



**Special Focus Report  
2001 - 2008**

**Victorian State Trauma Outcome  
Registry and Monitoring Group  
(VSTORM)**

## **SPECIAL FOCUS ON SPINAL CORD INJURY (SCI)**

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## ABOUT THIS REPORT

This report describes data on all hospitalised Victorian major trauma cases, defined according to the VSTORM major trauma definition.

For the purposes of generating this report, only data received by the Registry by the 30<sup>th</sup> April 2009 has been included.

Most of the data is presented across the whole trauma system and corresponds to patient level data. When the data is stratified across the trauma service levels, this is presented either on the basis of episodes of care, or according to information from either the first or definitive hospital of care, as indicated.

This report was prepared by Mimi Morgan and Andrew Hannaford of the Victorian State Trauma Outcome Registry and Monitoring (VSTORM) group at the Department of Epidemiology and Preventive Medicine, Monash University. The VSTORM Chief Investigators and members of the VSTORM Steering Committee are listed at the end of the report.

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The Victorian State Trauma Registry is a Department of Human Services and TAC Health Research funded and approved initiative.

## EXECUTIVE SUMMARY – SPECIAL FOCUS SPINAL CORD INJURY

- There were 464 spinal cord injury (SCI) cases captured by the VSTR from 2001-2008, with a stable incidence of injury
- The majority (64%) of SCI injuries were to the cervical region, and almost half (49%) of SCI cases were the result of road trauma
- SCI injuries demonstrated a different pattern of management to the general major trauma population with a high percentage (77%) experiencing at least one inter-hospital transfer, a longer median hospital length of stay (17.2 days) and almost 80 per cent discharged to an inpatient rehabilitation centre
- 73 per cent of SCI cases were definitively managed at the MTS for spinal injury
- The source of transferred SCI cases to the Austin has changed from 50% MTS in years 2001-02 to 2005-06 to between 70 and 80 % MTS in years 2006-07 and 2007-08 .
- At 6-months after injury, just over half of cervical (54%) and thoracic (56%) SCI cases were living independently, while the overall return to work rate for SCI cases who were working prior to injury was 20 per cent

## SPINAL CORD INJURY (SCI) IN VICTORIA – 2001-2008

### Case selection

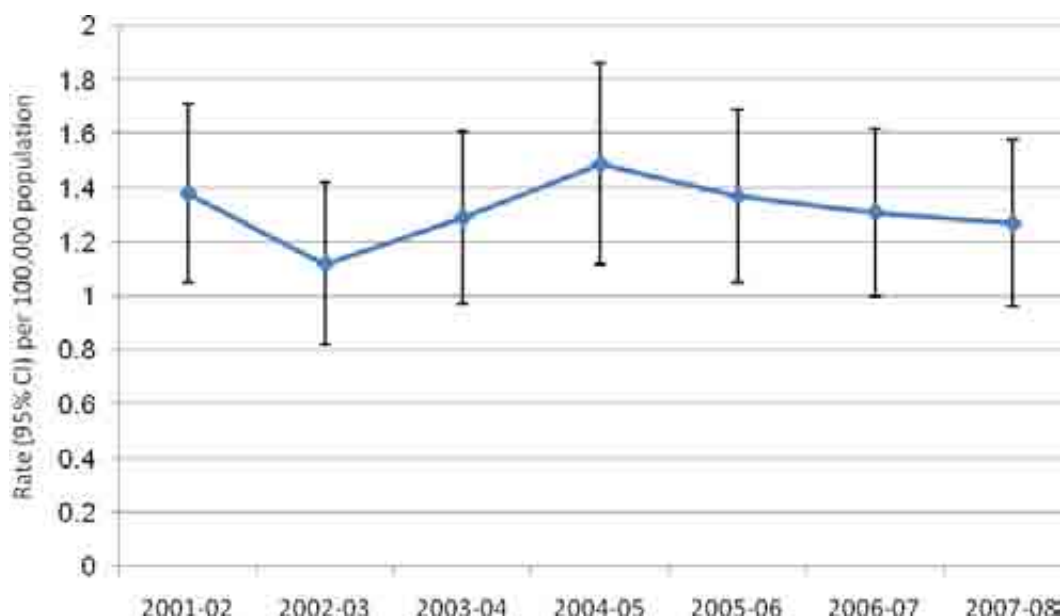
All SCI cases in Victoria captured by the Victorian State Trauma Registry (VSTR) with a date of injury between July 2001 and June 2008 (inclusive) were extracted for analysis. A SCI was defined as any injury involving the spine with an Abbreviated Injury Scale (AIS) severity score of four (severe) or greater. These injuries include:

- i. Cervical spine – cord contusions, incomplete cord syndromes, complete cord syndromes, cord lacerations
- ii. Thoracic spine – incomplete and complete cord syndromes, cord lacerations
- iii. Lumbar spine – incomplete and complete cord syndromes, cord lacerations, complete cauda equina syndrome

### Incidence

The VSTR recorded 464 SCI cases over the 2001-08 period; 67 in 2001-02, 55 in 2002-03, 64 in 2003-04, 75 in 2004-05, 70 in 2005-06, 68 in 2006-07, and 65 in 2007-08. Despite the increase in the population of Victoria, the rate of SCI in Victoria (per 100,000 population) has remained stable since 2001-02 (Figure 6). The majority (68%) of SCI cases lived in the metropolitan areas, particularly the southern metropolitan area (27%) and the eastern metropolitan area (20%).

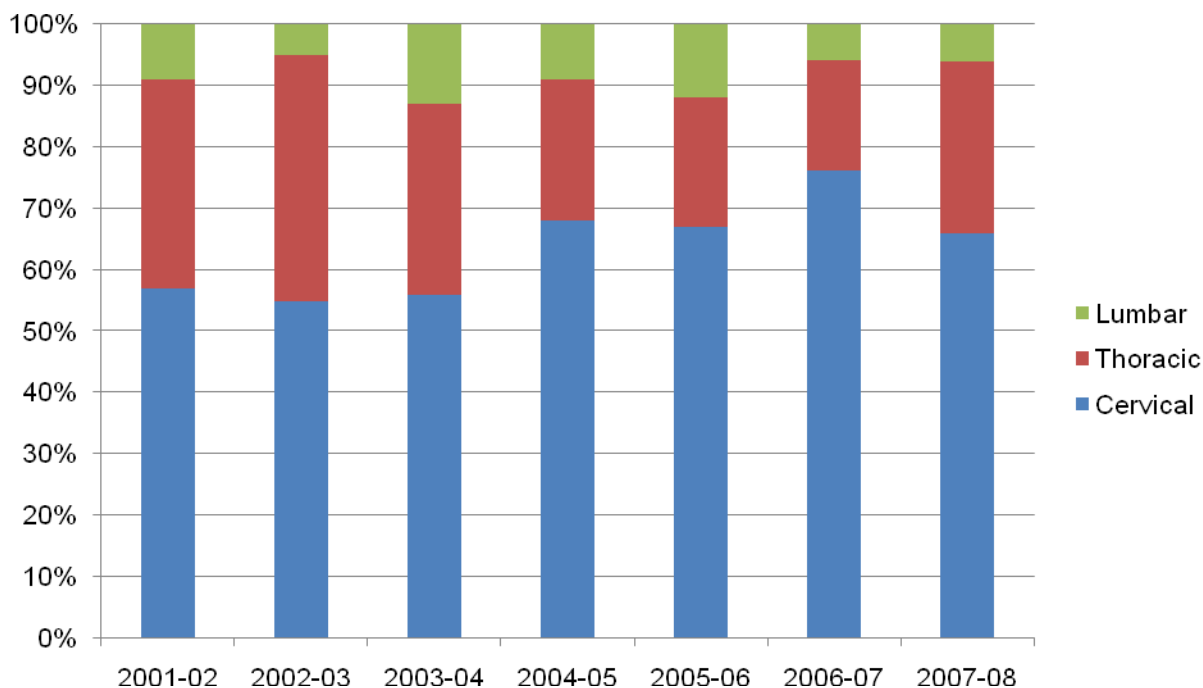
**Figure 6: Rate of hospitalised major trauma spinal cord injury cases in Victoria (2001-08)**



## Region injured

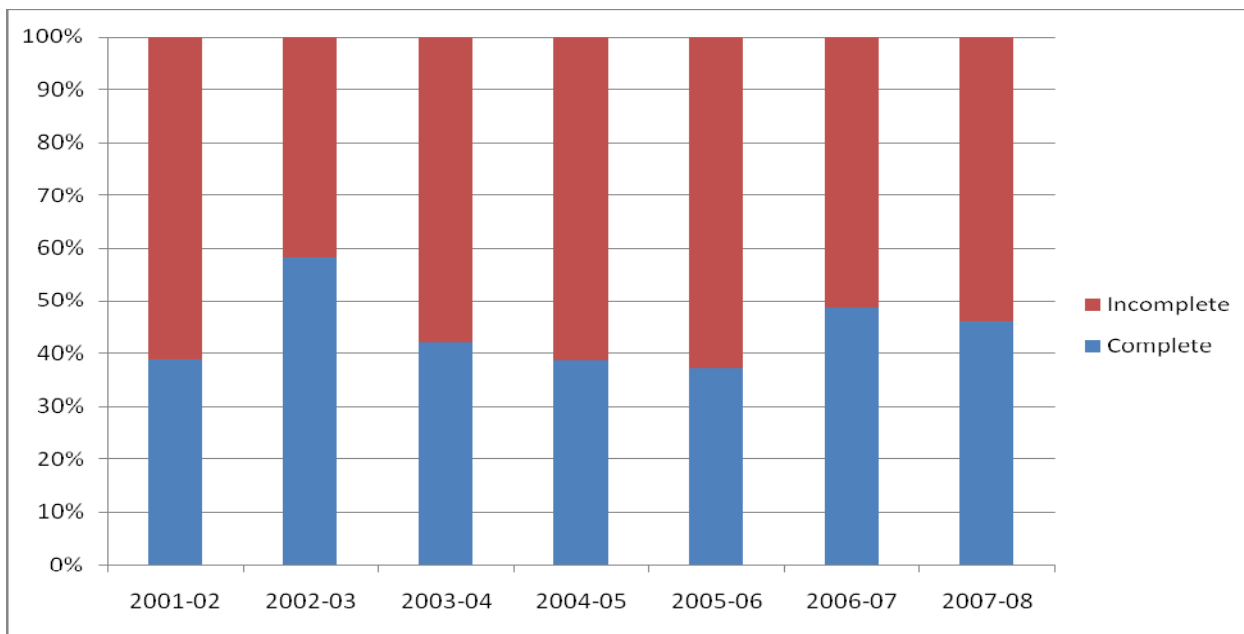
Figure 7 shows the percentage of SCI cases by region over the 7-year period. The percentage of cases in each spinal region has remained largely stable ( $p=0.190$ ) with cervical SCI predominant, accounting for 64 per cent of all SCI cases captured by the registry.

**Figure 7: Distribution of major trauma spinal cord injuries in Victoria by spinal region and year (2001-08)**



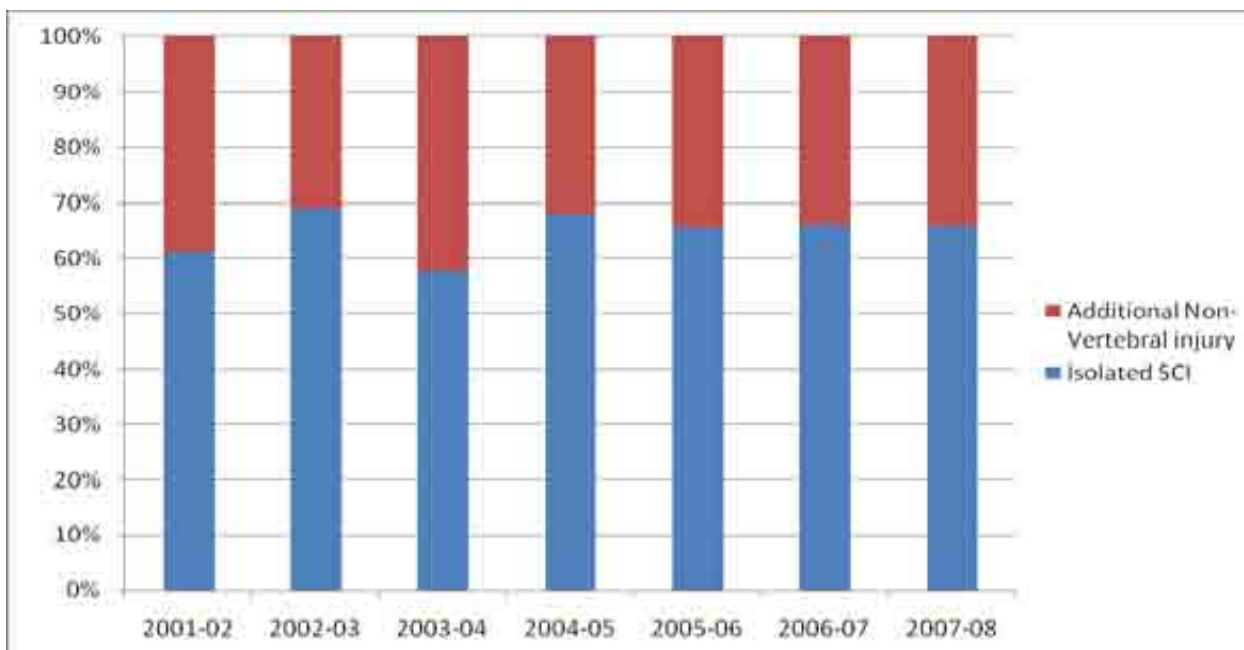
The SCI was complete for 34 per cent of cervical SCI cases, 68 per cent of thoracic cases and 38 per cent of lumbar cases. The percentage of complete SCI cases has remained unchanged between 2001 and 2008 for cervical ( $p=0.125$ ), thoracic ( $p=0.848$ ) and lumbar ( $p=0.692$ ) SCI cases. This is represented across all regions in Figure 8 below.

**Figure 8: Complete vs Incomplete spinal cord injuries in Victoria by year (2001-08)**



The composition of isolated SCI and those with additional non-vertebral injuries has also remained consistent across this time period with 60-70% of patients sustaining isolated SCI as shown in Figure 9 below.

**Figure 9: Spinal cord injuries in Victoria (2001-08)- Isolated vs Additional Non-Vertebral**



## **Patient demographics**

The median (IQR) age of SCI cases has risen from 37 (20-61) years in 2001-02 to 43 (26-65) years in 2007-08 but this was not significant ( $p=0.215$ ). The majority of SCI cases were male (80%) and this has not changed over time ( $p=0.266$ ).

## **Mechanism and intent of injury**

There has been no change in the cause of SCI injuries in Victoria over the 2001-08 period with almost half (49%) of the cases the result of road trauma. In particular, 23 per cent were the result of a motor vehicle collision and 17 per cent were motorcycle related. Low falls (18%) and high falls (19%) were also common causes of SCI. The mechanism of SCI in Victoria did not change over the 7-year period ( $p=0.236$ ). Consistent with the mechanism of injury, 98 per cent of cases were blunt trauma with the remaining cases considered penetrating trauma (1.4% cutting or piercing object, 0.6% firearm-related).

There was a significant association between the region of SCI and the mechanism of injury ( $p<0.001$ ). One quarter of cervical SCI cases were the result of a low fall, compared to 4 per cent of thoracic, and 13 per cent of lumbar, SCI cases. The percentage of lumbar SCI resulting from a high fall was 38 per cent, compared to 11 per cent of cervical, and 24% of thoracic, SCI cases. There was no difference in the percentage of cases in each spinal region for motor vehicle collisions but 36 per cent of thoracic SCI cases were the result of motorcycle crashes, compared to only 9 per cent of cervical, and 18 per cent of lumbar, SCI cases.

Consistent with the mechanism of injury, the vast majority of cases (96%) were unintentional injuries. The remainder were the result of intentional self-harm (2%) and assault (2%).

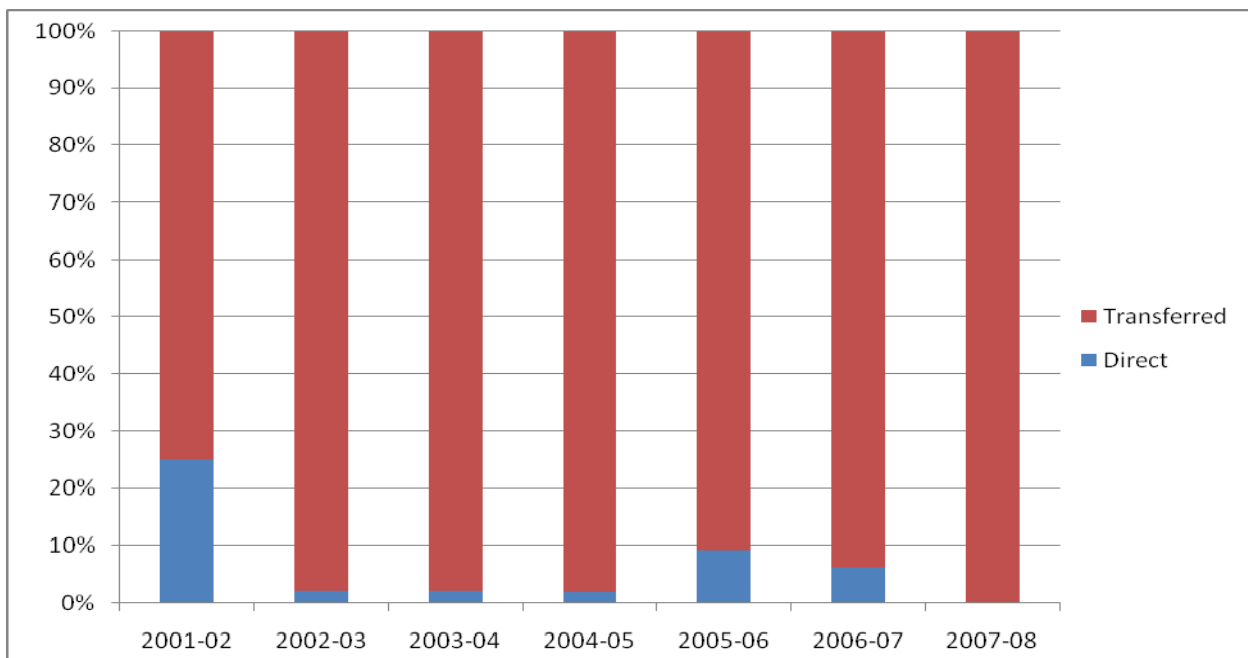
## **Transfer and management**

The majority (77%) of SCI cases arrived at their definitive hospital for management via another hospital (i.e. inter-hospital transfer). The percentage transferred has increased significantly from 63 per cent in 2001-02 to 79 per cent in 2007-08 ( $p=0.041$ ).

Almost three quarters (73%) of SCI cases were definitively managed at the Austin Hospital, while 18 per cent were definitively managed at The Alfred. The remainder were managed at Royal Melbourne Hospital (4%), the Royal Children's Hospital (2%) or a non-MTS hospital (3%). The distribution of hospital of definitive management of SCI cases was unchanged over the 7-year period ( $p=0.094$ ).

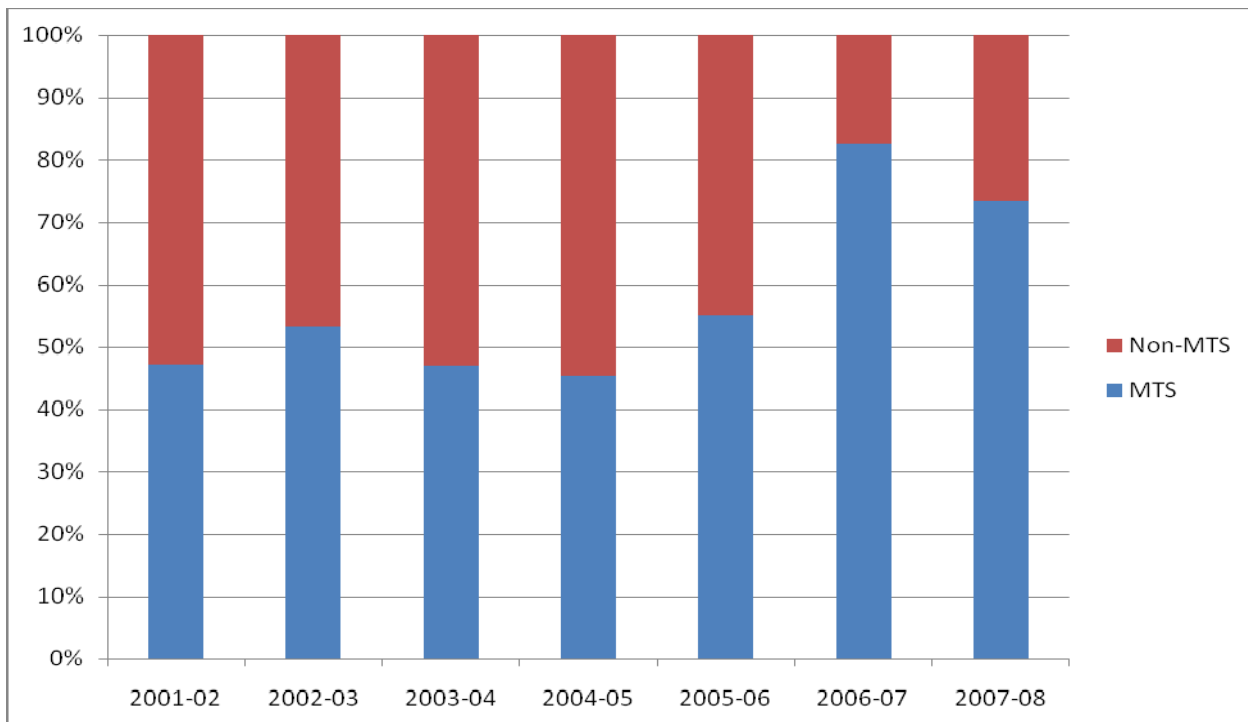
Where the definitive hospital for management was the Austin Hospital an even greater percentage (93.5%) of SCI cases arrived via another hospital as shown in figure 10 below. Since 2002-03 this has been 96.6%.

**Figure 10: Direct vs Transferred spinal cord injuries to Austin Hospital (2001-08)**



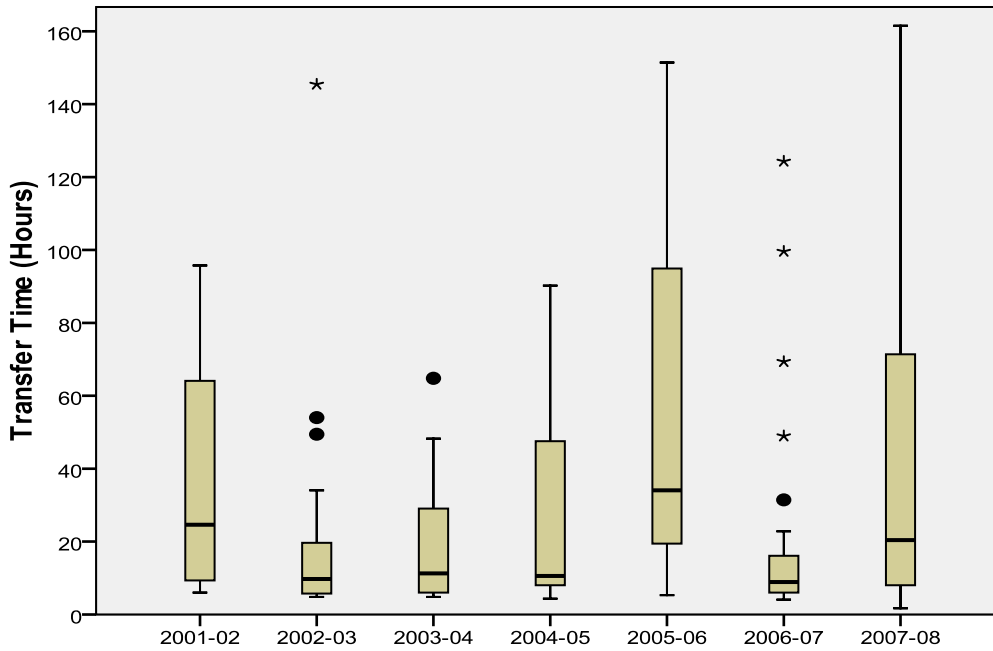
As shown in figure 11 below, the source of transferred SCI cases to the Austin has changed from 50% MTS in years 2001-02 to 2005-06 to between 70 and 80 % MTS in years 2006-07 and 2007-08 .

**Figure 11: Source of Transferred spinal cord injuries to Austin Hospital (2001-08)**

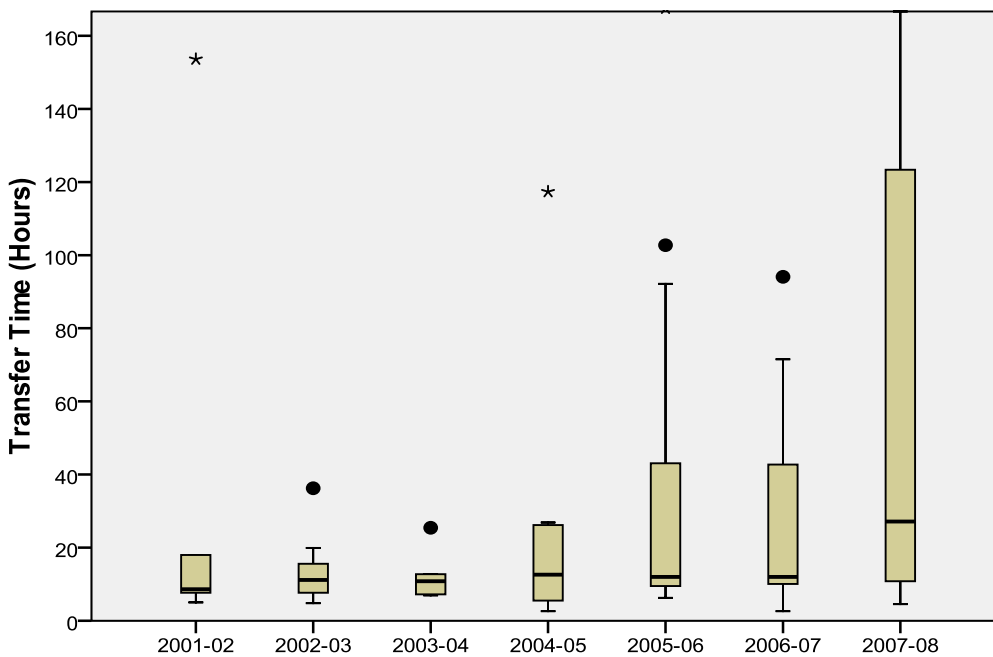


Transfer times to the Austin Hospital differed depending on the referring hospital service level as shown in Figures 12 and 13 below. The median (IQR) transfer time from MTS hospitals to the Austin for SCI cases was 17.8 (7.4-49.6) hours compared with 10.8 (7.2-16.7) hours from Non-MTS hospitals show this distinction by year.

**Figure 12 Transfer times for spinal cord injuries from MTS hospitals to Austin (2001-08)**



**Figure 13 Transfer times for spinal cord injuries from Non-MTS hospitals to Austin (2001-08)**



There was also a significant association between the hospital of definitive management and the presence of other serious (AIS severity score >2) injuries to body regions other than the spine ( $p < 0.001$ ) with the MTS hospitals managing a higher percentage of cases with other serious injuries (48-61%) compared to the Austin Hospital (31%). The majority (79%) of SCI cases definitively managed at a non-MTS hospital or the Austin Hospital were cervical SCI cases. Six of the 14 SCI cases managed at a non-MTS hospital died during their admission.

### **In-hospital outcomes**

Sixty-one per cent of SCI cases required an intensive care unit (ICU) stay; 68 per cent of cervical, 62 per cent of thoracic, and 30 per cent of lumbar, SCI cases. The percentage of cases requiring an ICU stay has not changed over time ( $p = 0.548$ ). The median (IQR) length of stay in the ICU was 6 (3-13) days.

The median (IQR) hospital length of stay for SCI cases was 17.2 (8.2-34.9) days, substantially higher than the median length of stay for all Victorian major trauma cases. Unlike all major trauma cases where a decrease in the median length of stay has been demonstrated over time, the length of stay for SCI cases has not changed ( $p = 0.367$ ). The Austin hospital demonstrated the highest median (IQR) length of stay of 21.2 (12.6-41.6) days.

While the percentage of SCI cases that died during their hospital stay did not change over time ( $p = 0.196$ ), there was some variation across the years with in-hospital mortality as low as 6 per cent in 2002-03 and as high as 21 per cent in 2006-07, reflecting the years with the lowest and highest percentage of cervical SCI cases, respectively. Overall, the in-hospital mortality rate was 20 per cent for cervical spine cases and six per cent for thoracic SCI cases. No lumbar SCI cases died during their hospital stay over the seven years.

There were 399 survivors to discharge, of which 80 per cent ( $n = 319$ ) were discharged to an inpatient rehabilitation centre. The remainder were discharged home ( $n = 58$ ), to an aged care facility ( $n = 8$ ), or to another hospital for convalescence ( $n = 14$ ). Of the SCI cases discharged directly home, 52 (41 cervical) were considered incomplete cord injuries according to AIS coding. Where the injury was coded as complete and the patient was discharged directly home from hospital, all were aged less than 45 years. The percentage of cases discharged to inpatient rehabilitation was the same for metropolitan (80%) and regional SCI cases (78%) ( $p = 0.666$ ).

### **6-month outcomes**

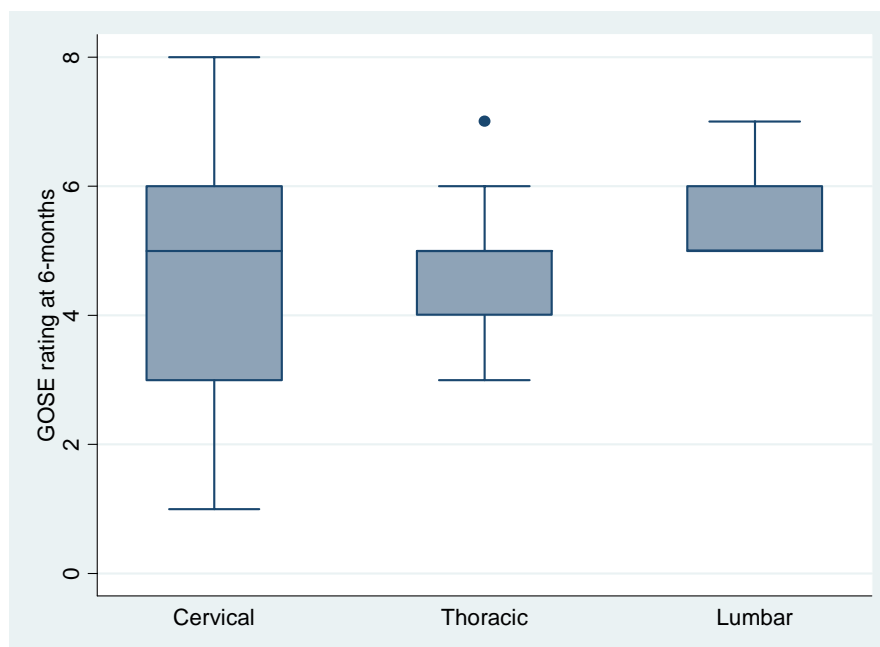
The VSTR has been following-up all adult major trauma patients who survived to hospital discharge, with a date of injury from October 2006, using functional, health status and pain measures, providing 21 months of six-month post-injury data for reporting. There were 85 adult SCI cases who survived to discharge with a date of injury from October 2006 to June 2008. Seventy-five per cent of these 85 cases were successfully followed-up six months following injury. The major reason for loss to follow-up at six months was data arriving too late to the registry to enable a six month follow-up. This relates to the very long lengths of hospital stays of the SCI and delays in receiving data from the primary hospital managing these cases. The follow-up rate for

cases definitively managed at the Austin Hospital was 70 per cent, compared to 94 per cent for the other MTS hospitals.

For all Victorian major trauma patients, a bias towards follow-up of blunt trauma, older, female, unintentional and transport-related injury has been shown. The pattern of loss to follow-up differed for the SCI cases with only 64 per cent of female SCI cases successfully followed-up six months after injury compared to 77 per cent of males. The follow-up rate for non-transport related cases was 87 per cent compared to 64 per cent of transport-related cases. Eighty per cent of non-compensable cases were followed-up successfully compared to 69 per cent of TAC and WorkSafe compensable cases. The differences are likely to relate to the type of patients managed definitively at the Austin with a higher percentage of transport-related and compensable cases definitively managed at the state's MTS for spinal injury (Austin).

Figure 14 shows the functional outcomes of SCI cases by region of injury, according to the Glasgow Outcome Scale – Extended (GOSE). There was one post-discharge death amongst the SCI cases. A GOSE score of five or above indicates that the patient is living independently. Just over half of the cervical (54 per cent) and thoracic (56 per cent) cases were living independently at the six-month follow-up while all five lumbar SCI cases followed-up were living independently. Only two cases were considered to have made a full recovery with no sequelae related to their injury and both of these were incomplete, cervical SCI cases.

**Figure 14: Functional outcome six-months following injury by region of spinal cord injury**



Of the 47 cases (73%) working or studying prior to injury, only 20 per cent had returned to work or study by six-months following injury. All had returned to their previous place of employment but only two thirds reported that their role within that organisation or workplace was unchanged. Almost all of the SCI cases who had returned to work held managerial, professional or associate professional occupations prior to injury.

Thirty-nine per cent of SCI cases reported no pain at the six-month follow-up while 29 per cent reported moderate to severe pain. Reporting moderate to severe pain was most common for thoracic SCI cases (36%).

The health status of major trauma cases is measured by the VSTR using the SF-12. The physical health outcomes of SCI cases by region of injury are shown in Figure 15, with the dashed line representing the Australian population norm for physical health according to the SF-12. The majority of SCI cases reported physical health scores well below the general population norm, and this is consistent with other sub-groups of major trauma.

**Figure 15: Physical Health (PCS-12) outcomes of SCI cases in Victoria six months after injury (dashed line represents Australian population norm)**

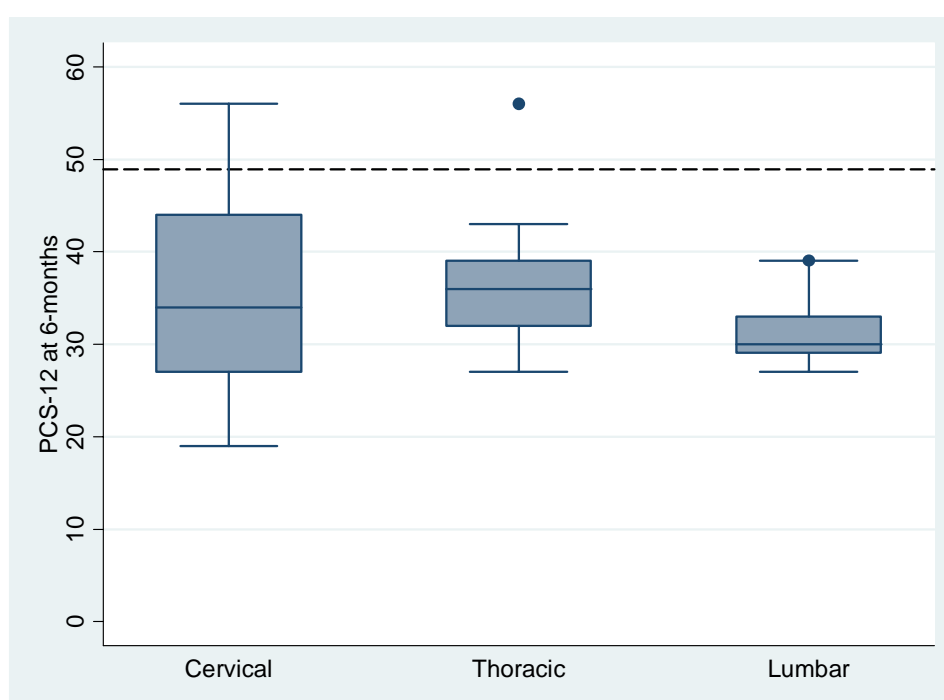
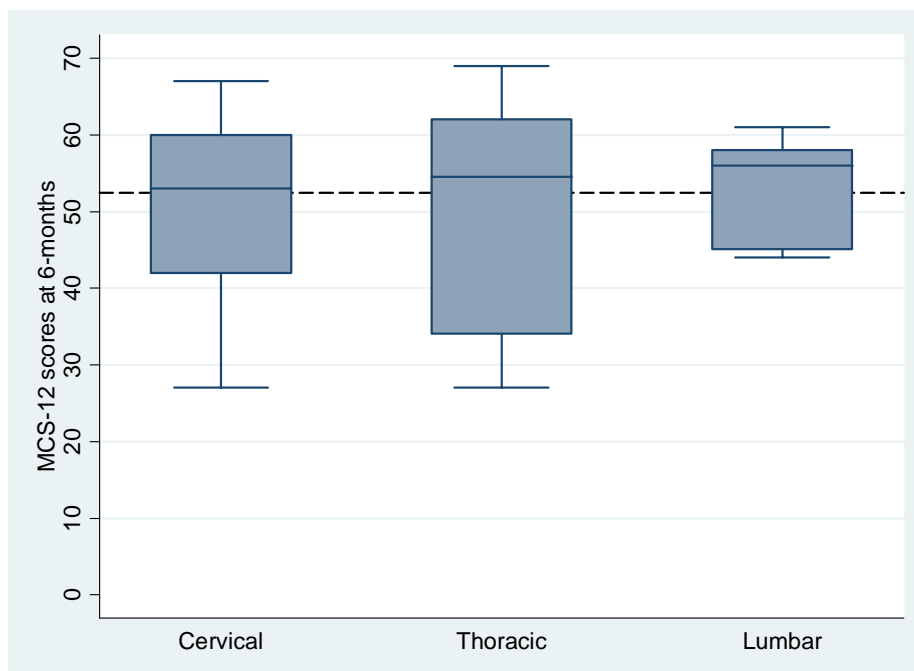


Figure 16 shows the mental health outcomes of SCI cases in Victoria six months following injury as measured by the MCS-12 summary score of the SF-12. In contrast to the physical health findings, SCI cases reported median MCS-12 scores at or above the general population norms for all regions of injury. This is not consistent with other sub-groups of major trauma who generally report physical and mental health scores lower than the population norms at six-months. However, it should be noted that the cohort of SCI cases followed-up was relatively small, and the SF-12 is usually only recommended for reporting health outcomes for 200 or more cases. Nevertheless, the findings provide an indication of the general outcomes of SCI in Victoria.

**Figure 16: Mental Health (MCS-12) outcomes of SCI cases in Victoria six months after injury (dashed line represents Australian population norm)**



## Conclusions

The rate of SCI in Victoria has not changed since 2001 with cervical SCI injuries predominant in the registry data. The majority of cases are managed at the state's specialist facility for spinal injury, particularly when other serious injuries are absent. In contrast to the increase in direct transfers from the scene to the definitive hospital of care noted for all major trauma cases, most SCI cases experience at least one inter-hospital transfer. Despite the challenges of obtaining the data in time to follow-up cases at six-months following injury, the longer term outcomes highlight the functional, physical health and work-related disability experienced by these cases.

## THE VSTORM GROUP

The Victorian State Trauma Outcome Registry and Monitoring (VSTORM) group, based at the Department of Epidemiology and Preventive Medicine at Monash University, coordinate the Victorian State Trauma Registry.

### The VSTORM Chief Investigators are:

- Professor Peter Cameron (Head of the Victorian State Trauma Registry, Monash University)
- Professor John McNeil (Head of Department of Epidemiology and Preventive Medicine, Monash University)
- Dr Belinda Gabbe (NH&MRC Population Health Research Fellow, Department of Epidemiology and Preventive Medicine, Monash University)

All Chief Investigators are members of the VSTORM Steering Committee. Other members of the VSTORM Steering Committee, all of whom have expertise in epidemiology, trauma management or related areas, include:

- Mr Bill Barger (Manager of Metropolitan Ambulance Service Victoria)
- Dr Stephen Bernard (Deputy Director of ICU, Dandenong Hospital)
- Dr Warwick Butt (Staff Specialist in Intensive Care, Royal Children's Hospital)
- Mr Alex Currell (General Manager Strategic Planning, Metropolitan Ambulance Service Victoria)
- Dr David Eddey (Director of Emergency Medicine, The Geelong Hospital)
- Mr Edward Chow (Database Manager, VSTORM)
- Associate Professor Rodney Judson (Director of Trauma, Royal Melbourne Hospital)
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- Mr Owen Williamson (Senior Lecturer, Department of Epidemiology and Preventive Medicine, Monash University)
- Mr Cameron Willis (PhD Student)
- Mr Jason Winnett (Trauma Surgeon, The Alfred Hospital)

## DEFINITIONS OF MAJOR AND POTENTIALLY MAJOR TRAUMA

The Registry has a particular focus on patients who meet the ROTES definition of major trauma. However, in order to ensure complete capture of all Victorian trauma patients fitting the ROTES major trauma definition a wider definition has been adopted for VSTORM. This means that the VSTORM database encompasses a broader spectrum of patients with both potentially major and major trauma.

### **ROTES major trauma definition**

**ALL trauma patients with injury as principal diagnosis IRRESPECTIVE OF AGE who meet ANY of the following criteria**

Death after injury

Admission to an Intensive Care Unit for more than 24 hours, requiring mechanical ventilation

Serious injury to two or more body systems (excluding integumentary)

Injury Severity Score (ISS) > 15

Urgent surgery for intracranial, intrathoracic, or intraabdominal injury, or for fixation of pelvic or spinal fractures

***Source: (Ministerial Taskforce on Trauma and Emergency Services and the Department of Human Services Working Party on Emergency and Trauma Services, 1999)***

To ensure the capture of all major trauma cases fitting the ROTES major trauma definition, the extra criteria for the VSTORM screening definition include patients with injury as principal diagnosis:

- Whose length of stay is 3 days or more;
- Who are transferred to, or received from, another hospital for further emergency care or admission to a high dependency area.

The formal VSTORM inclusion and exclusion criteria are shown below.

**VSTORM major and potentially major trauma screening inclusion criteria**

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**ALL trauma patients with injury as the principal diagnosis  
IRRESPECTIVE OF AGE who meet ANY of the following criteria**

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1. Death after injury.
  2. All patients admitted to an Intensive Care or High Dependency Area >24HRS and who have mechanical ventilation after admission.
  3. Significant injury to 2 or more ISS body regions or ISS>15. AIS>2 in 2 body regions
  4. Urgent surgery for intracranial, intrathoracic, or intraabdominal injury, or for fixation of pelvic or spinal fractures.
  5. Electrical injuries, drowning, asphyxia included if admitted to an Intensive Care Unit and have mechanical ventilation > 24 hours (or death after injury).
  6. All patients transferred to or received from another hospital for further emergency care or admission to a high dependency area - Unless meets exclusion criteria.  
*NB: For patients received from another hospital they must meet any of criterion 1 – 5 or have combined LOS of 3 or more days, as per criterion 7.*
  7. Length of stay is 3 days or more, the exception being transfers out of hospital. This includes combined length of stay for transfers from another hospital. - Unless meets exclusion criteria
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**VSTORM major and potentially major trauma screening exclusion criteria**

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**ALL trauma patients with injury as principal diagnosis who meet any  
one of the following criteria**

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1. Isolated # NOF.
  2. Isolated upper limb joint dislocation, shoulder girdle dislocation (unless associated with vascular compromise) and toe/foot/knee joint dislocation – *Unless meets inclusion criteria 1,2 or 4*
  3. Isolated closed, limb fractures only. (e.g. # femur, Colles # etc) – *Unless meets inclusion criteria 1, 2 or 4*
  4. Isolated injuries distal to wrist and ankle only. (e.g. Finger amputations) – *Unless meets inclusion criteria 1, 2 or 4*
  5. Soft tissue injuries only. (e.g. tendon and nerve injury and uncomplicated skin injuries) – *Unless meets inclusion criteria 1, 2 or 4*
  6. Less than 10% burns only – *Unless meets inclusion criteria 1, 2 or 4*
  7. Isolated eyeball injuries
- Electrocution, Drowning, Asphyxia (Unless these are associated with other injuries or death or patient receives mechanical ventilation for greater than 24 hours)
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