




ORIGINAL STUDY

The Association Between Injury Characteristics and in-Patient Outcomes in a Cohort of Adult Patients Admitted to a State Spinal Unit Following Spinal Injuries: A Retrospective Observational Study

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Abstract

Background: Spinal injuries are common and are associated with complications either directly related to the spinal injury itself, including autonomic or cord related events, or indirectly related medical complications. These complications are a frequent cause of morbidity and mortality and lead to an increase in the rates of hospitalisation, higher care costs, and decreased quality of life. Our primary outcomes were the impact of management on in-patient outcomes of medical complications, length of hospital stay, physical function on day three and discharge destination. Our secondary aim was to assess the impact of injury characteristics, ASIA score and level of injury (above lumbar and lumbosacral spine) on these outcomes.

Methods: In this retrospective observational study, we included 129 patients who were admitted to a state tertiary center over a 6-month period. Binary logistic and Cox proportional hazards regression models were used to assess the relationships between injury characteristics and management on inpatient outcomes. The models were adjusted for age, sex, baseline functional status and Charlson's Comorbidity Index.

Results: The mean age of the study sample was 48.6 (SD 23.4) years and 61.3% were males. The majority of the patients were ASIA E (92.2%) and 26 patients (20.2%) were treated surgically. Those who had a surgical approach were more likely to have inpatient complications (Odds ratio (OR) 11.3, 95% CI 3.26–38.8), be discharged to care facilities (OR 12.2, 95% CI 1.71–87.3), are less likely to discharge early (Hazard ratio (HR) 0.15, 95% CI 0.09–0.26) and not be independent on day 3 post admission (OR 51.9, 95% CI 7.21–374.0). These outcomes were also evident in those who were ASIA E compared to ASIA A–D. Whether the injury was above lumbar or lumbosacral spine was not associated with any of the outcomes measured.

Conclusion: Severity of the spinal injury and surgical management are strongly associated with unfavorable in-patient outcomes irrespective of basic demographic variabilities and therefore, are universally relevant.

Keywords: Spinal injuries, Spinal fracture, Complications, Surgery, Immobilisation, Length of stay, Conservative treatment, Orthopaedic

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Introduction

Vertebral fractures with spinal cord injury (SCI), whether complete or incomplete can be managed either conservatively, through immobilization, or via surgery [1]. A surgical approach is generally favored for an unstable fracture; however, overall management options vary depending on a host of factors including primary neurological state, trauma mechanism, and vertebral fracture location. Previous literature outlines that there is a better chance of neurological recovery in patients with SCI undergoing surgery for vertebral fractures, compared with conservative management [2,3]. However, it is unclear how surgical versus non-surgical approaches impact on medical complications and other inpatient outcomes such as length of hospital stay, functional recovery and discharge destination.

The extent of neurological deficits (mostly based on the American Spinal Injury Association (ASIA) classification [4]) has been considered the most important predictive factor for functional outcome and prognosis, with the higher the spinal cord injury generally resulting in worse deficits [5].

Complications can be either directly related to the spinal injury itself (including autonomic or cord related events) or indirectly related medical complications. Medical complications are a frequent cause of morbidity and mortality, and lead to increased rates of hospitalization, higher care costs, and decreased quality of life [6]. Medical complications can affect almost all body systems. Risk factors for cardiovascular disease are amplified in those with spinal injuries and so place individuals at higher risk of cardiovascular events [7]. Furthermore, due to physical inactivity and hemostasis, patients are at increased risk of pressure ulcers and venous thromboembolism, with the rate of thromboembolism varying from 0.3% to 31% following spinal surgery [8]. Patients with SCI may also experience significant psychological stress [9, 10].

Early mobilisation is known to promote the recovery of physical function and so the impact of how differing management, neurological deficit and level of injury may impact functional status in the acute phase is key to enhancing recovery. Optimising length of hospital stay (LOS) is paramount to elevating efficiency and quality of hospital management as it has a large impact on overall health system costs. Reduced LOS may have negative outcomes such as increased rates of re-admissions, whereas prolonged LOS may be associated with inpatients complications.

Understanding the impact of management options and injury features on in-patient outcomes will help to facilitate optimal care and avoid prolonged stays.

Additionally, it could help promote prompt discharge planning and rehabilitation referrals.

The primary aim of this study was to investigate the impact of management on in-patient outcomes of medical complications, length of hospital stay, physical function on day three and discharge destination. Our secondary aim was to assess the impact of injury characteristics, ASIA score and level of injury (above lumbar and lumbosacral spine) on these outcomes.

Patients and methods

Study design

We conducted a retrospective study on all consecutive adult patients that were admitted under the spinal team of a state tertiary center over a 6-month period (August 2022 to January 2023). All patients that had a spinal condition or injury documented as their primary issue in their medical records were included in the study.

Data collection

We collected baseline characteristics including age, sex, pre-morbid functional status and medical comorbidities (assessed using the Charlson Comorbidity Index (CCI)) [11]. The CCI was classified as mild (scores of 1–2), moderate (3–4) or severe (≥ 5). Characteristics of the injury itself included ASIA score and level of injury (above lumbar and lumbosacral spine). In patients with multiple contiguous vertebral fractures, the level most consistent with the motor or sensory deficit was considered the level of fracture. Above lumbar included cervical and thoracic spine fractures, while lumbosacral included the lumbar and sacral spine. The ASIA score was divided into ASIA E (normal sensation and motor function) and ASIA A–D (abnormal motor and/or sensation function). We considered surgical management, immobilisation, and conservative management. Immobilisation was inclusive of all fractures that were managed with braces. Conservative management referred to those that did not require immobilisation nor surgery and were managed through analgesia and physiotherapy.

Outcomes recorded were medical complications, discharge destination, length of hospital stay, and day three functional status. Medical complications included those that occurred at any stage during the admission and warranted review by the medical team, with or without intervention undertaken. Length of hospital stay was measured in days. Discharge destination was grouped as either direct discharge home or to an external care facility (inclusive of transitional care programs, rehabilitation centres and nursing

homes) or death. Functional status was categorised as independent and not independent (requiring assistance of an aid or requiring personal assistance (inclusive of 1 assist, 2 assist and bedbound)) and was assessed by a musculoskeletal physiotherapist. We chose to compare baseline functional status to day three functional status as it was the average day of initial comprehensive assessment post intervention (intervention being day 1) performed by the physiotherapist.

The study design (No. 47501) was approved by the hospital's Human Ethics and Research Committee as a quality improvement project.

Statistical analysis

Cox proportional-hazards models were run to investigate the relationships with hospital LOS (the event of interest was hospital discharge and those who died are censored at their date of death). Hazard ratios (HRs), 95% confidence intervals (CIs) and *p*-values were calculated. Binary logistic regressions were performed for outcomes of medical complications (event = "Yes"), discharge destination (event = "Care/Death") and day three functional status (event = "Not independent"). Odds ratios (ORs), 95% CIs and *p*-values are provided. Due to quasi-complete separation between ASIA score and the outcomes, Firth's correction for logistic regressions was used. When quasi-complete separation is present very large confidence intervals can be observed. Separate models were performed for management, ASIA score and level of injury. Results are presented for unadjusted models as well as models adjusted for patient age, sex, baseline functional status and CCI. Data was analyzed using the R environment for statistical computing [12].

Results

Demographic, injury and surgical data

In total, 129 patients, 61.2% male with mean age 48.6 (SD 23.4) years were enrolled (Table 1). The majority of patients (83.7%) were independent at baseline and 72.1% of patients had a mild CCI score. A total of 26 patients underwent a surgical procedure (20.16%). The majority of patients (92.2%) had normal motor and sensory function directly following injury (ASIA E), and 80.6% had an above lumbar injury.

Inpatient outcomes

Medical complications

In total, 48 (37.21%) patients had a medical complication (Table 1). The most common complications

Table 1. Summary of patient and injury characteristics as well as inpatient outcomes.

Parameters	N (%)
Patient characteristics	
Age (years)/Mean ± SD	48.6 ± 23.4
Sex	
Male	79 (61.24%)
Female	50 (38.76%)
Baseline functional status	
Independent	108 (83.72%)
Independent with aid	17 (13.18%)
Require person assistance	4 (3.1%)
Charlson comorbidity index	
Mild	93 (72.09%)
Moderate	14 (10.85%)
Severe	22 (17.05%)
Injury characteristics and management	
Management	
Conservative	43 (33.33%)
Immobilisation	60 (46.51%)
Surgical	26 (20.16%)
ASIA	
A	2 (1.55%)
C	2 (1.55%)
D	6 (4.65%)
E	119 (92.25%)
Level of injury	
Above lumbar	104 (80.62%)
Below lumbar	25 (19.38%)
Outcomes	
Medical complications	
Yes	48 (37.21%)
No	81 (62.79%)
Length of hospital stay	
Median (IQR)	4 (2-7)
Discharge destination	
Home	101 (78.29%)
Care	25 (19.38%)
Death	3 (2.33%)
Day 3 functional status	
Independent	81 (62.79%)
Independent with aid	4 (3.1%)
Require person assistance	44 (34.11%)

identified were those affecting the nervous system (29% of those with complications, 16% of the total cohort). These included but were not limited to delirium, cerebrovascular events and psychiatric complaints. Other commonly encountered complications included those affecting the genito-urinary and gastro-intestinal systems (20% of those with complications, 11% of the total cohort), with urinary tract infections and retention, predisposing to acute kidney infections accounting for the majority (Fig. 1).

The incidence of complications varied depending on injury characteristics and management (Table 2). Our cohort had more medical complications if managed with immobilisation in comparison to conservative management (38.3% vs 16.3% (95% CI

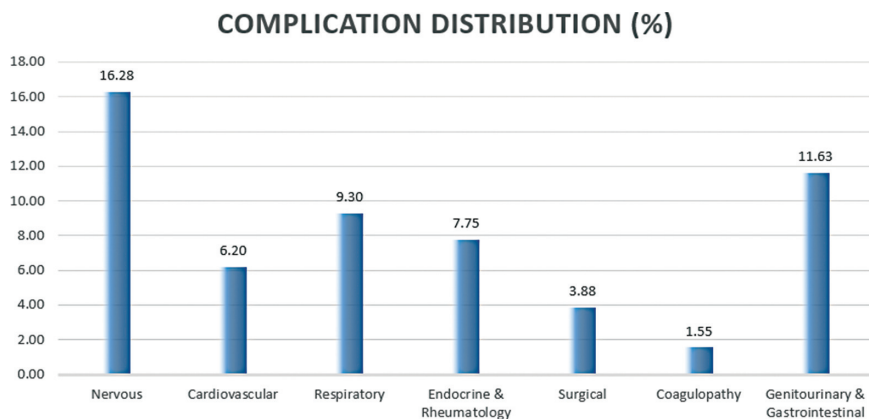


Fig. 1. Distribution of complications according to system affected.

of difference)), but those managed surgically had an apparent greater proportion of complications (69.2% vs 16.3%). All patients that were ASIA A–D had medical complications, compared to only 31.9% of those that were ASIA E. The rates of complications for those with above lumbar and lumbosacral spine injuries were similar (36.5% vs 40%).

Using regression models, (Table 3) the unadjusted data demonstrated those who were managed with immobilisation were more likely to have complications than those managed conservatively (OR 3.05, 95% CI 1.18–7.89), as were those who were managed surgically (OR 10.6, 95% CI 3.36–33.4). ASIA A–D showed a higher likelihood of complications (OR 44.4, 95% CI 2.21–892). After adjustment for baseline characteristics, those managed surgically were more likely to have complications than those managed conservatively (OR 11.3, 95% CI 3.26–38.8). The likelihood of complications in those immobilised in comparison to conservative management was no longer statistically significant (OR 1.29 (95% CI 0.41–4.07)). Those with ASIA A–D were still more likely to have complications than those with an ASIA E score (OR 22.3, 95%

CI 1.04–477). No relationship between level of injury remained.

Length of Hospital Stay (LOS)

The median LOS for the entire cohort was 4 days (IQR 2–7 days). LOS varied depending on injury characteristics and management (Table 2). Regarding management, both immobilisation and surgery yielded a longer LOS in comparison to conservative management (median 4 (IQR3–8) & 7.5 (IQR4–15) vs 2 (IQR1–3) respectively). ASIA A–D also revealed significantly longer LOS in comparison to ASIA E (median 20 (IQR15–30) vs 3 (2–6)).

Results from the survival analyses of unadjusted data revealed (Table 3), those managed with immobilisation were less likely to have an earlier discharge in comparison to conservative management (HR 0.30 (IQR 0.20, 0.45)), as were those surgically managed (HR 0.17 (IQR 0.10, 0.29)). Those with ASIA A–D were more likely to have a prolonged stay when compared to ASIA E (HR 0.12 (IQR 0.05, 0.31)). After adjustment, both ASIA score and management remained related

Table 2. Summaries of injury management and characteristics broken down by each outcome; complications, hospital length of stay, discharge destination and day 3 functional status.

Parameters	Complications	Hospital stay	Discharge destination	Day 3 functional status
	Yes (N = 48; 37.2%)	Median (IQR)	Care/Death (N = 28; 21.7%)	Not independent (N = 48; 37.2%)
Management				
Conservative	7 (16.28%)	2 (1–3)	2 (4.65%)	5 (11.63%)
Immobilisation	23 (38.33%)	4 (3–8)	17 (28.33%)	26 (43.33%)
Surgical	18 (69.23%)	7.5 (4–15)	9 (34.62%)	17 (65.38%)
ASIA				
A–D	10 (100%)	20 (15–30)	10 (100%)	10 (100%)
E	38 (31.93%)	3 (2–6)	18 (15.13%)	38 (31.93%)
Level of Injury				
Above lumbar	38 (36.54%)	4 (2–8)	21 (20.19%)	38 (36.54%)
Below lumbar	10 (40.00%)	4 (2–7)	7 (28.00%)	10 (40.00%)

Table 3. Unadjusted and adjusted model results. The events of interest for each model are complications, hospital discharge, discharged to care/death and independent on day three. All adjusted models include patient age, sex, baseline functional status and Charlson comorbidity index.

Parameters	Complications		Hospital stay		Discharge destination		Day 3 functional status	
	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Management								
Conservative immobilisation vs. conservative	Reference	Reference	Reference	Reference	Reference	Reference	Reference	Reference
	3.05 (1.18, 7.89)	1.29 (0.41, 4.07)	0.30 (0.20, 0.45)	0.55 (0.35, 0.88)	6.68 (1.64, 27.3)	2.14 (0.37, 12.4)	5.38 (1.90, 15.2)	4.37 (0.61, 31.4)
Surgical vs. conservative	10.6 (3.36, 33.4)	11.3 (3.26, 38.8)	0.17 (0.10, 0.29)	0.15 (0.09, 0.26)	9.01 (1.97, 41.3)	13.3 (1.82, 96.5)	12.9 (3.84, 43.3)	51.9 (7.21, 374)
ASIA								
A-D vs. E	44.4 (2.21, 892)	22.3 (1.04, 477)	0.12 (0.05, 0.31)	0.12 (0.04, 0.31)	115 (5.54, >999)	99.1 (3.08, >999)	44.4 (2.21, 892)	35.6 (1.28, 990)
Level of injury								
Below lumbar vs. above lumbar	1.17 (0.48, 2.86)	1.41 (0.52, 3.83)	1.00 (0.64, 1.57)	0.76 (0.48, 1.21)	1.58 (0.59, 4.23)	3.31 (0.81, 13.5)	1.17 (0.48, 2.86)	1.91 (0.59, 6.13)

to LOS, whilst no relationship between level of injury and LOS remained.

Discharge destination

78.29% of patients were discharged directly home, while 2.33% died. Discharge destination varied depending on management and injury characteristics (Table 2). In comparison to being discharged home, a higher number of those managed surgically were discharged to care or died compared to those managed conservatively (34.6% vs 4.65%), as were those that were managed with immobilisation (28.3% vs 4.65%). No patients that were ASIA A–D were discharged directly home compared to 84.9% that were ASIA E. The rate of patients discharged directly home was similar depending on position of injury, with 79% above lumbar and 72% lumbosacral discharged directly home.

Using regression models (Table 3), unadjusted data showed that those who were managed with either immobilisation or surgically were more likely to be discharged to a care facility or die than those who were managed conservatively (immobilisation OR 6.68, 95% CI 1.64–27.3; surgical OR 9.01, 95% CI 1.97–41.3), as were those that were ASIA A–D vs ASIA E (OR 115 (95% CI 5.54, >999). After adjustment, the relationship between ASIA score and discharge destination remained (OR 99.1, 95% CI 3.08, >999). Furthermore, those managed surgically were more likely to be discharged to care or die than those managed conservatively (OR 13.3, 95% CI 1.82–96.5). However, the relationship between immobilisation and conservative management was attenuated.

Functional status

At day three, 62.8% of patients were independent, and the remaining 37.2% were not (Table 1). All of those not independent at baseline remained not independent at day three, whilst of the 108 patients who were independent at baseline, 75% remained independent on day three.

After sub-analysing with regression models (Table 3), unadjusted results showed that patients with an ASIA score of A–D (OR 44.4, 95% CI 2.21–892) and those managed with either immobilisation or surgical management in comparison to conservative management (OR 5.38, 95% CI 1.90–15.2; OR 12.9, 95% CI 3.84–43.3, respectively), were more likely not to be independent on day 3. After adjustment for baseline characteristics including baseline functional status, the relationship between the ASIA score and surgical management with day 3 functional status remained not independent (OR 51.9, 95% CI 7.21–374.0)

Discussion

We investigated the impact of injury management and characteristics on in-patient outcomes, inclusive of complications encountered, LOS, discharge destination and functional status on day three of admission. Surgery plays a key role in stabilisation of an otherwise unstable spine but even simple spinal surgery carries an inherent risk of complications and the goal of managing spinal fractures is to ensure spinal stability and preserve neurological function. Non-operative management has limited benefit in instability but has a role in a stable spine with no neurological deficits. Several papers have considered the timing of spinal surgeries to avoid post-operative complications, with a trend of decreasing complications noted in groups with early surgery [13]. However, fewer studies have compared the incidence of complications in surgical versus non-surgical management. Similar to our study, McCullough et al, suggests that major complications are not improved, and healthcare utilization is increased with surgical procedures, specifically spinal augmentation when compared to conservative therapy [14]. The most encountered complications in our study were neurological complications, inclusive of delirium, which is one of the most prevalent complications in hospital in-patients, particularly amongst older people. Complications are further increased by patient comorbidities, as seen in our study with a more severe CCI index impacting on risk of medical complications versus a mild index [15]. However, after adjusting for comorbidities there was still an impact injury management and severity on the risk of complications.

LOS is significant from a patient and hospital systems perspective. It is a complex parameter affected by a multitude of different factors. It can vary greatly by the labour of care, personal and familial circumstances, and availability of rehabilitation beds. It is known that people with more co-morbidities tend to have longer hospital stays [16]. In this study, the average LOS in those with a severe CCI score was 12 days versus 4 days for those with a mild CCI. However, even after adjusting for CCI, there was still an impact of injury management and severity of neurological deficit on LOS. In our study, surgical management and ASIA score of A–D directly influenced LOS. This could be explained by those needing surgery or immobilisation and those with neurological deficits having a greater degree of injury. Our study revealed that level of fracture showed no significant difference in patient outcomes. The literature regarding effect of spinal fracture level on patient outcome is sparse, with more of a focus on fractures with an associated spinal cord injury.

Early mobilisation is a key component of enhanced recovery principles and is highly encouraged post-spinal surgery. To date, few studies have investigated functional outcome post-surgical procedure as a primary outcome as it is hard to justify [17]. A meta-analysis evaluating the benefits of surgical versus non-surgical management in osteoporotic fracture, showed surgical intervention was the most effective method in improving functional status [18]. Similarly, a study comparing management in lumbar stenosis showed patients treated surgically had greater improvement in functional status [19]. However, in both cases, functional status was assessed at a later stage (3 months and 1 year) and so it would be important to see whether the pattern of differential outcomes observed in our study would persist if evaluated at a later stage. Functional ability can be affected by a host of factors including pain, fear of falling and poor participation with allied health, thus functional outcome can differ from patient to patient irrespective of injury characteristics and management. Of note, day 3 functional outcome in our study was largely assessed in the immediate post-operative period, while traditionally functional outcome is reviewed at later stages post-injury. Perhaps future studies could focus on function as a primary outcome at a later stage.

A substantial proportion of patients with spinal injuries require rehabilitation after discharge. Discharge placement can be challenging, particularly when the patient may not be living within the hospital's catchment. Often the need for placement is not recognised until the acute phase has resolved and so recognising predictive factors on admission can facilitate identifying discharge destination earlier.

Study limitations

The study has some limitations. Firstly, it is retrospective, thus making some of the interpretations less exact and heavily reliant on the accuracy of documentation. However, the advantages of this retrospective design is that it is low in selection bias. Secondly, whilst further subdivision of level of injury may have yielded more specific data, in consideration of the sample size of this study, using the end of the spinal cord at the 1st lumbar spine as a cut off, dividing level of injury into above lumbar and lumbosacral spine was found to be most optimal for our cohort. Thirdly, the incidence of medical complications is reliant on clear documentation from the medical and surgical teams regarding its investigations and proposed intervention and therefore, some complications may have been omitted. Also, the patients that received surgical interventions may have been more prone to

complications prior to the surgery and this may partly explain the differential proportion of complications. Thus, the results of our study may be explained by residual confounding. Furthermore, the patients were assessed by different examiners every time and so are subjective and open to differences. Functional status may have been assessed by 2 different allied health professionals on day 1 versus day 3, yielding potential inconsistencies. Finally, mechanism of injury and fracture type was not included in our study and may have impacted outcome. Also the study did not analyze fracture characteristics and management (i.e. conservative vs immobilization vs surgical). Overall, this study provides valuable information to gain a better understanding on the factors that impact in-patient outcome post-spinal injury.

Conclusion

In summary, severity of the spinal injury (measured by ASIA score) and surgical management (compared to conservative and immobilisation techniques) are strongly associated with unfavorable in-patient outcomes including medical complications, prolonged length of stay, reduced baseline functional status and being less likely to discharge directly home, irrespective of basic demographic variabilities including age, gender, and co-morbidities. Further large-scale prospective studies are required to identify and modify risk factors of patients undergoing spinal surgery and those with severe injury to minimize these adverse outcomes.

Ethical information

The manuscript submitted does not contain information about medical device(s)/drug(s).

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Conflict of interest

The authors declare that they have no conflicts of interest to disclose.

List of abbreviations

ASIA	American Spinal Injury Association
CCI	Charlson's Comorbidity Index
CI	Confidence interval
HR	Hazards ratio
LOS	Length of stay
OR	Odds ratio
SD	Standard deviation

References

- [1] Alizadeh A, Dyck SM, Karimi-Abdolrezaee S. Traumatic spinal cord injury: an overview of pathophysiology, models and acute injury mechanisms. *Frontiers in Neurology* 2019;10. <https://doi.org/10.3389/fneur.2019.00282>.
- [2] Aito S, D'Andrea M, Werhagen L. Spinal cord injuries due to diving accidents. *Spinal Cord* 2004;43(2):109–16. <https://doi.org/10.1038/sj.sc.3101695>.
- [3] El Masri WS. Traumatic spinal injury and spinal cord injury: point for physiological conservative management as compared to surgical management. *Spinal Cord Ser Cases* 2018;4(1). <https://doi.org/10.1038/s41394-018-0045-z>.
- [4] Kirshblum SC, Waring W, Biering-Sorensen F, Burns SP, Johansen M, Schmidt-Read M, et al. Reference for the 2011 revision of the international standards for neurological classification of spinal cord injury. *J Spinal Cord Med* 2011;34(6):547–54.
- [5] Motiei-Langroudi R, Sadeghian H. Traumatic spinal cord injury. Long term motor, sensory, and urinary outcomes. *Asian Spine J* 2017;11(3):412–8. <https://doi.org/10.4184/asj.2017.11.3.412>.
- [6] Wannapakhe J, Arrayawichanon P, Saengsuwan J, Amatachaya S. Medical complications and falls in patients with spinal cord injury during the immediate phase after completing a rehabilitation program. *J spinal Cord Med* 2013;38(1):84–90. <https://doi.org/10.1179/2045772313y.0000000173>.
- [7] Cragg JJ, Noonan VK, Krassioukov A, Borisoff J. Cardiovascular disease and spinal cord injury: results from a National Population Health Survey. *Neurology* 2013;81(8):723–8. <https://doi.org/10.1212/wnl.0b013e3182a1aa68>.
- [8] Taghlabi K, Carlson BB, Bunch J, Jackson RS, Winfield R, Burton DC. Chemoprophylactic anticoagulation 72 hours after spinal fracture surgical treatment decreases venous thromboembolic events without increasing surgical complications. *North Am Spine Soc J* 2022;11:100141. <https://doi.org/10.1016/j.xnsj.2022.100141>.
- [9] Williams R, Murray A. Prevalence of depression after spinal cord injury: a meta-analysis. *Arch Phys Med Rehabil* 2014;96(1):133–40. <https://doi.org/10.1016/j.apmr.2014.08.016>.
- [10] Budd MA, Gater DR, Channell I. Psychosocial consequences of spinal cord injury: a narrative review. *J Pers Med* 2022;12(7):1178. <https://doi.org/10.3390/jpm12071178>.
- [11] Charlson Comorbidity Index (CCI) [Internet]. [cited 2023 Jun 23]. <https://www.mdcalc.com/calc/3917/charlson-comorbidity-index-cci>.
- [12] R Core Team. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing, 2022. <https://www.R-project.org/>.
- [13] Bourassa-Moreau É, Mac-Thiong JM, Ehrmann Feldman D, Thompson C, Parent S. Complications in acute phase hospitalization of traumatic spinal cord injury. *J Trauma Acute Care Surg* 2013;74(3):849–54. <https://doi.org/10.1097/ta.0b013e31827e1381>.
- [14] McCullough BJ, Comstock BA, Deyo RA, Kreuter W, Jarvik JG. Major medical outcomes with spinal augmentation vs conservative therapy. *JAMA Intern Med* 2013;173(16):1514. <https://doi.org/10.1001/jamainternmed.2013.8725>.
- [15] Brasil AV, Teles AR, Roxo MR, Schuster MN, Zauk EB, Barcellos BG da, et al. A simple scoring system for predicting early major complications in spine surgery: the cumulative effect of age and size of surgery. *Arq Neuro-Psiquiatr* 2016;74(10):803–9. <https://doi.org/10.1590/0004-282x20160127>.
- [16] Dasenbrock HH, Liu KX, Devine CA, Chavakula V, Smith TR, Gormley WB, et al. Length of hospital stay after craniotomy for tumor: a national surgical quality improvement program analysis. *Neurosurg Focus* 2015;39(6). <https://doi.org/10.3171/2015.10.focus15386>.
- [17] McKinley W, Meade MA, Kirshblum S, Barnard B. Outcomes of early surgical management versus late or no

- surgical intervention after acute spinal cord injury. *Arch Phys Med Rehabil* 2004;85(11):1818-25. <https://doi.org/10.1016/j.apmr.2004.04.032>.
- [18] Atlas SJ, Deyo RA, Keller RB, Chapin AM, Patrick DL, Long JM, et al. The maine lumbar spine study, part II. *Spine* 1996;21(15):1777-86. <https://doi.org/10.1097/00007632-199608010-00011>.
- [19] Zhu RS, Kan SL, Ning GZ, Chen LX, Cao ZG, Jiang ZH, et al. Which is the best treatment of osteoporotic vertebral compression fractures: balloon kyphoplasty, percutaneous vertebroplasty, or non-surgical treatment? A Bayesian network meta-analysis. *Osteoporosis Int* 2019;30(2):287-98. <https://doi.org/10.1007/s00198-018-4804-2>.