table 1. Demographics and clinical characteristics of NTSCI patients (N = 141)

Age (years), mean (SD), range	58.1 (14.2), 20-88
Gender, number (%)	
Men	84 (59.6)
Women	57 (40.4)
Pattern onset, number (%)	
Subacute (> 1 day to ≤ 7 days)	11 (7.8)
Prolonged (> 7 days to ≤ 1 month)	45 (31.9)
Lengthy (> 1 month)	85 (60.3)
Characteristics of SCI, number (%)	
Paraplegia complete	11 (7.8)
Paraplegia incomplete	74 (52.5)
Tetraplegia complete	3 (2.1)
Tetraplegia incomplete	53 (37.6)
Ward, number (%)	
Rehabilitation ward	109 (77.3)
Primary ward	32 (22.7)
Etiology, number (%)	
Spine degeneration	48 (34.0)
Neoplasm - benign	7 (5.0)
Neoplasm - malignant	4 (2.8)
Neoplasm - metastasis	32 (22.7)
Infection - bacterial	19 (13.5)
Infection - tuberculosis	14 (9.9)
Others - inflammation	11 (7.8)
Others - vascular	4 (2.8)
Others - osteoporosis	2 (1.4)
Rehabilitation length of stay (days)	
Mean (SD)	32.3 (23.3)
Median (IQR), range	27 (18-42), 7-198

IQR, interquartile range; NTSCI, non-traumatic spinal cord injury; SCI, spinal cord injury; SD, standard deviation

Table 2. Comparison of demographics, characteristics of NTSCI and rehabilitation by etiology

Characteristics	Degenerative	Neoplasm	Infection	Others	*p*-value
Number (%)	48 (34.0)	43 (30.5)	33 (23.4)	17 (12.1)	
Age (years) mean (SD)	62 (14.2)	56.6 (13.5)	57.3 (13.3)	52.2 (16.2)	0.07[a]
Sex, number (%)					
Men	36 (75)	21 (48.8)	20 (60.6)	7 (41.2)	0.027[b]
Women	12 (25)	22 (51.2)	13 (39.4)	10 (58.8)	
Pattern onset, number (%)					
Subacute (> 1 day, ≤ 7 days)	4 (8.3)	1 (2.3)	3 (9.1)	3 (17.6)	0.016[b]
Prolonged (> 7 days, ≤ 1 month)	8 (16.7)	18 (41.9)	10 (30.3)	9 (52.9)	
Lengthy (> 1 month)	36 (75.0)	24 (55.8)	20 (60.6)	5 (29.4)	
Characteristics of SCI, number (%)					
Paraplegia complete	1 (2.1)	5 (11.6)	3 (9.1)	2 (11.8)	0.000[b]
Paraplegia incomplete	15 (31.2)	30 (69.8)	19 (57.6)	10 (58.8)	
Tetraplegia complete	0 (0.0)	0 (0.0)	2 (5.9)	1 (5.9)	
Tetraplegia incomplete	32 (66.7)	8 (18.6)	9 (27.3)	4 (23.5)	
Ward, number (%)					
Rehabilitation ward	46 (95.8)	33 (76.7)	17 (51.5)	13 (76.5)	0.000[b]
Primary ward	2 (4.2)	10 (23.3)	16 (48.5)	4 (23.5)	
Length of stay (days), median (IQR)	18 (13)	28 (21)	37 (23)	28 (27)	0.000[b]

[a]One way ANOVA, [b]Pearson chi-square test, cKruskal-Wallis rank sum test; level of significance $p < 0.05$
IQR, interquartile range; NTSCI, non-traumatic spinal cord injury

tion on initial rehabilitation and at discharge total SCIM III scores. Meanwhile 59 out of the 65 patients had complete information on the breakdown of scores of the three functioning domains of SCIM III. The demographics of patients who had complete SCIM III scores were similar with total NTSCI patients referred for rehabilitation. Due to small number and heterogenous nature of patients in the 'Others' category, it was excluded from the analysis involving SCIM III total and subdomain score. Thus, the analysis involving total SCIM III scores involved 57 patients whilst analysis involving SCIM III subdomain involved 52 patients.

All etiologies showed almost similar mean SCIM III scores at initial rehabilitation, ranging from 35.9 to 38.2 points (Table 3). SCIM III scores at discharge were higher than the initial score in all etiologies, ranging from 50.5 to 57.8 points. Patients with spinal infection had the highest SCIM III score gain (21.9 points), followed by those with neoplasm (15.7 points) and degenerative diseases (12.6 points). However, there was no significant statistical differences between etiologies and SCIM III score at initial rehabilitation and at discharge.

In the subdomain of SCIM III (self-care score, respiration and sphincter management score, and mobility), there is no difference in score at initial rehabilitation, at discharge, and gain between the different etiologies. Nevertheless, our data showed that patients with spine neoplasms and spine infection had higher self-care score at initial rehabilitation and at discharge. Meanwhile, patients with spine degenerative had higher scores in respiration and sphincter management at initial rehabilitation and discharge. In the mobility domain, patients with spine degeneration and spine neoplasms had lower scores at initial rehabilitation but had higher gain at discharge. Patients with spine infection showed highest gain in self-care and respiration and sphincter management but had the lowest gain in mobility.

As can be seen from Table 4, functional outcome was compared between incomplete paraplegia and incomplete tetraplegia patients. There was no between group differences observed for total SCIM III score at initial rehabilitation, at discharge and gain. As expected, incomplete paraplegic patients compared to incomplete tetraplegia had significantly higher self-care scores at initial rehabilitation and at discharge. There was no significant difference in the initial and discharge SCIM score in the respiration and sphincter management score, and mobility score.

Discussion

This is the first study that provided insight to the demographic and functioning of people with NTSCI in Malaysia. The two common etiologies in this study were spine degeneration and spine neoplasms, which is in line with other studies in the developed countries.[7,11,12,17-20] The current study showed patients with NTSCI had improvement in functioning following inpatient rehabilitation regardless of the etiologies. This includes patients with spinal metastases who formed the majority of patients in the spine neoplasms group. The current study showed that all patients had improvement in their SCIM III score. A study by Sciveletto reported that an improvement of at least 4 points of the total SCIM is needed to obtain a small significant improvement and of 10 points to obtain a substantial improvement.[21] Thus in this study patients with NTSCI, regardless of the etiology, achieved clinically significant change in their functioning following rehabilitation.

Although various outcome measures were used in previous studies, all showed NTSCI patients had improvement in functional outcome with inpatient rehabilitation. Most studies used Functional Independence Measure (FIM)[22-25], in which New et al. reported mean admission FIM motor score of 39.6 and discharge FIM motor score of 58.7.[22] Jolien et al. used

Table 3. Comparing total and subdomains SCIM III score with etiologies of NTSCI

Etiology	N	Mean (SD)	Median	IQR	[a]*p*-value
SCIM III score					
At initial rehabilitation (0-100)					
Degenerative	24	37.9 (17.8)	36	24.5-47.0	0.947
Neoplasm	22	38.2 (13.7)	31	29.5-53.0	
Infection	11	35.9 (13.2)	34	30.8-49.3	
Total	57	37.9 (15.4)	33	26.5-51.5	
At discharge (0-100)					
Degenerative	24	50.5 (20.7)	45	36.0-75.0	0.470
Neoplasm	22	53.9 (14.8)	48	43.0-63.5	
Infection	11	57.8 (12.9)	57.5	44.5-66.3	
Total	57	53.9 (17.3)	52	43.0-71.5	
Self-care score					
At initial rehabilitation (0-20)					
Degenerative	21	9.1 (5.3)	8	4.5-12.5	0.068
Neoplasm	21	11.8 (3.4)	11	10.0-14.5	
Infection	10	11.1 (2.8)	11	8.8-13.3	
Total	52	10.6 (4.2)	10	8.0-14.0	
At discharge (0-20)					
Degenerative	21	12.1 (6.2)	13	6.0-17.0	0.065
Neoplasm	21	15.3 (2.9)	17	13.5-18.0	
Infection	10	16.9 (2.6)	17.5	14.0-19.3	
Total	52	14.3 (4.8)	16	11.0-18.0	
Respiration and sphincter management score					
At initial rehabilitation (0-40)					
Degenerative	21	21.7 (10.1)	19	13.5-32.0	0.421
Neoplasm	21	19.7 (10.0)	15	10.0-30.0	
Infection	10	17.1 (7.0)	15	10.8-22.0	
Total	52	20.0 (9.5)	17	11.0-29.0	
At discharge (0-40)					
Degenerative	21	27.0 (9.7)	29	17.0-36.0	0.295
Neoplasm	21	23.9 (9.9)	22	16.0-33.5	
Infection	10	28.4 (8.5)	27.5	20.8-36.0	
Total	52	26.1 (9.4)	25	17.0-35.0	
Mobility score					
At initial rehabilitation (0-40)					
Degenerative	21	7.2 (6.5)	6	2.0-11.0	0.294
Neoplasm	21	7.1 (4.2)	6	4.0-10.0	
Infection	10	9.6 (4.4)	9	5.8-14.0	
Total	52	7.4 (5.2)	7	3.0-11.0	
At discharge (0-40)					
Degenerative	21	13.1 (6.6)	13	7.0-20.0	0.465
Neoplasm	21	13.1 (4.7)	14	12.0-15.5	
Infection	10	11.6 (3.5)	11.5	9.5-13.8	
Total	52	13.1 (5.6)	13	10.0-16.0	

[a]Kruskal-Wallis rank sum test.

IQR, interquartile range; NTSCI, non-traumatic spinal cord injury; SCIM Spinal Cord Independence Measures; SD, standard deviation

functional status scale consisting of 5 items (mobility, self-care, bladder management, bowel management, and transfers), reported the median score of 47.5 at admission and 90 at discharge.[11] A study in India reported improved functional status using Barthel Index, with mean scores of 31.3 at admission and 55.6 at discharge.[26]

In contrary to the current study, previous studies reported that malignant neoplasms had lesser neurological recovery and poorer functional outcome as compared to other etiologies.[11-13,17] Although the current study did not differentiate between benign and malignant cases, majority (36/43) of cases in the neoplasm group are malignant. There are two possible reasons for this difference; patients in previous studies were older (mean age ranged from 59 to 69), while the mean age in the current study was 54.5 years. Besides that, UMMC is a tertiary center whereby patients can receive advanced high-efficacy anticancer therapeutic agents and radiotherapy, and therefore could have led to a better outcome.

McKinley et al. reported that the most significant improvements achieved during the rehabilitation stay were noted in wheelchair transfers, upper and lower extremity dressing, and toilet and tub transfers.[27] In this study, patients with spine neoplasm compared to other etiologies had higher self-care score and mobility score at discharge. However, our patients

Table 4. Total and subdomains SCIM III scores with NTSCI at initial rehabilitation and at discharge

Characteristic of NTSCI	N	Mean (SD)	Median	IQR	*p*-value
Total SCIM III score					
At initial rehabilitation (0-100)					
Paraplegia incomplete	35	39.9 (14.6)	34.0	30.0-53.0	0.200
Tetraplegia incomplete	24	36.2 (17.5)	31.0	22.5-50.0	
Total	59	38.4 (15.8)	34.0	26.0-53.0	
At discharge (0-100)					
Paraplegia incomplete	35	57.7 (15.1)	57.0	44.0-73.0	0.092
Tetraplegia incomplete	24	49.1 (20.0)	44.5	30.3-71.5	
Total	59	54.2 (17.7)	52.0	43.0-73.0	
Self-care score					
At initial rehabilitation (0-20)					
Paraplegia incomplete	32	11.6 (3.4)	10.0	9.25-14.75	0.029*
Tetraplegia incomplete	21	8.9 (5.2)	8.0	4.5-11.5	
Total	53	10.5 (4.3)	10.0	8.0-14.0	
At discharge (0-20)					
Paraplegia incomplete	32	15.7 (3.4)	16.5	14.0-18.0	0.012*
Tetraplegia incomplete	21	11.7 (5.7)	13.0	6.0-16.0	
Total	53	14.1 (4.9)	15.0	11.0-18.0	
Respiration and sphincter management score					
At initial rehabilitation (0-40)					
Paraplegia incomplete	35	19.3 (9.4)	15.5	10.0-28.75	0.202
Tetraplegia incomplete	24	22.3 (9.8)	20.0	15.0-32.0	
Total	53	20.5(9.6)	17.0	11.0-30.0	
At discharge (0-40)					
Paraplegia incomplete	32	26.4 (9.3)	25.0	17.0-35.0	0.956
Tetraplegia incomplete	21	26.4 (9.8)	24.0	17.0-37.0	
Total	53	26.4 (9.4)	25.0	17.0-35.0	
Mobility score					
At initial rehabilitation (0-40)					
Paraplegia incomplete	35	8.1 (5.0)	9.0	4.0-10.75	0.278
Tetraplegia incomplete	24	6.7 (6.1)	6.0	1.5-11.0	
Total	53	7.6 (5.5)	8.0	2.5-11.0	
At discharge (0-40)					
Paraplegia incomplete	32	13.7 (4.7)	14.0	12.0-16.75	0.553
Tetraplegia incomplete	21	12.7 (7.1)	12.0	7.0-20.0	
Total	53	13.3 (5.7)	14.0	10.0-17.5	

Mann–Whitney test, *$p < 0.05$

IQR, interquartile range; NTSCI, non-traumatic spinal cord injury; SCIM Spinal Cord Independence Measures; SD, standard deviation

had lower sphincter management scores at discharge. Most of the patients who had spinal metastasis were kept with indwelling catheter for convenience of care, as many are still undergoing active radiotherapy or chemotherapy. This could have contributed to the lower score in this subdomain.

Kennedy et al. and Kay et al. had reported that patients with spine infection had more rehabilitation needs and lower rehabilitation outcome.[6,12] The current study showed the opposite; patients with spine infection had improvement in all domains and had equal functional outcomes with other etiologies. This could be attributed to the fact that there were a higher proportion of patients with complete injury[6], and thoracic level involvement[12] as compared to our patients. Apart from that, another possible reason was our patients had longer stay to complete the antibiotic treatment, which allowed more time for rehabilitation.

There is paucity of studies comparing the functional outcome between the levels of injury in NTSCI patients. Our data had demonstrated that both incomplete paraplegia and incomplete tetraplegia group had similar SCIM III median score at initial rehabilitation, at discharge and gain. There was significant difference in self-care score, and this is self-explanatory as persons with paraplegia has no impairments in their upper limbs. As majority of patients in this study were incomplete motor (AIS D), this explains the similar gain in all other domains. This particular finding indicates that despite the different baseline score between individuals with incomplete paraplegia and tetraplegia, the net gain in SCIM III score remains the same.

There are several limitations in our study. As this is a retrospective study, missing values, and incorrect documentation may exist causing inaccuracies. Besides that, SCIM III score was not done or documented for all NTSCI patients, therefore only a small sample size was available for the analysis of the functional outcome. The second limitation is that there is selection bias as not all NTSCI patients are referred to the rehabilitation team, for example, the patients with minimal impairments, those who are not ready to participate in rehabili-

tation, those who are medically unstable, those who are in an advanced stage, or probably no available beds in the rehabilitation ward. The number of patients included in this study is not adequate to achieve statistical power. Sample size calculation indicated that this study needs 190 patients to achieve 95% confidence interval with 5% margin of error. There are a small number of patients in each etiology, and some etiologies need to be combined into a group to obtain enough for analysis. This might be the reason why some of our data showed a difference in the SCIM III score between groups, but it was not statistically significant. Furthermore, our data might not represent the national population as this is a single center study.

Conclusions

Spine degeneration and spine neoplasms were the most common etiology of NTSCI in this study. All etiologies had functional gain during the inpatient rehabilitation. However, there were no significant differences between etiologies and level of functioning. Therefore, all NTSCI patients should be given equal opportunity to rehabilitation in order to improve functional status. A prospective study involving larger groups of patients are needed to provide better quality evidence on the functional outcome of people with NTSCI.

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