

A Retrospective Review of Traumatic Spinal Cord Injuries to Appropriately Forecast Future Service Requirements at a National Trauma Centre

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Abstract

Aim

In recent decades, a concerning rise in spinal cord injuries (SCI) parallels increased trauma-related admissions. Our aims were to review traumatic spinal cord injury (TSCI) admissions to a national tertiary centre and conduct analysis of costs for resource planning.

Methods

TSCI patients presenting to the Mater Misericordiae University Hospital between 2017 and 2019 were retrospectively reviewed. Demographics, clinical characteristics, level of neurological deficit as per the 5-point American Spinal Injuries Association (ASIA) scoring system (with grade A representing the most severe and the grade D representing the least severe grade of deficit) and length of stay (LOS) were compared for annual years.

Results

Our cohort consisted of 148 patients (73% male). A yearly rise in the percentage of cases of ASIA grade A was noticed in conjunction with a decrease in mean age and increase in mean LOS. A similar increase was also noted in ASIA Grade D patients, along with an increase in mean age and mean LOS.

Discussion

ASIA Grade A and D patients may be constituting a greater percentage of all cases in our institution, with the most severe form of TSCI increasingly occurring in younger demographics, implying that greater resource planning will be required to accommodate these patients.

Introduction

Traumatic injuries are a leading cause of mortality and account for 8% of deaths worldwide¹. The Major Trauma Audit (MTA) quantifies the scale of traumatic injuries on the Irish healthcare system in particular, with these injuries affecting 4,055 individual patients and accounting for 67,705 hospital bed days in 2021².

Traumatic injuries are also a major contributor to the incidence of spinal cord injuries (SCI)³, another leading cause of disease and disability that affects 2,500 people in Ireland on a daily basis⁴ and 15 million people globally⁵. Over the last 3 decades, a concerning rise in SCI has been noted, with global estimates taken in 2019 indicating a 52.7% increase in SCI incidence in comparison with estimates taken in 1990. Factors such as falls and road traffic accidents (RTA) have been cited as major contributors to this surge⁶.

SCI are not only associated with severe disease burden on patients and their families, but also impose significant financial burdens. Analysing trends aids in resource allocation and tailored strategies for prevention, acute care and rehabilitation. Consequently, the aims of this study were to (a) produce a review of traumatic spinal cord injuries (TSCI) admissions to a national tertiary centre and (b) conduct cost projection analysis to aid resource planning.

Methods

This study is a retrospective single centre review from a national tertiary referral centre for spinal injuries. Data was gathered from a database which included patients admitted to our institution with TSCI from January 2017 to January 2019. Patients were excluded if they presented outside of 2017 to 2019, presented with non-traumatic SCI, if the patients were not admitted to our institution (e.g. outpatient) or if the patient was admitted, managed and discharged under the care of another team within our institution.

Patient demographics and clinical characteristics noted include age, biological sex, injury mechanism and American Spinal Injury Association (ASIA) Impairment Scale grade, a standardized scoring system used to measure the neurological function in patients presenting with SCI. Patients presenting with ASIA grade A to D were included, with A being the most severe level of neurological deficit and D being the least severe. ASIA grade E indicates no loss of neurological function and was excluded.

LOS was determined for each eligible patient using admission and discharge data from the electronic health record of our institution. LOS was classified as ward, high dependency unit

(HDU) or intensive care unit (ICU). All data was collected on an electronic spreadsheet, with demographics, clinical characteristics and LOS being tabulated according by year in order to conduct trend analysis.

A secondary aim of study was to conduct cost-projection analysis. For the purpose of this study, the cost per patient was set as their LOS (per bed type) x cost per bed per day. In June 2025, the Health Service Executive (HSE) reported the average daily running cost of an in-patient hospital bed in an acute hospital setting to be €1260. This figure is described as a “fully-absorbed” cost and accounts for treatment theatre and associated running costs such as light and heat and pointedly is a national average. We utilised this figure to represent LOS for patients in wards and HDU. For ICU, the HSE quotes a national average of €2430 per day⁷.

All data collection, analysis and generation of figures and tables was completed using Microsoft Excel version 6.2.14. Ethical approval was granted by the ethics committee of our institution.

Results

148 participants met the inclusion criteria for this study. 108 of the participants (73%) were male and 40 (27%) were female. The mean age of this cohort was 60.52 and the median age was 60.45. The oldest patient presenting was 96 years of age and the youngest was 22. Exactly 50% of patients in our cohort (74) were under the age of 65 at the time of injury. The most frequent cause of injury were falls (64.86%), including both high and low energy, followed by RTA (14.86%) and injuries to cyclists (5.41%). Regarding the neurological deficit scale, ASIA D accounted for the highest proportion of all patients (44.59%), followed by ASIA A (25.68%), ASIA C (16.22%) and lastly by ASIA B (13.51%)

Length of Stay (LOS)

The patient cohort accounted for 2969 hospital bed days across the three years included in this study, with a mean LOS of 20.06 days per patient. Male patients accounted for 2351 days (79.81%) and females patients accounted for 618 (20.82%). As with the aforementioned findings, falls were responsible for the greatest proportion of hospital days (1706) followed by RTA (452) and cyclists (372).

The vast majority of hospital days were associate with HDU (76.76%), followed by ward admissions (12.56%) and ICU (10.74%). ASIA A patients accounted for the greatest percentage

of time spent in ICU (44.2%), followed by ASIA D (31.35%), B (19.12%) and C (5.33%) patients respectively. This trend was also repeated across ward and HDU.

ASIA A patients accounted for the most hospital days (36.17%), followed by ASIA D (28.63%), ASIA B (23.07%) and lastly by ASIA C (12.13%). This was not reflected in mean LOS per patient where ASIA B patients accounted for the largest value (34.25 days), followed by ASIA A (28.26 days), ASIA C (15.00 days) and ASIA D (12.88 days). These results are further summarised in Table 1.

Variable	Number of days (n)	% of total LOS	Mean LOS (days)
LOS			
Total	2969	100%	20.06
Male	2351	79%	21.77
Female	618	21%	15.45
ASIA Grade			
ASIA A	1074	36%	28.26
ASIA B	685	23%	34.52
ASIA C	360	12%	15.00
ASIA D	850	29%	12.88
Bed Type			
Ward	373	13%	n/a
HDU	2279	77%	n/a
ICU	319	11%	n/a
Injury Mechanism			
Fall	1706	57.46%	17.77
Cyclist	372	12.53%	46.50
Driver Restrained	158	5.32%	52.67
Driver Unrestrained	111	3.74%	37.00
Pedestrian	62	2.09%	8.86
RTA	452	15.22%	20.55
Sporting Injury	108	3.64%	12.00

Table 1: Summary of LOS by biological sex, ASIA grade classification at time of admission, bed type and injury mechanism

Cost Projection Analysis

Using our formula of cost per bed per night multiplied by LOS, we costed all TSCI admissions from January 2017 to 2019 relevant to the study as €4,116,690.00. Of this, HDU accounted for €2,871,540.00, wards accounted for €469,980.00 and ICU LOS was costed at €775,170.00. The overall mean cost per patient calculated as €27,815.47. 2018 was associated with the highest total cost (€1,488,510) and 2019 was associated with the lowest total cost (€1,263,060.00).

When taking mean cost per patient into account, 2019 was associated with the highest individual cost per patient (€30,072.86) and 2018 was associated with the lowest (€26,580.54). ASIA B was associated with the highest cost per patient (€46,723.50), followed by cohorts in grade A (€39,952.89), C (€19,728.75) and D (€18,000.00). ICU costs were the highest in ASIA A patients (€342,630.00) and accounted for 44.2% of all ICU costs. ASIA A (€1,025,640.00) and Asia D (€806,400.00) accounted for 63.80% of all HDU LOS.

Trend Analysis

Trends were observed across demographics, clinical characteristics, LOS and cost-projection analysis. Figure 1 displays the proportion of total cases each ASIA grade accounted for on a yearly basis. The strongest positive trends was noted in the case of ASIA A patients, with more subtle positive change noted in ASIA D patients. An overall decrease in the proportion of cases accounted for by ASIA B and ASIA C patients from the beginning to the end of the study period.

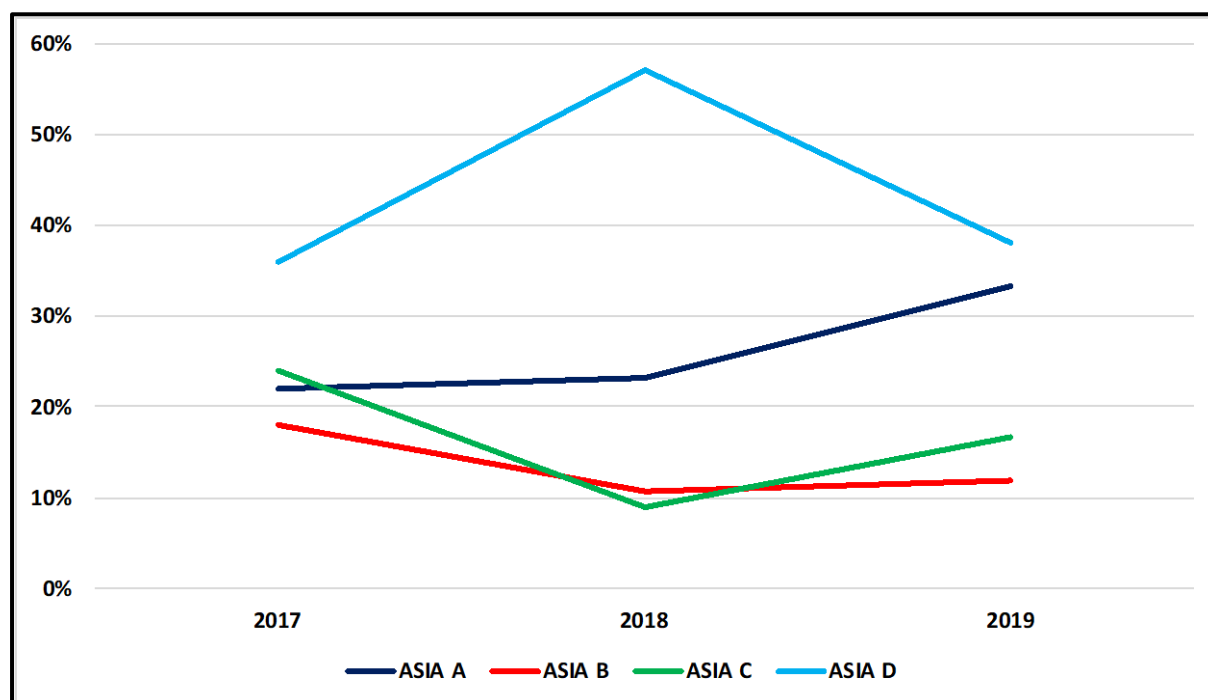


Figure 1: Annual percentage of total TSCI cases attributed to ASIA grade A,B,C and D in our institution, based on the year of admission

Trends were noted regarding the mean age of the cohort and are summarised in Figure 2. Negative and positive trends were noted in ASIA A and D cohorts, with no clear trend noted in ASIA B and C cohorts.

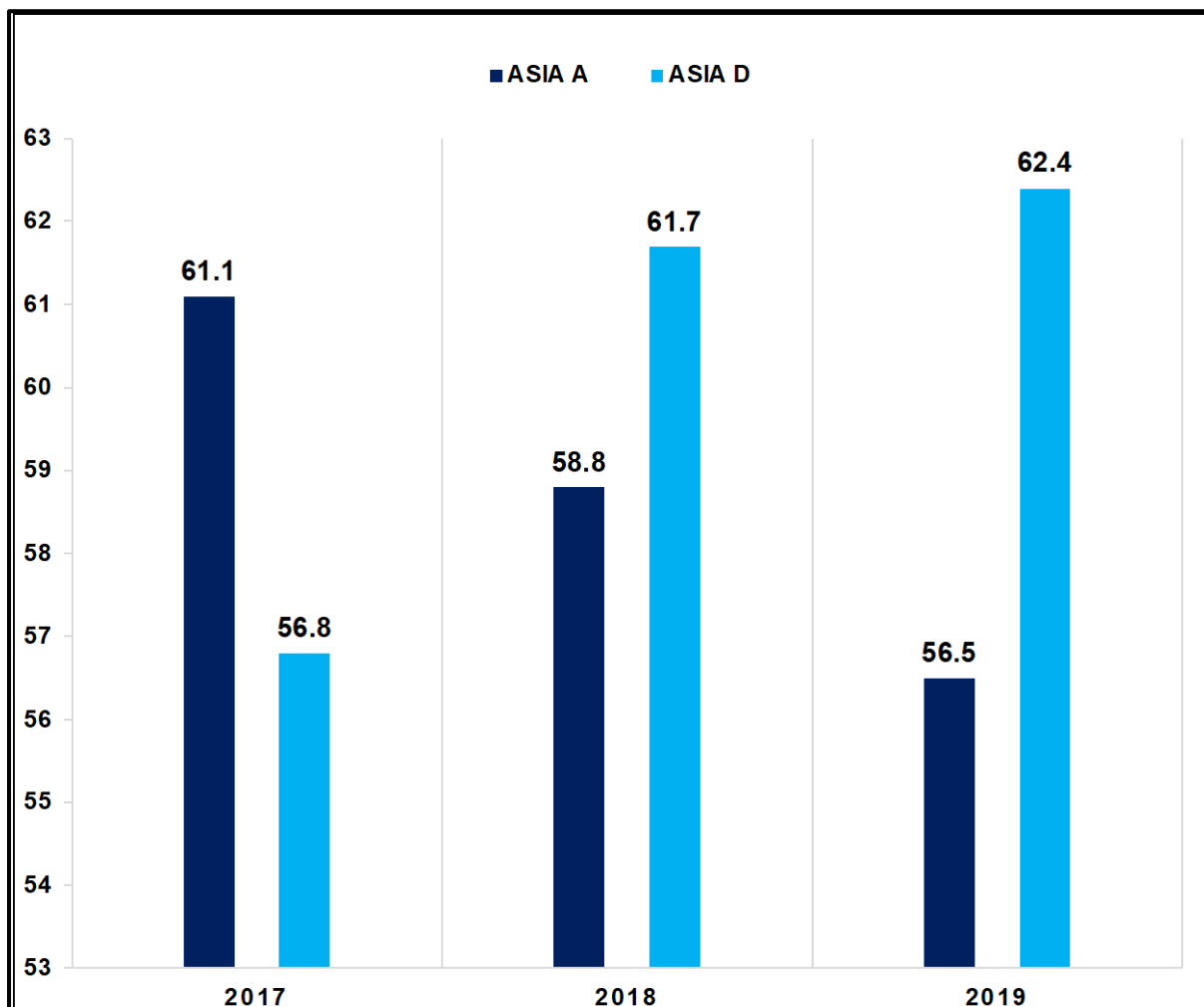


Figure 2: Annual mean age of all patients TSCI presenting with ASIA A and D injuries to our institution, based on the year of admission

Trends of note were observed regarding mean LOS per patient as well and associated mean cost per patient. ASIA A and ASIA D saw an overall positive trend for these metric as seen in Figure 3. Mixed trends were noted in ASIA C and especially in ASIA B, most likely due to large variations in the data for that particular cohort. Trends regarding overall LOS for the study cohort was positive overall as well, ranging from 20.18 (2017) to 21.83 (2019).

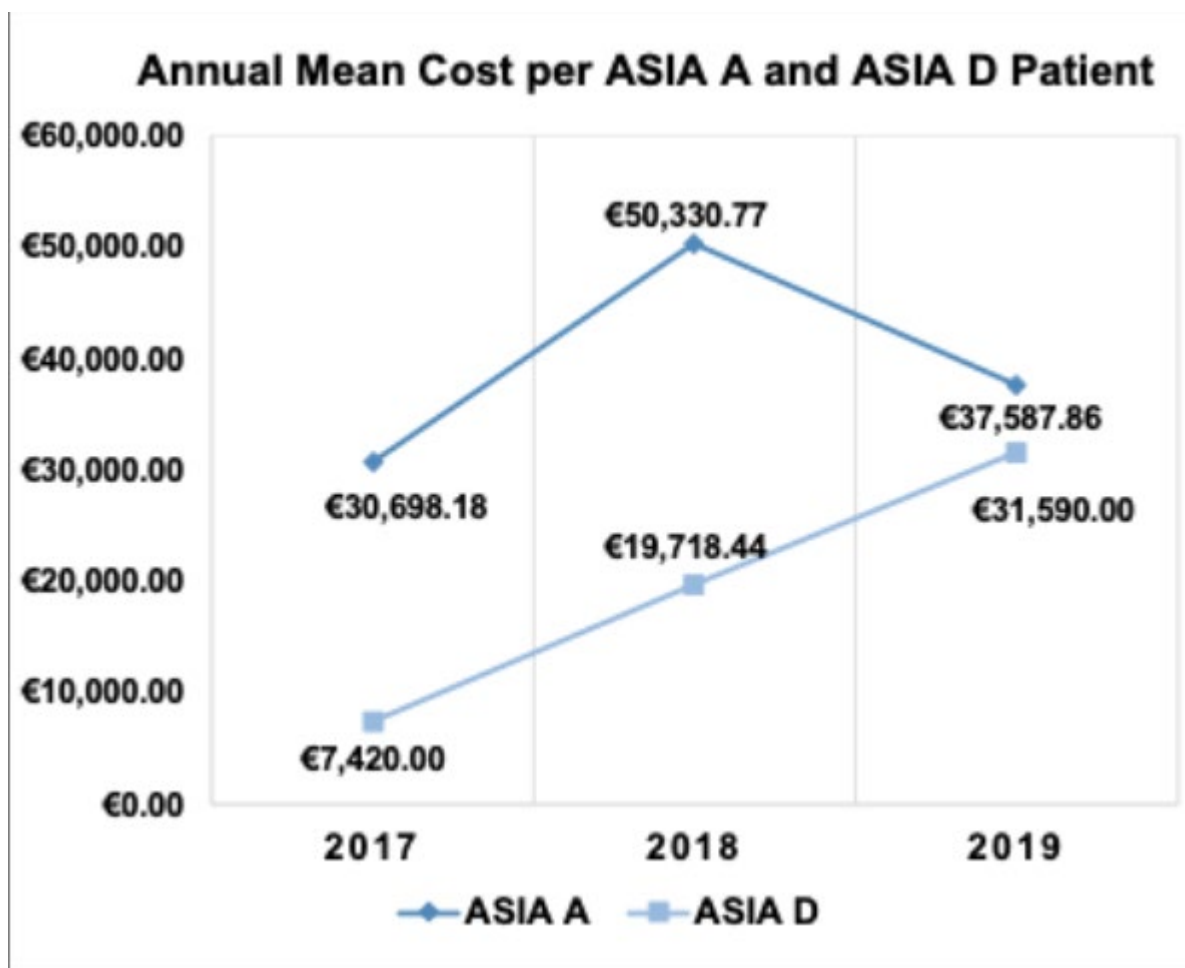


Figure 3: Mean cost per ASIA A and ASIA D patients by year of admission. A positive trend in both cohorts is related to positive trends regarding LOS in our study

Discussion

TSCI are serious, potentially life-altering injuries. They affect millions worldwide⁵ and are predominantly caused by traumatic injuries, most commonly arising from motor vehicle accidents and falls³.

The scale of traumatic injuries in Ireland is well documented as a result of the MTA, yet few studies have attempted to classify the demographics and clinical characteristics of Irish patients presenting with TSCI. A review of SCI completed in 2006 was one of the first, and examined 46 patients admitted across the span of a year in 2000⁹. Another study analysed the epidemiology of spina trauma and estimated the incidence of TSCI in Ireland at 19.54 cases/100,000 persons per year¹⁰. This study captures a wide range of data pertaining to the patient demographics and clinical characteristics of TSCI, whilst framing them in the context of neurological deficit and length of stay.

Results produced from this study are in line with the findings of other studies, specifically that falls and accidents related to motor vehicles are the most common sources of traumatic SCI^{3,8} and that males constitute a greater proportion of patients presenting with traumatic SCI⁹. Data pertaining to neurological deficit and LOS indicate some interesting trends. In our cohort, it found that that ASIA Grade A and D patients are increasingly constituting a greater proportion of all trauma cases with SCI. A steady rise was noticed in the former, from 22 to 33.33 percent. An overall positive trend was noticed in ASIA D patients as well, which may be explained by the increasingly elderly population in Ireland, which increased by 40% from 2013 to 2023¹¹. Elderly patients are particularly susceptible to traumatic incidents, as well as spinal injuries, often as a result of age-related co-morbidities such as osteoporosis¹². Trends related to age also suggest this, as the mean age of this cohort increased from 56.8 in 2017 to 62.4 in 2019 in our study.

An increase in ASIA A cases may have been driven by an increase in motor related serious injuries. Results from this study illustrate that RTA accounted for 26 percent of all ASIA A cases, with RTA only accounting for 12% of cases in the next closest ASIA classification. An unusual trend was noticed related to mean age in ASIA A patients, which decreased from 61.1 in 2017 to 56.5 in this cohort. This could be attributed to the involvement of younger patients in RTA for example, although causation is beyond the scope of this study.

Positive trends were noticed for mean LOS overall, specifically within ASIA A and ASIA D. The reasons are unclear for this, but could be attributed to patients spending more time admitted in our institution as they wait for allocation to our national rehabilitation centre. It is clear that this increase in LOS caused an increase in cost per patient with traumatic SCI in our cost-projection analysis, regardless of the cause.

A potential limitation of this study is that cases were identified retrospectively from a single institution. The extraction of some data, specifically LOS, was limited in scope. Furthermore, as our institution is a tertiary institution for spinal injuries, it is possible that the included cohort may not be fully representative of all patients with traumatic SCI. Certain situations may have necessitated patient management in referring institutions, such as if the patient was too ill to be transferred or if they were deemed suitable to receive treatment by orthopaedic teams in local centres. Costs regarding HDU may have been understated due to lack of available data.

To conclude, this study quantifies the demographics and clinical characteristics of patients presenting with TSCI over a 3 year period. Our results indicate that ASIA Grade A and D patients are increasingly constituting a greater proportion of all traumatic SCI cases. While an

increase in the latter might not be unexpected, given the ageing Irish population, the increase in ASIA A cases is unexpected, with this severe form of SCI increasingly recorded in younger patients in this study. This study has limitations and is limited in scale. Our results provide interesting observations and trends, but causation is beyond the scope of this study. These findings convey that TSCI necessitate a robust and large audit to better characterise the scale of these injuries. In the case of our institution, it is clear that greater resource planning will be required to accommodate trauma patients with SCI.

Declarations of Conflicts of Interest:

None declared.

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