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Mapping the continuum of care to surgery following traumatic spinal cord injury

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ABSTRACT

Background: Traumatic spinal cord injury (SCI) is a devastating injury, frequently resulting in paralysis and a lifetime of medical and social problems. Reducing time to surgery may improve patient outcomes. A vital first step to reduce times is to map current pathways of care from injury to surgery, identify rapid care pathways and factors associated with rapid care pathway times.
Methods: A retrospective review of the Alfred Trauma Service records was undertaken for all cases of spinal injury recorded in the Alfred Trauma Registry over a three year period. Patients with an Abbreviated Injury Scale (AIS) code matching 148 codes for spinal injury were included in the study. Information extracted from the Alfred Trauma Registry included demographic, clinical and key care timelines.
Results: Of the 342 cases identified, 119 had SCI. The average age of SCI patients was 52 years, with 84% male. The vast majority of SCI patients experienced multiple concurrent injuries (87%). Median time from injury to surgery was 17 h r 28 min for SCI patients in comparison to 28 h r 23 min for non-SCI patients. Three pathways to surgery were identified following Trauma Centre presentation- transfer to surgery direct from trauma unit (median time to surgery was 4 h 17 min.), via Intensive Care (median time to surgery was 24 h 33 min) and via the ward (median time to surgery 28 h r 35 min.) SCI was independently associated with the fastest pathway - direct transfer from trauma unit to surgery - with 41% of SCI cases transferred directly to surgery from the trauma unit.
Conclusion: Notwithstanding that the vast majority of SCI patients presented with other traumatic injuries, half of all SCI cases reached surgery within 18 h of injury, with 25% within 9 h. SCI was independently associated with direct transfer to surgery from the trauma unit. SCI patients achieve rapid times to surgery within a complex trauma service. Furthermore, the trauma system is well positioned to implement further time reductions to surgery for SCI patients.

Introduction

Spinal cord injury (SCI) is a most devastating and frequently irreparable event. SCI is typically associated with otherwise healthy young men, resulting in paralysis and a lifetime of medical and social sequelae [1–3]. In addition, patients with SCI may be subject to increased cardiovascular disease and early mortality associated with long term impediments to mobility [4]. The mechanism of injury for SCI patients is often blunt trauma. Motor vehicle accidents are the primary cause, affecting younger males 16–44 years of age [5,6]. Low falls are increasing in incidence and account for 30% of SCI cases, predominately in males over 65 years of age [5,6]. However overall, with SCI being more common amongst younger adults, this increases the years of 'healthy' life lost to disability and early mortality, posing a great cost to the individual, their families and the healthcare system. For all new cases of traumatic SCI in Australia during a single year, the estimated total lifetime cost (including burden of disease and financial costs) has been estimated at $2.0 billion. The total lifetime cost per individual is $5 million for those with paraplegia and $9.5 million for those with quadriplegia [7].

In an effort to improve SCI patient outcomes, the mechanism of spinal cord injury has been under increasing scrutiny. Authors of pre-clinical studies have reported that spinal cord injury occurs as both a primary and secondary injury. Primary mechanical trauma

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makes the spinal cord vulnerable to compressive forces. A period of compression appears to contribute to spinal cord damage after the initial trauma [8–11] and it is suspected that a complex cascade is activated, leading to ischemia, oedema and apoptosis [8–10]. Early surgical decompression has been reported to ameliorate the effects of this secondary injury [8–10,12], but the ideal timing of this decompression is contested [13]. Pre-clinical studies have shown positive outcomes in motor and sensory function if spinal decompression occurs within 6 h [8–11]. However, the logistical, operational and clinical application of meeting this deadline within an acute trauma system has proved to be challenging [12,13]. Results reported in recent studies indicate that patient outcomes may improve if surgical decompression is instigated within 24 h, and outcomes are further improved if decompression is performed within 4–8 hours of injury [12,14–16]. Authors of these studies excluded "SCI with polytrauma" cases, reporting isolated SCI. Therapeutic hypothermia has been proposed as a possible solution to achieving timely surgical decompression after SCI, but there are associated complications of hypothermia [11,17–20]. The 'Miami Project' has sought to address these problems and create a prospective randomised controlled trial instituting therapeutic hypothermia in SCI [19]. A similar project, the ICED (Immediate Cooling and Emergency Decompression) protocol has been commenced in Australia [21].

A common proposition from authors of recent studies is that a reduction in time from spinal cord injury to surgical decompression may reduce secondary injury and improve patient outcomes. Currently the SCI-POEM study - a multisite international study in Europe - is investigating the feasibility of 12 h times from injury to surgery to determine if this target can be reasonably achieved [22]. SCI is recognised as "Major Trauma", commonly does not occur in isolation and requires special consideration in developed trauma systems.

Trauma systems, by definition, are an integrated and systematic structure of guidelines and protocols designed to improve patient outcomes following injury [23,24]. The continuum of care for trauma patients is complex and influenced by a vast array of variables including the severity, location and concurrency of patient injuries. Any proposed reduction in time to surgical decompression for patients with SCI may require changes in the organisation of trauma care currently provided [25,26]. A vital first step in developing strategies to reduce time to surgical decompression is to identify and understand the pathways of care currently being provided. This includes timelines, pathways, activities, investigations and procedures undertaken within the trauma service.

We sought to identify the care provided within a well-established, inclusive trauma system for adult patients presenting with suspected spinal cord injury. Specifically, we sought to map the pathways of care provided to SCI patients as they transition from injury site to The Alfred Emergency & Trauma Centre (Trauma Centre) reception and then surgery, and to identify factors that may be associated with "time to surgery".

Methods

study design and study setting

This study was a retrospective audit of The Alfred Major Trauma Service presentations over a three-year period from July 1, 2011 to June 30, 2014 and recorded the Alfred Trauma Registry. The Alfred Trauma Registry is a trauma epidemiology, injury surveillance and performance monitoring system. It is a major provider of information to the Victorian State Trauma System and the Victorian State Trauma Outcomes Registry. All trauma presentations recorded on the Registry during the study period were reviewed to identify patients with an AIS code matching 148 codes that represent spinal injuries. Abbreviated Injury Score (AIS) inclusion code selection was undertaken with the advice of the Alfred Trauma Registry Manager, Trauma Registry nurses and Trauma Health Information staff. The AIS code includes both the location and severity of injuries. Patients presenting with a spinal injury (Spinal, Abbreviated Injury Score (AIS) severity code 3, 4, 5, or 6) were identified for inclusion in the study. Spinal AIS severity codes of 4, 5 and 6 describe Spinal Cord injuries that may be incomplete SCI (AIS 4) or Complete SCI (AIS 5 and 6) injuries.

Information extracted from the Alfred Trauma Registry including demographic, clinical and timelines was provided in an excel spreadsheet for analysis.

Statistical analysis

Descriptive statistics were used to present patient demographic, situational variables and pathways to surgery. Univariable regression analysis was used to identify variables associated with factors of interest. Variables included demographic characteristics and key clinical service markers including, but not limited to, location, transport mode, mechanism of injury, injury description, severity of injury, concurrent injuries, procedures undertaken and time points within the process of care from injury to surgery. Odds Ratio (OR) (95% CI), and p-value of <0.05 was considered statistically significant. A multivariable regression model was developed. Backward stepwise elimination was used. All variables were entered into the model. The least significant variable was removed and the model rerun. This process was repeated until all variables had a p-value of <0.05. A p-value of <0.05 was considered significant. Data analysis used STATA version 12. [27].

Ethics approval

The reported research findings adhere to the National Statement for the Conduct of Human Research by the Australian National Health and Medical Research Council. The Alfred Health Ethics Committee approved this study as a low risk review. (Ethics Number: 337/14)

Results

Patient demographics and injury characteristics

During the study period a total of 342 patients were included in the study (Table 1). The mean age was 48 years. Males represented 76% of all cases (n = 260), with 44% (n = 152) stating they were previously healthy.

Spinal injury severity was categorised into two separate groups:

1 Spinal Cord Injuries were experienced by 119 patients (35%). Of these, an isolated single SCI was identified in 16 cases with 12 cases having multiple SCIs. All other cases experienced multiple injuries to other regions as well as the SCI (n = 90). These patients had a spinal AIS score greater than 3.
2 Damage to the nerves around the spinal cord or transient neurological signs were experienced by 223 patients (65%). These patients had a spinal AIS score of 2 or 3.

Overall the median Injury Severity Score (ISS) for included patients was 17 (IQ 13–27). The median number of injuries per patient was 4 (IQ 2–8). Thirty-seven patients (11%) died of their injuries during the primary admission. Virtually all injuries were blunt trauma (99%) with 56% of injuries (n = 192) occurring within the Melbourne Metropolitan area. A referral hospital was included in the process from injury to admission in 34% of cases (n = 115).

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