Factors affecting the length of stay of patients with traumatic spinal cord injury in Tianjin, China

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Purpose: To describe the acute care length of stay (ACLOS) of adult patients with traumatic spinal cord injury (TSCI) in Tianjin, China, and identify the associated demographic and clinical factors.

Methods: TSCI patients admitted to a general hospital in Tianjin, China from 2004 to 2007 were identified. The predictor variables were demographic and clinical factors, including age, gender, etiology, level of injury, severity, associated injuries, surgery, and complications. The outcome variable was ACLOS. Multivariable linear regression analysis models were used to examine the association between predictor and outcome variables.

Results: This study included 631 TSCI patients. The mean ACLOS was 32.4 ± 37.7 days, with a range of 1–294 days. The median number of hospitalization days was 21 days. Admission to a suburban hospital surgery, urinary infection, poorer functional status, pressure ulcers, and associated injuries were significantly associated with ACLOS.

Conclusion: This study examined the effect of epidemiological and clinical factors on ACLOS in Tianjin, China. The factors that influenced the ACLOS were different from factors reported in other studies. More studies are needed in China to determine the effect of these factors on ACLOS in TSCI patients and to propose a predictive model.

Keywords: China, Length of stay, Spinal cord injury, Trauma

Introduction

Traumatic spinal cord injury (TSCI) is one of the most devastating types of injury, and it results in different neurological deficits below the level of injury. There is no cure for TSCI, despite the enormous amount of TSCI research, which grows annually. The neurological sequelae in patients with a severe TSCI require long-term care and create an enormous economic burden on affected patients, their families, and society.^{1,2} China is one of the largest countries in the world (accounting for an estimated 25% of the world's population) and has an enormous TSCI patient population. To optimize resource utilization for acute care centers that treat TSCI patients, it is important to evaluate the determinants of hospitalization length. As for the

length of stay (LOS), most research has focused on the rehabilitation LOS,³ and expounded on the effect of gender, age, etiology, severity, level of injury, associated injuries, surgery, complications, and source of hospitalization costs.^{4–8} The systematic study of the effect of the aforementioned variables on acute care length of stay (ACLOS) has been rare.^{9,10} However, predicting ACLOS is of great interest to patients and their family members and caregivers since ACLOS is closely correlated with the cost of care. The efficiency of healthcare provided in an acute care setting is generally completed within a few months. In addition, neurological recovery reaches a plateau, making it timely for the patient to be discharged. Starting rehabilitation as soon as possible is beneficial to functional outcome at discharge.^{11–13}

These factors could be used to predict LOS in the departments in which they were examined. However, LOS differed from various places owing to the difference in the economic and social status of the patients and differences in the medical health system. As the largest

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developing country, the national condition of China is unique because of its large population, rapid economic development, and reform of the social medical health system. To our knowledge, no such study has been reported in China. The goal of this survey was to describe the ACLOS and to identify the possible factors associated with it in Tianjin that is the third largest city in China.

Methods

Subjects and setting

This was a retrospective study of TSCI patients who were admitted and discharged between 2004 and 2008. The patients were all admitted to 17 tertiary hospitals (11 urban hospitals and 6 suburban hospitals) located in eight districts in Tianjin, China. To refine the definition of ACLOS, TSCI patients who were admitted in 2008 and died during hospitalization were excluded to avoid a bias towards a shorter LOS. Patients whose records were missing the date of admission or date of discharge were also excluded. Of the 869 admissions, 631 TSCI patients aged 15 years or older met the inclusion criteria. Excluded were 201 patients who were admitted in 2008, 10 patients who died during hospitalization, and 27 patients who had no date of admission or date of discharge.

Measures and definition

The outcome variable, ACLOS, was obtained from the dataset and examined in the current study. ACLOS only included acute medical care LOS, which was calculated as the number of days in the hospital from the day of the patient's first admission after injury to the date of discharge to the care of family, community hospitals, rehabilitation centers, nursing homes, and so on. The day of admission was day 0.

The predictor variables were composed of sociodemographic and clinical variables. The main sociodemographic variables were age and gender. The main clinical variables were etiology, severity, level of injury, associated injuries, surgery, and complications. We also obtained information regarding the location of the admitting hospital. On the basis of the administrative division to which the medical establishments belonged, the hospitals were classified into two groups: urban or suburban. All predictor variables were obtained from the dataset. Age was a continuous variable, and all other sociodemographic and clinical variables were categorical variables.

Based on the results of our previous study,^{14,15} the patients were grouped into the following age groups: 15–30, 31–45, 46–60, 61–75, and 75 years or older.

The etiology of the TSCI included motor vehicle collisions, low fall (less than 1 m), high fall (greater than 1 m), being struck by a falling object, and other injuries. The severity of the injury was recorded by using the American Spinal Injury Association (ASIA) impairment scale. Associated injuries were defined as other injuries that occurred at the same time as the TSCI. Based on previous studies,^{16,17} associated injuries included head trauma, chest trauma, abdominal trauma, pelvic trauma, and limb fractures. Patients with any of the listed injuries were placed into the associated injury group.

In accordance with the International Spinal Core Injury Core Data Set,¹⁸ patients in this study were classified in either the surgical treatment group or the conservative treatment group. Operative procedures included, but were not limited to, laminectomy, spinal decompression, neural canal restoration, discectomy, bone graft, and fusion and internal fixation of the spine. Patients undergoing any the aforementioned surgeries were classified in the surgical group.

Complications included pneumonia or atelectasis, urinary tract infection or urinary stones, electrolyte disturbances, pressure ulcers, wound infections, or fever and deep venous thrombosis. These complications were closely correlated with TSCI. Patients with any of the complications were placed in the complication group.

Statistical analyses

All statistical analyses were performed by using SPSS version 17.0. Descriptive statistics including the means, standard deviation (SD), median, and interquartile range (IQR) were calculated for ACLOS. Because the patients' ACLOSs were highly skewed, we log transformed the data and used the log-transformed ACLOS as the outcome variable. Because the log-transformed ACLOS met the assumption of a normal distribution, parametric statistics (e.g. *t*-tests and one-way analysis of variance) were used to detect significant differences between subgroups. Multiple linear regression analysis was performed to examine the association between ACLOS and the predictor variables. Predictive variables using a *P* value equal to or less than 0.1 for the univariate analysis were put through a regression test. The significant independent variables contributing to ACLOS in TSCI patients were extracted by using stepwise selection methods. The criteria for inclusion in the final model were *P* values of less than 0.05.

Results

A total of 631 patients with TSCI were included. Table 1 summarizes the characteristics of the hospitalized

Table 1 Characteristics of TSCI and univariate analysis of the factors for ACLOS

Variables	N (%)	Mean $\pm$ SD	Median	IQR	Statistic*	P value
Gender					$t = 1.379$	0.168
Male	537 (85.1%)	31.6 $\pm$ 37.0	21	11–36		
Female	94 (14.9%)	37.3 $\pm$ 41.5	23	14–46		
Age					$F = 3.893^{\dagger}$	0.004
15–30	100 (15.8%)	38.1 $\pm$ 40.0	26.5	15–46		
31–45	207 (32.8%)	33.1 $\pm$ 38.4	21	10–38		
46–60	239 (37.9%)	31.8 $\pm$ 36.9	21	13–36		
61–75	74 (11.7%)	28.1 $\pm$ 36.8	19	8–35		
>75	11 (1.7%)	11.2 $\pm$ 5.2	11	9–15		
Location of hospital					$t = 3.762$	0.000
Urban	172 (27.3%)	28.5 $\pm$ 39.5	17	8–28		
Suburb	459 (72.7%)	34.1 $\pm$ 37.0	24	13–41		
Etiologies					$F = 7.231^{\ddagger}$	0.000
MVC	217 (34.4%)	36.8 $\pm$ 42.1	25	12.5–42		
Low-fall	244 (38.7%)	23.0 $\pm$ 20.6	18	10–30		
High-fall	113 (17.9%)	42.2 $\pm$ 49.7	26	17–45		
Struck by object	40 (6.3%)	41.6 $\pm$ 45.5	25	15.5–58		
Others	17 (2.7%)	26.6 $\pm$ 25.0	19	8.5–29		
AIS [§]					$F = 16.469^{\P}$	0.000
A	136 (21.6%)	46.3 $\pm$ 49.5	27	18–58		
B	132 (20.9%)	35.9 $\pm$ 39.7	26	13–43		
C	109 (17.3%)	34.1 $\pm$ 41.8	23	11–41.5		
D	254 (40.3%)	22.5 $\pm$ 21.4	17	9–28		
Level of injury					$F = 1.631^{**}$	0.197
Cervical	449 (71.2%)	31.0 $\pm$ 36.5	21	11–35		
Thoracic	82 (13.0%)	32.9 $\pm$ 32.1	24.5	12–43		
Lumbar	100 (15.8%)	38.8 $\pm$ 46.1	22.5	15–43		
Associated injuries					$t = 3.819$	0.000
Yes	163 (25.8%)	40.7 $\pm$ 44.8	28	16–49		
No	468 (74.2%)	30.0 $\pm$ 34.5	20	10–34		
Complication						
Urinary infection	33 (5.2%)	69.2 $\pm$ 66.2	46	27–96.5	$t = 5.301$	0.000
Respiratory infection	51 (8.1%)	40.8 $\pm$ 36.5	28	17–55	$t = 2.734$	0.006
Hyponatremia	28 (4.4%)	40.0 $\pm$ 23.0	35	21–56.5	$t = 2.581$	0.010
Pressure ulcer	17 (2.7%)	75.0 $\pm$ 57.7	52	31.5–109.5	$t = 4.521$	0.000
Deep venous thrombosis	10 (1.6%)	67.7 $\pm$ 57.4	51.5	20–108	$t = 2.750$	0.006
Operation					$t = 13.43$	0.000
Yes	339 (53.7%)	40.8 $\pm$ 37.0	28	21–49		
No	292 (46.3%)	22.8 $\pm$ 36.3	12	7–22		

SD, standard deviation; IQR, interquartile range; MVC, motor vehicle collision; AIS, American Spinal Injury Association impairment scale.

*Independent samples *t*-test (*t*) or one-way analysis of variance (*F*) (performed on log-transformed LOS).

[†]A Bonferroni *post hoc* test revealed significant differences between 15–30 and >75 ($P < 0.05$). All other subgroups were not significantly different from each other.

[‡]A Bonferroni *post hoc* test revealed significant difference between low-fall and MVC, high-fall, low-fall, low-fall, and struck by object ($P < 0.05$). All other subgroups were not significantly different from each other.

[§]On admission.

[¶]A Bonferroni *post hoc* test revealed no significant difference between AIS B and AIS C, AIS A and AIS B, AIS C, and AIS D. All other subgroups were significantly different from each other ($P < 0.05$).

**A Bonferroni *post hoc* test revealed that all subgroups were not significantly different from each other ($P > 0.05$).

patients. Approximately 70% of the hospitalized patients were between 31 and 60 years old. The proportion of males (85.1%) was approximately six times the proportion of females (85.1 vs. 14.9%, respectively). Most patients were admitted in suburban hospitals, accounting for 72.7% of all hospitalizations in Tianjin (Table 1).

The mean duration of hospitalization was 32.4 ± 37.7 days and ranged from 1 to 294 days. The median number of days of hospitalization was 21 days (the IQR was 11–37 days). Within 14 days of admission,

31.9% of patients were discharged; within 60 days, 88.6% were discharged. Table 1 summarizes the ACLOS for the different subgroups and the factors associated with prolonged hospitalization in univariate analysis. Based on univariate analysis, ACLOS was significantly associated with age, etiology, location of the hospital, ASIA impairment scale (AIS), associated injuries, surgery, and complications ($P < 0.05$). Table 2 summarizes the results of the association between ACLOS and the independent variables from the multivariable analysis. Having an operation was the strongest

Table 2 Multiple regression analysis of the factors for ACLOS

Variables	Unstandardized coefficients (β)	Standardized coefficients (β)	t value	P value
Constant	1.892		8.967	0.000
Operation	0.333	0.402	11.354	0.000
Urinary infection	0.248	0.134	3.863	0.000
AIS	0.036	0.104	2.852	0.004
Location of hospital	0.086	0.092	2.658	0.008
Pressure ulcer	0.200	0.078	2.239	0.025
Associated injuries	0.070	0.074	2.154	0.032

AIS, American Spinal Injury Association impairment scale.

determinant of a longer ACLOS. A significantly longer LOS in patients was associated surgery, a urinary infection, a poor functional status, and hospitalization in a suburban hospital, compared to the LOS of patients without these factors ($P < 0.01$). A longer LOS in patients was associated with pressure ulcers and associated injuries, compared to the LOS of patients without these factors ($P < 0.05$). Etiology and age were not independent determinants of ACLOS.

Discussion

This is the first study in China that aimed to identify the factors impacting the ACLOS for inpatients after a TSCI. The rising incidence of TSCI in the next few years will likely increase the demand for access to hospitalization. Identifying factors that impact inpatient ACLOS will allow better prediction of bed flow and access, will support effective resources allocation, and potentially will allow better care planning.

In the scientific literature, there are wide ranges and differences in ACLOS among various studies.^{17,19–21} In this study, ACLOS was longer than that reported in other studies in Taiwan (8.5 ± 8.8 days in 2000–2003)¹⁷; in Canada (16.8 ± 21.6 days in 1997–2001 and 22.7 ± 32.8 days in 2003–2006)^{19,20}; and in the United States (24 days in 1988–1990).²¹ Another survey of people with TSCI in a tertiary hospital in Nigeria during 1992–2006 revealed that the duration of hospital stay ranged from 2 weeks to 60 weeks with a mean of 12 weeks (SD = 8.6 weeks).²² The mean ACLOS was 48.8 days (SD = 45.2) during 2000–2003 in the Netherlands.⁴ This difference may be attributable to the following:

1. Most LOS studies examined the difference by using the mean, rather than the median. LOS in acute care hospitalization data is skewed; therefore, the mean is less informative. This is one of the main reasons that the outcomes in LOS studies are inconsistent.
2. Differences in the patients' characteristics or differences in the criteria used before discharging patients

to rehabilitation centers or home may have contributed to the difference in ACLOS among the various studies.

3. Differences between studies in the LOS must be considered within the context of the healthcare organization.

In China, the lack of rehabilitation centers is a significant issue that lengthened the ACLOS of the patients. Undertaken within a mixed public–private healthcare system with no national initiatives in place, the median ACLOS was also higher than figures from similar studies in the United States.

The ACLOS is often thought of as an indicator of the efficiency of the health service. Long periods of hospitalization increase costs and negatively affect the quality of life of patients. Our results demonstrated that having surgery, urinary infection, AIS, location of hospital, pressure ulcers, and associated injuries were significantly associated with ACLOS. The severity of the injury predicted inpatient ACLOS. This was not a surprising finding. Pickett *et al.*¹⁹ reports that patients with complete injuries (i.e. ASIA A classification) had a significantly longer mean LOS, compared to patients with incomplete injuries (i.e. ASIA categories B, C, and D; $P < 0.008$). Our finding of a longer ACLOS among patients with a greater degree of impairment at the time of admission supported this.

In this study, surgery was found to influence the patients' ACLOS. Surgery predicted a longer ACLOS because the patients who needed surgery had a greater degree of injury on admission. Surgical treatment causes additional trauma to the body, and more time should therefore be needed for recovery. However, Tator *et al.*²³ report finding no significant difference between the surgical group and the nonsurgical group, although the LOS of the surgical group was a little longer. McKinley *et al.*²⁴ have reported that spinal surgery is associated with a shorter LOS. Further research is necessary to analyze the independent influence of surgery on ACLOS.

In the current study, urban patients had a shorter ACLOS, compared to suburban patients. This finding

may be explained by the influence of the medical environment. Previous research has suggested that the LOS was decreased in patients who underwent early surgery after an acute TSCI, especially if the procedure was performed within 24 hours following the trauma.²⁵ In suburban hospitals, medical facilities are generally unaffordable for most people, resulting in surgical delay. Therefore, the treatment of TSCI patients in suburban hospitals was not as effective as the treatment given in urban hospitals. Furthermore, most urban hospitals are teaching hospitals in which the nursing care is more professional and skilled in providing services to patients. Many studies report that specialized centers of care for spinal cord injury could decrease the rehabilitation LOS.^{26,27} Early admission to an organized TSCI care system consistently reduces the LOS. Acute care hospitalization is reduced by almost 50% when patients are treated in a specialized short-term care center.²⁷ As far as we know, there is no previous research that has elaborated the effect of hospital location on ACLOS. Further prospective research is needed to examine whether the ACLOS of inpatients in urban hospitals is shorter than that in suburban hospitals.

Our results indicated that the ACLOS of TSCI patients with associated injuries was conspicuously longer than that of patients with no associated injury; this finding was in agreement with previous reports.¹⁷ This may be because patients must reach a stable medical status with the resolution of all associated injuries before discharge to a rehabilitation center or home. This resulted in an additional LOS.

Previous studies have suggested that complications for TSCI tend to prolong the LOS. Previous research has shown that there is a marked increase in rehabilitation LOS after TSCI when comparing those patients experiencing complications (e.g. respiratory, gastrointestinal, thromboembolic complications, genitourinary complications, and pressure ulcers) with those patients without such complications.^{4,23} However, our study demonstrated that only urinary infections and pressure ulcers influenced the ACLOS. Therefore, future studies must focus on identifying whether complications could be associated with ACLOS.

Our study had a few limitations. First and foremost, it was a retrospective study and therefore there was a lot of dependence on the accuracy and completeness of documentation in the medical notes. Second, it was conducted in one geographical area in China and therefore it may not be possible to make generalizations about the results with regard to other countries or even the rest of China. Third, owing to the lack of data on insurance status, the relationship between ACLOS and

the surgical time and time from the event were not interpreted in this study, although these factors would have contributed to the analyses of the ACLOS. Fourth, there were a lack of rehabilitation LOS and no survey about the place of discharge. Fifth, we only examined the effect of the epidemiological and clinical factors on ACLOS and did not identify the correlation between these factors (e.g. the AIS, surgery, location of hospital, and complications). Further research including these factors is obviously required. Overall, this exploratory study has provided valuable information for future prospective study in China with regard to better understanding the factors that impact the ACLOS for inpatients after a TSCI.

Conclusion

This study examines the effects of epidemiological and clinical factors on ACLOS in Tianjin, China. Surgery, AIS, urinary infection, location of hospital, pressure ulcers, and associated injuries were associated with a significant increase in ACLOS among the admitted TSCI patients. More studies are needed in China to determine the effect of these factors on the ACLOS of TSCI patients and to propose a predictive model.

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