

## Original Article

# Nontraumatic spinal cord lesions: a prospective study of medical complications during in-patient rehabilitation

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**Study design:** Prospective study between 1st Jan 1995 and 31st Dec 1999.

**Objective:** To document medical complications among subjects with Nontraumatic Spinal Cord Lesions (NTSCL) during in-patient rehabilitation.

**Setting:** Bangalore, India.

**Methods:** Persons with NTSCL admitted for in-patient rehabilitation were included in the study. Clinical evaluation was carried out according to The International Standards for Neurological and Functional classification of Spinal Cord Injury. Disability was quantified using Barthel index. All medical complications were documented.

**Results:** A total of 297 subjects (154 men and 143 women) with NTSCL were included. The number of medical complications in each patient varied from 0 to 17 (mean =  $6.1 \pm 3.7$ ). Common complications seen were urinary tract infections (184), spasticity (169), pain (149), urinary incontinence (147), depression (114), respiratory tract infections (101), constipation (92), pressure ulcers (89), contractures (52) and sleep disturbance (43). The number of medical complications correlated positively with duration of stay (Pearson's correlation coefficient  $r = 0.5$ ,  $P < 0.01$ ) and negatively with Barthel Index at admission ( $r = -0.2$ ,  $P < 0.05$ ) and at discharge ( $r = -0.2$ ,  $P < 0.05$ ). Complications were more frequent among people with tetraplegia than those with paraplegia ( $P < 0.001$ ).

**Conclusions:** Medical complications are frequent among subjects undergoing rehabilitation for NTSCL. Patients with severe disability at admission have more complications during rehabilitation. Conversely, individuals with more complications have greater disability at discharge.

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**Keywords:** medical complications; nontraumatic spinal cord lesions; rehabilitation; spinal cord injury

## Introduction

Individuals with lesions of spinal cord are prone to several medical complications, which increase the duration and cost of hospitalization, result in loss of therapy time, interfere with the rehabilitation program, and add to disability. Nontraumatic lesions account for about 30–50% of spinal cord disorders<sup>1,2</sup> and constitute a major risk factor for medical complications during rehabilitation.<sup>3</sup> However, most of the studies on medical complications are from cohorts of individuals with traumatic Spinal Cord Injury (SCI). There is a paucity of literature on medical complications in people with Nontraumatic Spinal Cord Lesions (NTSCL). A Med-

line search with the keywords spinal cord, complications, myelopathies, spinal cord injury and nontraumatic spinal cord injury revealed only two retrospective studies on medical complications in this important group.<sup>4,5</sup> The objective of this study was to prospectively document medical complications observed among subjects with NTSCL during in-patient rehabilitation.

## Subjects and methods

This prospective descriptive study was performed in inpatient rehabilitation unit of a tertiary care university hospital for Neurology, Neurosurgery and Psychiatry in South India. Consecutive subjects with NTSCL admitted for in-patient rehabilitation from January 1995

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to December 1999 were included. Clinical evaluation was carried out according to The International Standards for Neurological and Functional Classification of SCI.<sup>6</sup> Criteria used for the diagnosis of Acute Transverse Myelitis (ATM) were acute or subacutely evolving motor, sensory and sphincter disturbance, spinal segmental sensory disturbance with well-defined upper limit, absence of clinical or laboratory evidence of spinal cord compression, absence of other diseases such as syphilis, multiple sclerosis, spinal cord arteriovenous malformations, sarcoidosis or HIV infection, and lack of clinical progress after 4 weeks.<sup>7</sup> Disability was quantified using Barthel index.<sup>8</sup> Medical complication was defined as signs and symptoms warranting medical consultation, investigations or treatment, and/or resulting in absence from a scheduled therapy session. All complications were documented in a predesigned format.

Statistical analysis was performed with SPSS version 11.0. Relation between the number of medical complications and duration of stay, disability at admission and disability at discharge was assessed by calculating Pearson's correlation coefficient. Frequency of medical complications in people with paraplegia and tetraplegia was compared with  $\chi^2$  test and Fisher's probability test. The significance of differences in means of duration of stay, number of medical complications and Barthel at admission and discharge were calculated with 't' test. *P*-values of less than 0.05 were taken as significant.

## Results

During the period of study 297 subjects with NTSCl underwent in-patient rehabilitation. Their ages ranged from 2 to 90 years (mean =  $32 \pm 15.8$  years, median = 30). Etiologies of NTSCl were as follows: tuberculosis of spine – 44 (14.8%), tuberculosis with spinal arachnoiditis – 33 (11.1%), tumors – 85 (28.6%), acute transverse myelitis – 101 (33.6%) (idiopathic – 48, postinfectious – 43 and postvaccination – 10), degenerative diseases of spine – 17 (5.7%), multiple sclerosis – 14 (4.7%) and spinal cord infarction – three (1%).

Among these subjects, 283 (95.3%) had at least one medical complication during in-patient rehabilitation. The number of medical complications in each patient varied from 0 to 17 (mean =  $6.1 \pm 3.7$ ). The complications affected different systems. Overall, 51 different medical complications occurred in the study population. Frequencies of common medical complications are shown in Table 1.

In all, 232 (78.1%) subjects had paraplegia and 65 (21.9%) had tetraplegia. Mean number of medical complications in subjects with tetraplegia was  $6.31 \pm 3.9$  and in those with paraplegia was  $3.6 \pm 2.8$  ( $t = 6.57$ ,  $P < 0.001$ ). Comparison of frequency of different complications between these two groups is shown in Table 2. Orthostatic hypotension, pneumonia and contractures were significantly more frequent among people with tetraplegia. Urinary tract infections

**Table 1** Frequency of medical complications during in-patient rehabilitation of subjects with NTSCl

Complications	Frequency, *N = 297 (%)
Cardiovascular system	56 (18.9)
Hypertension	8 (2.7)
Hypotension	14 (4.7)
Deep venous thrombosis	27 (9.1)
Respiratory system	106 (35.7)
Upper respiratory infections	101 (34.0)
Pneumonia	4 (1.3)
Pulmonary embolism	1 (0.3)
Gastrointestinal system	135 (45.5)
Vomiting	29 (9.8)
Constipation	92 (31)
Diarrhea	24 (8)
Bleeding	3 (1)
Genitourinary system	224 (75.4)
Urinary infection	184 (62)
Incontinence	147 (49.5)
Retention	36 (12.1)
Catheter-related problems	21 (7.1)
Musculoskeletal system	222 (74.7)
Spasticity	169 (56.9)
Contractures	52 (17.5)
Heterotopic ossification	13 (4.4)
Skin	113 (38)
Pressure ulcers	89 (29.9)
Infections	26 (8.8)
Allergy	18 (6.1)
Psychiatric	157 (52.9)
Depression	114 (38.4)
Insomnia	43 (14.5)
Agitation	20 (6.7)
Pain	149 (49.3)

\*Each complication was counted as one and hence total numbers will not tally

and incontinence were more frequent among subjects with paraplegia (Table 2).

Duration of neurological symptoms at the time of admission to the rehabilitation ward varied from 4 to 98 weeks (mean =  $19.8 \pm 12.3$  weeks, median = 20 weeks). There was no significant correlation between frequency of medical complications and duration of symptoms ( $r = 0.03$ ). The mean duration of stay in rehabilitation facility was  $76.6 \pm 63.5$  days (median = 60 days). The number of medical complications correlated positively with duration of stay (Pearson's correlation coefficient  $r = 0.5$ ,  $P < 0.01$ ). The Barthel Index score at the time of admission ranged from 5 to 90 (mean =  $36.2 \pm 21$ ). The number of medical complications correlated negatively with the Barthel index score at admission ( $r = -0.2$ ,  $P < 0.05$ ). The mean Barthel index at discharge was

55.1±27.2 (range = 5–100). There was a significant negative correlation between the number of medical complications and the Barthel index score at discharge ( $r = -0.2$ ,  $P < 0.05$ ).

Frequency of common complications in different age groups is shown in Table 3. There was no correlation between age and the number of medical complications ( $r = 0.034$ ,  $P =$  not significant). Table 4 shows frequency of individual complications in different spinal cord lesions.

In all, 154 men (52.5%) and 143 women (47.5%) were included in this study. There were no significant differences in age (men = 33.5±15.2, women = 30.6±15.9,  $P = 0.117$ ), number of medical complications (men = 6.1±3.7, women = 6.2±4.2,  $P = 0.78$ ), Barthel index scores at admission (men = 38.4±22.8, women = 37.2±20.1,  $P = 0.735$ ) Barthel index scores at discharge

(men = 56.2±31.3, women = 54.6±28.8,  $P = 0.739$ ), and length of stay (men = 75.5±60.8, women = 78.6±66.6,  $P = 0.681$ ). Urinary retention was noted in 25 men (16%) and 11 women (7.8%). This difference was significant ( $P = 0.030$ ). Pressure ulcers were significantly more common among men ( $N = 60$ ) than women ( $N = 29$ ) ( $P < 0.001$ ). There were no significant differences in frequency of other medical complications between the two genders. The results of the present study were compared with two other similar studies (Table 5).

## Discussion

The etiology on NTSCS is highly varied. In our study, the most frequent causes were tuberculosis, transverse myelitis and tumors. McKinley *et al*<sup>1</sup> from USA reported that spinal cord stenosis is the most frequent cause (54%) of NTSCS. Other common etiologies in that series were tumors (26%), ischemia (3%), infections (3%) and myelitis (2%). Common causes of NTSCS in Turkey were tumors (32%), transverse myelitis (13.9%), spinal tuberculosis (12.1%) and intervertebral disc prolapse (11.3%).<sup>9</sup> Etiologies in a study from Australia were tumors (20.1%), multiple sclerosis (19.4%), degeneration (17.9%) and vascular (11.9%).<sup>5</sup> Compared with these reports; tuberculosis and transverse myelitis were more common in our series.

Traumatic SCI is four times more common in men than in women.<sup>10</sup> Gender distribution is more equal in NTSCS.<sup>1</sup> The proportion of women was almost same as that of men in the present study. Gender was not a significant factor in the functional outcome of traumatic SCI.<sup>11</sup> We also did not find any significant differences in length of stay in rehabilitation unit, disability at admission and disability at discharge between men and women with NTSCS. Women with SCI tend to suffer more from pain<sup>12</sup> and depression.<sup>13</sup> In the present study, we did not notice any significant differences between men and women in these complications. Women also have gender-related needs like issues of sexuality,

**Table 2** Medical complications in nontraumatic lesions of Spinal cord: comparison between people with paraplegia and tetraplegia

Complication	Paraplegia N = 232	Tetraplegia N = 65	$\chi^2$	P
Orthostatic hypotension	3	14	47.98	0.001
DVT	23	6	0.03	0.87
Pneumonia	1	3		0.034*
Constipation	78	15	2.62	0.105
Urinary tract infection	154	31	7.55	0.006
Incontinence	128	21	10.62	0.0011
Retention	31	5	1.53	0.22
Spasticity	135	38	0.00	0.97
Contracture	30	24	19.65	0.001
Pain	120	34	0.01	0.93
Heterotopic ossification	11	3		0.633*
Pressure ulcers	70	19	0.02	0.88
Depression	91	25	0.01	0.91
Insomnia	36	8	0.41	0.52

N = Number of subjects; \*Fisher's probability test;  $\chi^2$  = Chi square test; DVT = deep venous thrombosis

**Table 3** Frequency of medical complications in different age groups

	0–14 years (N = 38)	15–45 years (N = 205)	46 years and above (N = 54)
DVT	4 (10.5%)	21 (10.2%)	4 (7.4%)
Pressure ulcers	12 (31.6%)	64 (31.2%)	13 (24.1%)
Urinary tract infection	26 (68.4%)	128 (62.4%)	30 (55.6%)
Urinary incontinence	19 (50%)	106 (51.7%)	22 (40.7%)
Constipation	10 (26.3%)	63 (30.7%)	19 (35.2%)
Pneumonia	1 (2.6%)	1 (0.5%)	2 (3.7%)
Orthostatic hypotension	0	7 (3.4%)	7 (13.0%)
Spasticity	10 (26.3%)	128 (62.4%)	31 (57.4%)
Contracture	9 (23.7%)	38 (18.5%)	5 (9.3%)
Depression	7 (18.4%)	89 (43.4%)	18 (33.3%)
Insomnia	2 (5.2%)	32 (15.6%)	9 (16.7%)
Heterotopic ossification	0	11 (5.4%)	2 (3.7%)
Pain	18 (47.4%)	106 (51.7%)	25 (46.3%)

N = number of subjects; DVT = deep venous thrombosis

**Table 4** Frequency of medical complications in different diagnostic categories

	<i>TB of spine</i> N = 44	<i>Tumor</i> N = 85	<i>TB-SA</i> N = 33	<i>ATM</i> N = 101	<i>Spinal cord infarction</i> N = 3	<i>MS</i> N = 13	<i>Degenerative diseases of spine</i> N = 17
DVT	3 (6.8%)	3 (3.5%)	5 (15.5%)	13 (12.9%)	0 (0)	3 (23.1%)	0 (0)
Pressure ulcers	7 (15.9%)	17 (20.0%)	15 (45.5%)	38 (37.6%)	1 (33.3%)	3 (23.1%)	8 (47.1)
Urinary tract infection	19 (43.2%)	53 (62.4%)	27 (81.8%)	66 (65.3%)	1 (33.3%)	9 (69.2%)	9 (52.9%)
Urinary incontinence	12 (27.3%)	48 (56.5%)	20 (60.6%)	52 (51.5%)	3 (100%)	8 (61.5%)	4 (23.5%)
Constipation	14 (31.2%)	29 (34.1%)	16 (48.5%)	30 (29.7%)	0 (0%)	3 (23.1%)	0 (0)
Pneumonia	1 (2.3%)	2 (2.3%)	0 (0)	1 (0.9%)	0 (0)	0 (0)	0 (0)
Orthostatic hypotension	0 (0)	7 (8.2%)	3 (9.1%)	2 (1.9%)	2 (66.7%)	0 (0)	0 (0)
Spasticity	27 (61.4%)	66 (77.6%)	18 (54.5%)	46 (45.5%)	2 (66.7%)	6 (46.2%)	4 (23.5%)
Contracture	10 (22.7%)	13 (15.3%)	7 (21.2%)	14 (13.9%)	1 (33.3%)	5 (38.5%)	2 (11.8%)
Depression	15 (34.1%)	38 (44.7%)	15 (45.5%)	35 (34.7%)	2 (66.7%)	7 (53.8%)	2 (11.8%)
Insomnia	6 (13.6%)	11 (12.9%)	6 (18.2%)	16 (15.8%)	0 (0)	4 (30.7%)	0 (0)
Heterotopic ossification	2 (4.5%)	3 (3.5%)	1 (3.0%)	7 (6.9%)	0 (0)	0 (0)	0 (0)
Pain	26 (59.1%)	53 (62.3%)	20 (60.6%)	39 (38.6%)	1 (33.3%)	6 (46.2%)	4 (23.5%)

N = number of subjects; TB = tuberculosis; TBSA = tuberculosis with spinal archnoiditis; ATM = acute transverse myelitis; MS = multiple sclerosis; DVT = deep venous thrombosis

**Table 5** Comparative frequency of medical complications in subjects with nontraumatic SCI

<i>Complications</i>	<i>McKinley et al.</i> <sup>4</sup> N = 38 (%)	<i>New et al.</i> <sup>5</sup> N = 134 (%)	<i>Present series 2002.</i> N = 297 (%)
DVT	7.9	1.5	9.1
Pressure ulcers	21.1	31.3	28.6
Autonomic dysreflexia	0	0.8	0
Pneumonia	2.6	4.4	1.3
Orthostatic hypotension	5.3	NA	4.7
Spasticity	21.1	14.9	56.9
Depression	23.7	8.2	38.4
Urinary tract infections	52.6	32.8	62
Heterotopic ossification	2.6	0	4.4
Pain	55.3	18.7	49.3
GI bleed	2.6	NA	1

N = number of subjects; DVT = deep venous thrombosis; NA = data not available; GI = gastrointestinal system

menstrual hygiene, pregnancy and breast-feeding. As, there are more women in cohorts with NTSCl, rehabilitation program need to focus on these gender-specific issues.

Mortality and morbidity after traumatic SCI is higher in people with higher age at injury.<sup>14</sup> However, in Stockholm SCI study, Levi *et al* noted that only frequency of pain was significantly associated with age.<sup>15</sup> There was no significant correlation between age and frequency of medical complications in our study. This does not mean that morbidity and mortality of NTSCl is not influenced by age. This study is designed to document medical complications during postacute rehabilitation, and does not take into consideration the problems during acute care. Age may not influence

overall frequency of medical complications during the rehabilitation phase of NTSCl.

Medical complications are frequent among subjects with traumatic SCI. Studies by Anson and Shepard,<sup>16</sup> and Levi *et al*<sup>17</sup> reported that at least one medical complication occurred in 94–95% of subjects with traumatic SCI. We too noted a similar frequency of medical complications among subjects with NTSCl. However, New *et al*<sup>5</sup> observed a lower incidence (63.2%) of medical complications in subjects with NTSCl. Most frequent causes of NTSCl in our series were infections and transverse myelitis. These diseases tend to evolve more rapidly than other causes of NTSCl such as tumors and spinal canal stenosis. In our series, UTI and pressure ulcers were more frequent among subjects with tuberculosis with spinal archnoiditis and ATM. Spasticity was the most frequent problem among people with more slowly evolving NTSCl like tumors and degenerative diseases of spine (Table 4). The higher incidence of medical complications in the present series compared with the series of New *et al*<sup>5</sup> may be due to differences in etiology, severity of disability, admission policies, length of stay and resources available.

Genitourinary problems are very common after traumatic SCI. Overall, 70% of subjects in the present study had genitourinary complications and 60% had at least one episode of UTI during rehabilitation. This figure is similar to the 64–80% frequency of UTI among subjects with SCI treated in different rehabilitation settings within National Health Service (NHS) of UK.<sup>18</sup> Frequency of UTI in the current study is higher than that in other studies (32.8–52.6%)<sup>4,5</sup> of NTSCl. This could be due to differences in etiology of NTSCl, bladder management techniques, usage of antibiotics, infection control protocols and length of stay. UTI and incontinence were more frequent among subjects with paraplegia than those with tetraplegia (Table 2). These

subjects were more often given training in self-clean intermittent catheterization. Incontinence and infections are frequent during the initial learning period. This may be the reason for the high frequency of these complications in subjects with paraplegia. Other genitourinary complications noted in the present study are urinary incontinence, retention of urine, catheter blockage and difficulty in removing the catheter.

Gastrointestinal complications are less frequent compared with genitourinary problems in traumatic SCI.<sup>19</sup> In the current study 45.5% of subjects had complications involving gastrointestinal system (Table 1). The most common gastrointestinal problem in subjects with traumatic SCI is difficulty in evacuation of bowels.<sup>19</sup> Levi *et al*<sup>17</sup> reported bowel dysfunction in 38.2% of subjects in the Stockholm SCI study. Similarly, 36.5% of subjects in Tetrafigap study also had this complication.<sup>20</sup> In the present study 31% of subjects with NTSCl had constipation. This could be due to immobility, changes in colonic compliance, prolonged transit time, fecal impaction, poor fluid intake and low fiber content in diet. A regular bowel program with adequate fluid and fiber intake may help in preventing constipation.

Medical complications involving the musculoskeletal system were noted in 74.7% of patients with NTSCl, the most frequent being spasticity, pain, contractures and heterotopic ossifications. Spasticity is a common problem after traumatic SCI. The frequency of spasticity in studies on traumatic SCI varies from 60 to 70%.<sup>18,21</sup> In NTSCl, the frequency of spasticity ranged from 14.9 to 21.1%,<sup>4,5</sup> much lower than the present study (56%). Spasticity often develops late after SCI. Maynard *et al*<sup>21</sup> noted that while 32.2% of persons with traumatic SCI developed spasticity before discharge from hospital, another 42.7% developed spasticity within a year after injury. Our study was limited to in-patient rehabilitation with the average duration of stay being only 76 days. The relatively short duration may account for the lower incidence of spasticity in this series.

Contractures resulting in reduced joint mobility are common after traumatic SCI. Yarkony *et al*<sup>22</sup> noted  $7 \pm 6.2$  contractures in subjects with SCI between 6 and 7 weeks. The Tetrafigap survey of patients with tetraplegia reported contractures in 84.7% of respondents.<sup>20</sup> In the present study, at least one contracture was observed in 17.3% of subjects with NTSCl. The contractures interfere with performance of motor tasks, contribute to spasticity and result in deformity. They may cause pain, pressure ulcers and sleep disturbances.<sup>23</sup> Measures to prevent contractures like stretching and proper positioning of joints should be initiated early in subjects with NTSCl.

Heterotopic ossification is often regarded as a complication of traumatic SCI. Unless addressed early, it may result in restriction of range of motion and aggravate disability. Incidence of heterotopic ossification in traumatic SCI is around 15%. While New *et al*<sup>6</sup> did not encounter any heterotopic ossification in NTSCl, McKinley *et al*<sup>4</sup> reported an incidence of

2.6%. A previous prospective study from our center revealed an incidence of 6% in NTSCl.<sup>24</sup> In the current series, 4.4% of subjects with NTSCl developed this complication. Heterotopic ossification occurs in NTSCl although less frequently than in people with traumatic SCI. A high index of suspicion is necessary for early intervention and limitation of disability.

Pulmonary embolism is a preventable cause of death in patients with SCI. Most of these emboli originate from deep veins of the lower limbs. The incidences of deep vein thrombosis (DVT) in patients with SCI in different settings within NHS of the UK vary from 1.5 to 4.8%.<sup>18</sup> During in-patient stay with Model Systems, DVT occurred in 13.6% of persons with SCI.<sup>25</sup> In subjects with NTSCl, the frequency of DVT ranged from 1.5 to 7.9%.<sup>4,5</sup> Frequency of DVT in our study was 9.1% and one subject died due to pulmonary embolism. Anticoagulation alone may not protect subjects with SCI from DVT and pulmonary embolism.<sup>26</sup> Additional measures like exercises and intermittent pneumatic compression should be incorporated into the NTSCl rehabilitation program to prevent this life-threatening complication.

Pain following SCI interferes with rehabilitation and has a negative impact on quality of life.<sup>27</sup> On an average, 65% of individuals with traumatic SCI suffer from pain.<sup>28</sup> In earlier reports, frequency of pain in NTSCl varied from 18.7 to 55.3%.<sup>4,5</sup> Pain in these patients may be neuropathic, visceral or musculoskeletal in origin. In the present study, 49.3% of subjects with NTSCl complained of pain warranting evaluation, treatment and/or interruption of therapy. Pain is a subjective sensation. Different studies use different methods and definitions accounting for wide variations in frequency of pain following SCI. It is a significant problem in individuals with NTSCl and often requires different therapies like pharmacotherapy, nerve blocks, physical modalities and behavioral interventions.

Around 20–40% of patients with traumatic SCI develop pressure ulcers during initial hospital stay.<sup>16,29,30</sup> The frequency of pressure ulcers in the current study (28.6%) is similar to that in other studies on NTSCl.<sup>4,5,10</sup> Often, these ulcers take a long time to heal and may require surgical interventions. Strategies of prevention and treatment of pressure ulcers should be an integral part of the protocol for rehabilitation of subjects with NTSCl.

Depression interferes with participation in the rehabilitation program, coping with SCI, adaptation to disabilities and motivation to attain functional recovery. The reported incidence of depression varies between 20 and 40% in traumatic SCI<sup>31,32</sup> and 23.7% in NTSCl.<sup>4</sup> In the present study we noticed depression in 38% of subjects. It was more frequent among subjects with multiple sclerosis (Table 4). Various issues such as an emotional reaction to SCI, premorbid personality and duration of hospital stay confound the diagnosis of depression in this population. Criteria for diagnosis of depression include biological symptoms like loss of appetite, sleep disturbances, loss of weight and con-

stipitation. SCI itself causes these symptoms, and hence, diagnosis of depression in these subjects is often difficult.<sup>33</sup> Wide variability in reported prevalence of depression could be due to differences in methods used to assess depression and differences in setting. Services of psychologist and/or psychiatrist may be needed during in-patient rehabilitation for managing depression.

Medical complications in traumatic SCI prolong hospital stay, increase cost of treatment, delay recovery and interfere with the rehabilitation program.<sup>15,34</sup> In the present study, we noted that a number of medical complications in individuals with NTSCl correlated with length of stay in rehabilitation unit. Patients with tetraplegia and more severe disability tended to have more complications. Subjects with medical complications had poor functional recovery.

## Conclusions

Medical complications were frequently encountered during in-patient rehabilitation of patients with NTSCl. Common complications were UTI, spasticity, pain, depression and pressure ulcers. People with more disability at the time of admission to the rehabilitation unit had more complications. These complications resulted in prolongation of hospital stay. Subjects with medical complications tended to have more disability at the time of discharge. Strategies for early detection, treatment and prevention of these complications should be an integral part of rehabilitation protocols for subjects with NTSCl.

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