Victorian State Trauma Registry
1 July 2003 to 30 June 2004

Summary report


State Government Victoria

Victorian State Trauma Registry
1 July 2003 to 30 June 2004

Summary report

Victorian Trauma Foundation

State Government Victoria

Prepared by Monash University: Victorian State Trauma Outcome Registry and Monitoring Group

Published by Victorian Government Department of Human Services, Melbourne Victoria

Funded by the Victorian Trauma Foundation

Authorised by the Victorian Government, 555 Collins Street, Melbourne Victoria

Printed by Kosdown Printing, 63-69 Rouse Street, Port Melbourne Victoria 3207

August 2005

(050713)

Contents

List of key indicators

List of tables

List of tables

Foreword

During 2003–04, 1,684 major trauma patients were treated in Victorian public hospitals. The majority of these patients were treated at a Major Trauma Service.

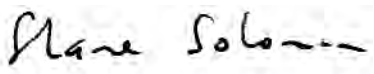
This is the third year of trauma registry data which will provide a robust basis upon which to develop evidence-based policies and practices within the Victorian State Trauma System. Registry data has already been used to inform system development and improve patient outcomes.

It is now possible to make comparisons regarding the operation of the system over a three-year period and to undertake measured planning for the system going forward. Interestingly, in 2003-04, the system recorded the highest number of major traumas since data collection began in 2001-02.

In 2003, the department introduced the Victorian Adult Emergency Retrieval Coordination Service (VAERCS) which has helped to ensure that trauma patients receive care at the most appropriate point.

I would like to take this opportunity to thank the Victorian Trauma Foundation for their ongoing support of this project.

I commend this report to you and look forward to future developments in the Victorian State Trauma System.



Shane Solomon
Under Secretary, Health

Executive summary

A system of trauma care in Victoria was introduced progressively from 2000. The trauma system is maturing and continues to meet ongoing challenges to ensure high quality care across the system. It is not possible to have an effective trauma system without formal monitoring and feedback processes. The Department of Human Services commissioned the Victorian State Trauma Registry as a base component of the trauma system.

This is the third annual report of the registry. Data collected during these first three years has enabled the monitoring of trends in trauma incidence, severity, management and outcomes.

Key points

- A total of 1,684 major trauma patients were treated at 132 hospitals in year three (1 July 2003 to 30 June 2004).
- Over three years, there has been a significant increase in major trauma from 1,393 patients in year one to 1,684 patients in year three.
- In year three, 77.9 per cent of major trauma patients received their care at a major trauma service.
- In year three the death rate was 12.5 per cent. Using the Revised Trauma Score and Injury Severity Score (TRISS) method for risk adjustment, this rate is equivalent to or better than that in Major Trauma Outcome Study hospitals in the United States of America.
- Length of stay has trended downwards over the past three years from 8.8 days in year one to 8.5 days in year three.
- The number of patients with severe functional disability at discharge and six-months post injury is less than expected.
- Almost the same number of patients is discharged to rehabilitation as to home.

The registry's overall goal is to collect information about all patients from every hospital and health care facility managing trauma patients in Victoria. Data are presented for 1,684 major trauma patients treated at 132 hospitals over the 12-month period from July 2003 to June 2004. The inability to report 100 per cent capture of major trauma patients reflects the lack of ethics committee approval from one metropolitan trauma service for the third year of operation. Further discussion of this issue is contained in the limitations and data caveats at the end of the report.

The overall rate of major trauma (presenting to hospitals) is 34 patients per 100,000 population, which is an increase of six patients per 100,000 population compared with last year. The overall major trauma death rate (both in-hospital and at-scene) is 21.3 deaths per 100,000 population.

During the reporting period, 80.5 per cent of all major trauma patients had an Injury Severity Score (ISS) greater than 15 (including those who died in hospital), and 14.9 per cent had a Glasgow Coma Score (GCS) less than nine.[1]

1 If no GCS was recorded at an emergency department or the patient was intubated or sedated on arrival, the patient's pre-hospital GCS value was used. There were 42 patients with no information of GCS.

The data presented in this report provide evidence that hospitals are generally adhering to the major trauma triage guidelines: 77.9 per cent of all major trauma patients received their definitive care at a major trauma service and 1.5 per cent were treated for spinal injury at Austin Health. It is anticipated that the percentage of cases receiving definitive care at a major trauma service and the specialist spinal unit will increase to 85–90 per cent with improved education and training. The remaining major trauma patients received their definitive care at a metropolitan trauma service or regional trauma service. The patterns of transfer across the system indicate patients are being transferred appropriately to a trauma service with a higher designation, unless there is a need for specialist care (for example, spinal cord injury).

Almost the same number of patients were discharged to home as to a rehabilitation centre from their hospital of definitive care. There appears to have been a decrease in the number of patients discharged to rehabilitation centres compared with years one and two. This may reflect the decrease in the number of very severely injured trauma patients (those with an ISS greater than 40).

Overall, 12.5 per cent of all major trauma patients died after arrival at hospital. This death rate is similar to those reported internationally; for example, in trauma systems in the United Kingdom and the United States of America. After adjusting for age, physiologic status and injury severity using the TRISS, the registry cohort has significantly improved survival (probability less than 0.05). The TRISS is an estimate of the probability of survival for individual patients. It is derived from injury severity and other measures of the patient's trauma.

The addition of more detailed outcomes data, including functional disability, will significantly improve the registry's capacity to monitor improvements in system performance. The degree of severe disability at discharge and at six months is less than expected.

The collected data presented in this third annual report and in previous annual reports provide a reliable basis for future monitoring of the Victorian state trauma system. It also represents an important opportunity to improve the outcome for trauma victims, and have already been used to make significant changes to the trauma system.

About this report

This is the third annual report of the Victorian State Trauma Registry and Monitoring Group (VSTORM). The report begins with the rationale for establishing the registry and provides an overview of the progress made during the third year of its implementation.

Data collected during the third and successive year are compared with previous years' data and will provide valuable information for monitoring the performance of the State's trauma system.

This report is divided into two volumes. Volume one describes the registry and its activities and provides summary data to describe the Victorian state trauma system and the major trauma patients treated during the period July 2003 to June 2004. Key indicators of system performance are presented and the profile of Victorian major trauma patients is described. Most of the data in this volume are presented across the whole trauma system and correspond to patient level data. Where the data are aggregated across the trauma service levels, this aggregation is done either on the basis of episodes of care or according to information from either the first or definitive hospital of care, as appropriate. Volume one also contains a glossary of terms and description of the limitations of the database.

Volume two provides additional data for readers who are interested in further tabulations of the registry data. Many of these tabulations describe in greater detail the data according to trauma service level on the basis of episodes of care or according to information from either the first or definitive hospital of care, as appropriate.

Throughout these two volumes, incomplete major trauma data from year one (July 2001 to June 2002) and year two (July 2002 to June 2003) have been updated, and an asterisk in a table cell indicates a count of one to five cases (either patients or episodes of care). To maintain the individuals' full confidentiality, in accordance with privacy requirements, the table cells do not show the actual numbers.

Why a Victorian State Trauma Registry?

The Ministerial Taskforce on Trauma and Emergency Services and the Department Working Party on Emergency and Trauma Services (1999) concluded that injury, including acquired brain injury and permanent disability, is the leading cause of death across all ages (particularly in the one to 44 years age group) in Victoria. Broadly defined, major trauma is those injuries with the highest severity in terms of requiring time-critical specialist care.

Based on recommendations from a ministerial review of trauma and emergency services, known as the ROTES report (Ministerial Taskforce on Trauma and Emergency Services & Department of Human Services Working Party on Emergency and Trauma Services 1999), a new system of trauma care was introduced to Victoria in 2000 in a staged process. This review recognised it is not possible to have an effective trauma system without a formal monitoring and feedback process. It also strongly recommended a state trauma registry be established to ascertain the effectiveness of the Victorian trauma system and to provide ongoing monitoring of major trauma patients. In response to this, the Department of Human Services commissioned the development of the Victorian State Trauma Registry.

The purpose of the registry database is to monitor the statewide system of trauma management in order to reduce preventable deaths and permanent disability from major trauma. Interventions and changes to the system of care can be monitored to ensure outcomes are improving. It is essential to have ongoing data collection to determine the extent of anticipated reductions in death and disability over time.

The registry was established in 2001. The VSTORM group (Appendix 1), based in the Department of Epidemiology and Preventive Medicine at Monash University, coordinates the registry.

The registry aims to collect information on all patients from every hospital and health care facility managing trauma patients across the state. In its third year of operation the registry collected information from 132 facilities (Appendix 2).

The last two annual reports identified major trauma admissions to Victorian hospitals were in the range of 1,400–1,500 patients a year. In this report, the number of major trauma admissions is higher (1,600–1,700) and compares with the estimates based on International Classification of Disease (ICD) discharge data (Jackson, Babbel & Papastamopoulos 2001; Peeters et al. 1999).

What was achieved during the third year?

The third year of the registry saw many achievements in registry implementation, quality and performance. VSTORM now captures the majority of major trauma across the state and provides data to policymakers in a timely manner.

Capture rate

The registry has established formal working relationships with 132 hospitals and health care facilities across Victoria which provided data for the period July 2003 to June 2004. The implemented data collection processes have shown good tracking of trauma patients across the trauma system in Victoria. Linkages of episodes of care across hospitals with both ambulance and coronial data sources have meant patients can be monitored across the continuum of care.

Education

The registry is an important contributor to trauma education and informs health agencies about the status of the trauma system. For example, complete documentation is fed back to the relevant hospitals and the staff are advised of the importance of good data recording. Similarly, the registry helps hospitals with documenting important aspects of care, including monitoring of the GCS.

Issues regarding adherence to the trauma triage guidelines are fed back to metropolitan and regional hospital quality committees and to the State Trauma Committee.

Data collection

All major trauma services submit data electronically, while regional data are submitted on paper forms, which registry staff manually check.

Implementing recording of a functional measure at discharge and six months following injury has improved documentation of morbidity outcomes. It is hoped the trial of electronic data collection in the ambulance services will result in more accurate data collection and linkage of pre-hospital data. VSTORM is actively involved in this development.

Quality assurance

Quality control processes were further developed during the third year of the registry's operation. Extensive daily data management quality assurance processes include recording and checking manual and electronic data forms and running range and consistency data checks. Completeness of pre-hospital data was improved through greater linkages with the Victorian ambulance services. This includes identifying missing ambulance sheets and manually cross-checking pre-hospital data with ambulance data.

Cross-validating registry data with other sources to ensure the highest patient capture rates possible has been an important internal audit process. Where discrepancies are identified, further tracking of patients and episodes of care is undertaken to ensure the registry is complete.

Systems to more effectively link registry data with ambulance records and coronial databases have been developed. Data collection is an ongoing challenge. Data collection processes are undergoing review to ensure even more streamlined flagging and reporting systems in 2005. Notwithstanding these problems, the registry demonstrated a high patient capture rate and improved data quality during its third year of operation.

Comorbidity

The VSTORM Steering Committee has reviewed available co-morbidity measures and in 2004 trialled the Charlson Comorbidity Index (see glossary). Of interest is the fact that adjusting for co-morbidity in the Victorian major trauma population group adds little to risk adjustment for age.

Information dissemination

During 2004, VSTORM prepared eight peer-reviewed journal articles, which were accepted for publication. It submitted another three for consideration in peer-reviewed journals and is preparing a number of manuscripts. A list of publications and presentations is provided after the references list at the end of this report.

Protocols for external requests to access registry data were also developed and are strictly monitored by the VSTORM Steering Committee. No patient level identifying data have been provided to third parties. Only summary or consolidated data are provided.

Finally, data collected by the registry have also been used to help develop local prediction rules for intensive care unit admission. Such prediction rules are useful in guiding pre-hospital triage. Development to date has identified the motor component of the Glasgow Coma Score as the most powerful predictor of an intensive care unit stay. Further work is occurring to assess the ability of ambulance officers to accurately identify severely injured patients. A number of collaborations have been established with the National Trauma Registry Consortium, the National Injury Surveillance Unit, and the Monash University Accident Research Centre.

The complexity of the registry data collection process reflects the complexity of the Victorian trauma service wherein patients can be transferred from hospital to hospital to ensure they receive optimal care. The presentation and analysis of major trauma data will therefore be an iterative process and improvements to the reporting system will continue for some time.

How does the Victorian State Trauma Registry operate?

The registry was established in 2001, with formal data collection commencing in July of that year. The registry does not just evaluate hospital care. It incorporates information from across the entire continuum of care, including pre-hospital services, emergency department, hospital admission and surgery, and in the future will expand to collect data on rehabilitation outcomes and long term quality of life. Data from each phase of treatment at all health care facilities across the state, including both pre-hospital and post-discharge data, are included.

Eligible patients

To ensure the registry captures all major trauma patients in Victoria, broad-based inclusion criteria are used. Anyone who has suffered a 'potentially major' to major trauma is entered onto the registry. The registry captures all trauma patients whose principal diagnosis is injury, irrespective of age, and who meet any of the VSTORM criteria (Table 1). The first four criteria are based on those recommended in the ROTES report (Ministerial Taskforce on Trauma and Emergency Services & Department of Human Services Working Party on Emergency and Trauma Services 1999) and the remaining criteria are screening filters to capture the wider population of potentially major trauma patients.

Table 1: The Victorian State Trauma Registry patient inclusion criteria

1. All deaths after injury
2. All patients admitted to an intensive care unit or high dependency area for more than 24 hours and mechanically ventilated after admission
3. Significant injury to two or more ISS body regions (corresponding to Abbreviated Injury Score (AIS) of greater than two in two or more body regions) or an ISS greater than 15
4. Urgent surgery (within 24 hours of injury) for intracranial, intrathoracic or intraabdominal injury, or fixation of pelvic or spinal fractures
5. Electrical injuries, drowning, asphyxia included if admitted to an intensive care unit and have mechanical ventilation for longer than 24 hours
6. All patients with injury as principal diagnosis whose length of stay is three days or more – **unless they meet exclusion criteria**
7. All patients with injury as principal diagnosis transferred or received from another hospital for further emergency care or admitted to a high dependency area – **unless they meet exclusion criteria**

Specific exclusion criteria are listed in Table 2.

Table 2: The Victorian State Trauma Registry patient exclusion criteria

1. Isolated fractured neck of femur
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 (for example, fractured femur, Colles fracture) – **unless meets inclusion criteria 1, 2 or 4**
4. Isolated injuries distal to the wrist and ankle only (for example, finger amputations) – **unless meets inclusion criteria 1, 2 or 4**
5. Soft tissue injuries only (for example, tendon and nerve injury and uncomplicated skin injuries) – **unless meets inclusion criteria 1, 2 or 4**
6. Burns to less than 10 per cent of the body – **unless meets inclusion criteria 1, 2 or 4**

Data capture

Data coordinators collect data at the major trauma services and data collectors employed on a casual basis collect data at the metropolitan trauma services and metropolitan primary care services. Regional trauma data collection is the responsibility of regional trauma coordinators employed in each of the five regional areas: Barwon South West, Gippsland, Grampians, Loddon-Mallee and Hume.

In-hospital flagging systems have been established to identify eligible patients. Data coordinators at the three major trauma services prospectively identify trauma patients by checking the hospital information system, emergency department admission records, intensive care unit admission records and ward rounds with the trauma service daily. The metropolitan data collectors and regional trauma coordinators undertake retrospective data collection. Regional trauma coordinators have established individual flagging mechanisms in their hospitals of responsibility and are notified when a regional hospital receives a trauma patient.

The regional trauma coordinators also make frequent telephone calls to the services within their region to maintain contact and the registry's profile. Trauma patients are identified by manually checking emergency department registries, by checking intensive care unit registries, or by retrospectively running reports using ICD-10 codes to identify patients with injury as their principal diagnosis. These reports are set up to include length of stay, intensive care unit admission, and outcome (to identify transfers and deaths).

Relevant data are extracted from the medical records maintained at the hospitals and health care facilities that provided any service to a major trauma patient during their episode of care. The extracted information is recorded onto a registry data collection form with specified data fields and formats. During the third year, all major trauma services provided this information to the registry electronically.

Registry training

To ensure all trauma data coordinators and collectors designated to collect data for the registry collect data in a standardised format, VSTORM regularly conducts formal training sessions and workshops. This includes training in registry procedures, data collection/extraction processes and definitions of data variables. VSTORM periodically offers Abbreviated Injury Scaling (AIS 90, Update 98) training courses to the data collectors. Data collectors are provided with updated data forms, data dictionary and manuals as necessary.

Registry data quality assurance

Every effort is made to ensure the trauma patient data the registry captures are complete and as accurate as possible. Quality control measures include training trauma coordinators and data collectors. Validation rules have been put in place and missing data are continually addressed.

VSTORM conducts extensive data checks before the data are entered onto the registry. These checks initially involve ensuring the key patient identifying data items of patient surname, date of birth, and date of injury have been recorded. If this information is not available from the original source data (the medical records), VSTORM attempts to complete the data records from other relevant sources. Alternatively, it notes data fields as being 'not documented' in the original data records. The data checking process then involves examining the completeness and accuracy of all data elements as outlined in the following two examples.

Injury data: To ensure consistency, the codes for human intent, injury cause, activity, place and type are cross-checked with the text being used to describe the 'incident details'. Discrepancies are followed up through the patient's medical record if necessary.

Date/time of injury: Because of the importance of collecting information across each patient's entire continuum of care, the date and time of injury are checked to ensure they strictly correspond to the order of care provided to the patient. For example, the date and time of the ambulance call, the time to arrive at the scene, the time to depart, the time to arrive at hospital must be in a logical sequence. If the patient is transferred through to another designated trauma service level, the dates and times of the transfer must also be recorded in the correct sequence. These rules have also been built into the database on data entry.

Clinical data: The accuracy of the AIS code allocated to each individual injury and the corresponding ISS body region is carefully checked. Data describing the operations and procedures are also checked to ensure the codes match the description and correspond to the injuries received by the patient.

VSTORM also thoroughly checks the manually collected data before they are entered onto the computerised database for completeness and accuracy. When missing or inaccurate data are identified, the relevant data collector is notified. Any alterations to the paper data form are signed. VSTORM also provides each data collector with a feedback list of common mistakes or issues arising during data collection and advice on how to correct these.

Validation rules have been built into the electronic data entry system. These require that certain data items be completed before moving to another data item and before an electronic data form can be closed. For example, the hospital code must be entered before a form can be closed and no dates can be entered that occur before the date of injury.

Following data entry, and before running any database queries for reporting, a series of data verification procedures are run. These include range checks to identify extreme values that lie outside a valid range.

Further checks are performed to ensure complete capture of all Victorian trauma patients fitting the major trauma definition. Capture–recapture methods are used to cross-reference different data sources. For example, the registry death records are compared against those recorded by the National Coronial Information System based at the Monash University National Centre for Coronial Information and the Registry of Births, Deaths and Marriages. Where possible, metropolitan and rural ambulance patient care records are checked to identify all ambulance contacts with a patient who has had a traumatic event. This is to ensure all patients meeting the inclusion criteria have been identified and relevant data collectors are duly notified. Once a patient has been entered on the registry, data collectors are contacted to obtain and complete any missing information for episodes of care.

Patient confidentiality

The registry was established under the guidelines of the National Health and Medical Research Council to ensure confidentiality and privacy of patients are maintained at all times. For the reporting period, ethics committee approval was obtained from each hospital and health service before any data on trauma patients was collected (Appendix 2). Approval was also obtained from the ethics committees of the Department of Human Services, Monash University and the National Coronial Information System.

As the registry collects personal details of patient care, it is imperative that confidentiality is maintained at all times. All paper data forms and the electronic database are securely stored. Paper forms are stored in locked filing cabinets. Personal identifying information is stored separately from the main body of the data collection form.

Only staff members directly employed by the registry have access to patient information. Access to the registry database is password-protected and user-level security limiting which parts of the database a particular staff member can access or change has been implemented.

How many major trauma patients were there during the period July 2003 to June 2004?

This section provides information about the number of major trauma patients (both patients reaching hospital and deaths at the scene of injury) in Victoria during the 12-month period from 1 July 2003 to 30 June 2004. These data are limited because not all Victorian trauma hospitals contributed to the data collection during this period. An estimate of the registry coverage is provided.

Major trauma patients

The registry recorded 1,684 major trauma patients in Victoria over the 12-month period. The number of major trauma patients for each quarter is shown in Key Indicator 1. This seasonal trend is a key indicator of the activity of trauma services over time. There were more major trauma patients during the warmer months of January to March than at any other time in all three years of the registry's operation.

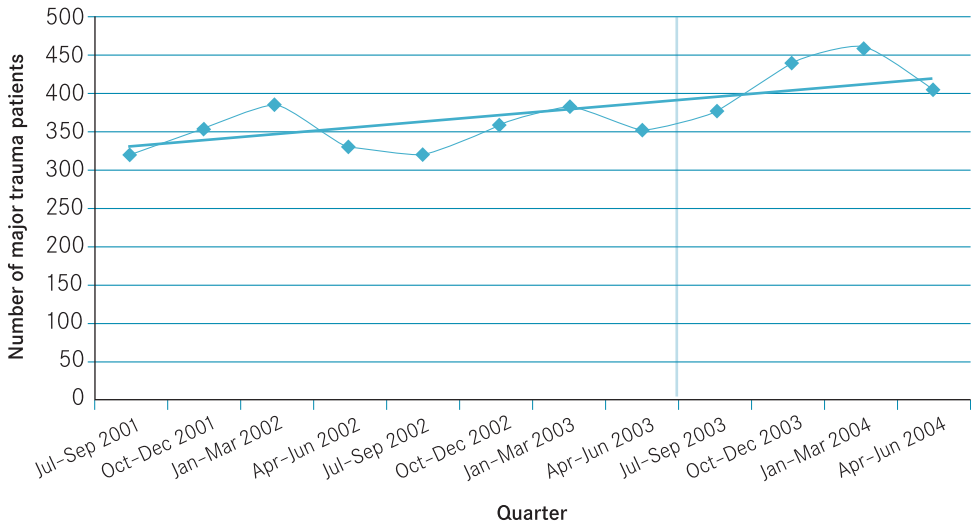
The overall annual rate of in-hospital major trauma in Victoria during year three was 34 per 100,000 population.[2] This is an increase from the first year's overall annual rate of 30 and the second year's overall annual rate of 28 major trauma patients per 100,000 population. The reasons for this increase are unclear. A proportion may be due to more complete data entry and the inclusion of major trauma patients at St Vincent's Hospital from July 2003.

2 This rate is based on the Australian demographic statistics for 2004 of 4,972,800. (Australian Bureau of statistics website 2005)

KEY INDICATOR 1 – Number of major trauma patients

The registry recorded 1,684 major trauma patients during the period July 2003 to June 2004.

Figure 1: Seasonal trends in the number of major trauma patients



Episodes of care

The 1,684 patients required a total of 2,270 hospital care episodes. The majority (1,141 or 67.8 per cent) required only one episode of care, 500 (29.7 per cent) experienced two episodes of care, and 43 (2.6 per cent) patients had three episodes of care. Forty-nine per cent of patients (818 patients) required an intensive care unit admission. For all hospitals and health services, the intensive care unit admissions were identified as patients with an intensive care unit length of stay of more than zero minutes, or were identified from the disposition from the emergency department. Thirty-five per cent of patients (587 patients) had an intensive care unit length of stay requiring mechanical ventilation of more than 24 hours. Seasonal variation has resource implications in terms of intensive care unit beds and on-call and theatre arrangements. This will continue to be monitored over the following years.

Deaths

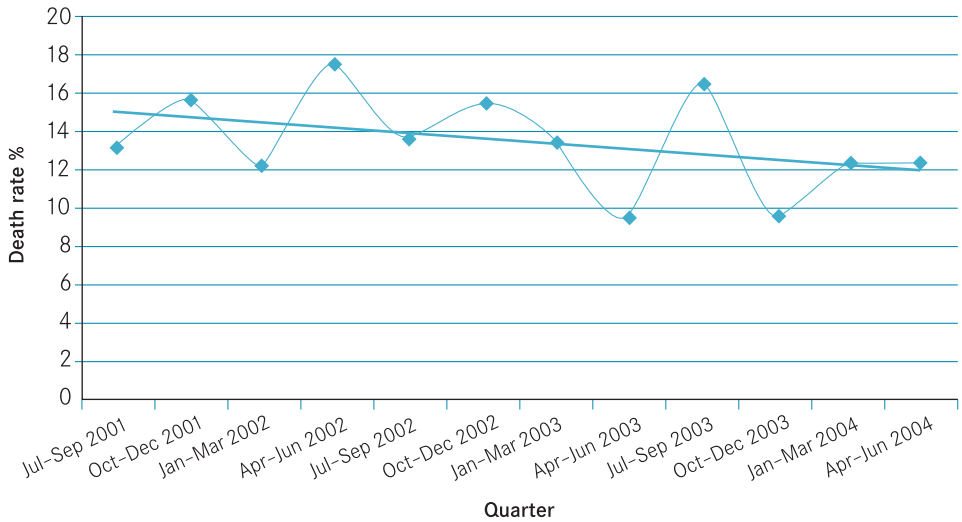
Overall, the registry recorded 211 deaths in the 1,684 major trauma patients. This corresponds to an overall death rate of 12.5 per cent among the hospitalised major trauma patients. This death rate excludes patients who may have died because of trauma-related injuries after discharge from their acute hospital stay. This is a major deficit, which is experienced by many trauma registries internationally. To rectify this deficit, collecting post-discharge outcome data from all patients has commenced and linkage with the Victorian Registry of Births, Deaths and Marriages has been established.

KEY INDICATOR 2 – Death rates

The overall death rate due to major trauma in Victoria is 21.3 deaths per 100,000 population.[3]

The rate of in-hospital major trauma deaths is 12.5 per cent of all patients.

Figure 2: Seasonal trends in the death rate of major trauma patients



3 This rate is based on the Australian demographic statistics for 2004 of 4,972,800.

Table 3: Difference in death rate of major trauma patients for each quarter relative to year one

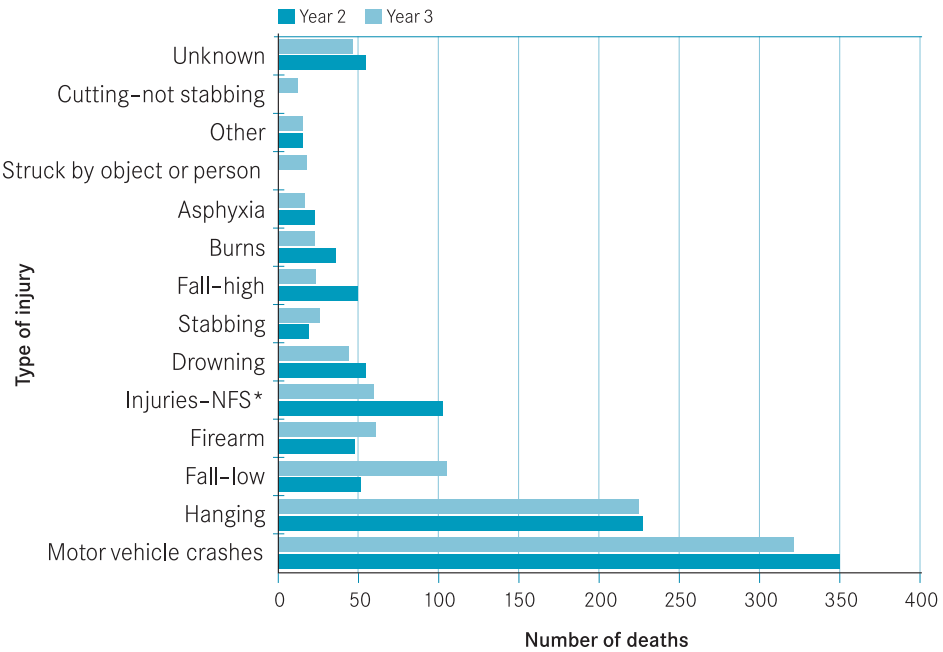
	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Differences in death rates	+3.2%	-5.9%	0.0%	-5.2%

Note: A negative value is a drop in death rate and a positive value is an increase in death rate compared with the same quarter in year one.

The death rate in year one was 14.6 per cent, in year two it was 13 per cent, and in year three it was 12.5 per cent. The observed decrease in the death rate in years two and three could be due to improved trauma management. There has also been a reduction in injury severity among major trauma patients.

The National Coroners Information System recorded 997 trauma deaths (excluding fractured neck of femur deaths) from July 2003 to June 2004 in Victoria. At the time of writing this report, coronial investigations were closed (completed) on 67 per cent of these deaths. Of the 211 VSTORM-recorded deaths, 176 (83.4 per cent) were reported in the Coroner's database. Of the remaining 35 VSTORM-recorded deaths, 34 were of patients who were elderly or had co-morbidity, who fell and were possibly not referred to the Coroner. The estimated number of trauma deaths in Victoria, at the scene or in hospitals, is 1,060 cases a year (997 complete on the National Coroners Information System; 18 on the National Coroners Information System but incomplete; ten not identified as trauma by the National Coroners Information System; and 35 on VSTORM but not found on the National Coroners Information System). There are an additional 110 cases in which the Coroner has not determined if the cause of death is natural or external.

Figure 3: National Coroners Information System trauma deaths**



** NFS = not further specified. Injuries – NFS includes deaths as a result of injuries with mechanism not further specified.*

*** All traumatic deaths reported to the Coroner are included for years two and three only.*

For year three, the major causes of death were motor vehicle crashes (32.3 per cent), hangings (22.1 per cent) and falls (high and low) (11.7 per cent). In comparison to year two, the number of deaths due to motor vehicle crashes declined and the number of deaths due to low falls increased. Low falls generally relate to elderly patients.

As most of the patients who die from hanging, drowning or asphyxia do not reach hospital alive, these cases will generally not be included on the VSTORM database (only eight attempted hangings were recorded in year three). The low number of stabbings in the National Coroners Information System database is consistent with the low numbers in the VSTORM database. The number of deaths for 2003-04 appears lower than for 2002-03.

Registry coverage

Estimates of the number of major trauma patients in Victoria using ICD-9 conversion to ISS have been as high as 1,790 + 162 (Jackson et al. 2001). The number of major trauma patients in year three (1,684) falls within this estimated range. Patient coverage is estimated to be greater than 90 per cent of all trauma cases that reach hospitals alive in Victoria. Patients treated at hospitals without ethics committee approval and subsequently transferred to a major trauma service are included in the registry.

Reason for inclusion in the registry database

For year three, a hierarchical classification was used to classify patients as meeting the major trauma definition for registry inclusion. Patients were only counted once and the hierarchical order was:

1) death

2) ISS greater than 15

3) intensive care unit stay greater than 24 hours requiring mechanical ventilation

4) urgent surgery.

For example, if the reason for a patient being classified as a major trauma patient was death, then that person was not counted within the 'ISS greater than 15', 'intensive care unit stay greater than 24 hours with mechanical ventilation' or 'urgent surgery' reason classifications, even if these criteria were also met.

Overall, the distribution of the 1,684 registry patients according to this hierarchical classification is:

- 12.5 per cent of patients died.[4]
- 70 per cent of patients had an ISS greater than 15.
- 5.7 per cent of patients spent more than 24 hours in an intensive care unit with mechanical ventilation.
- 11.8 per cent of patients required urgent surgery.

4 Of these, 66.9 per cent had an ISS greater than 15.

Demographic profile of major trauma patients

Consistent with other international and local trauma registries and injury surveillance systems (Neale, Kassulke & McClure 1998; American College of Surgeons 2004 South West Sydney Area Health Service 2000), the majority of injured patients were male (69.4 per cent). The predominance of males was consistent across all age groups. Young adults (aged 15-24 years) accounted for 21.1 per cent and 21.4 per cent were aged over 65 years. There were relatively few paediatric (aged zero to 14 years) major trauma patients (6.8 per cent of the total) compared with adults.

What are the causes and location of the events leading to a major trauma?

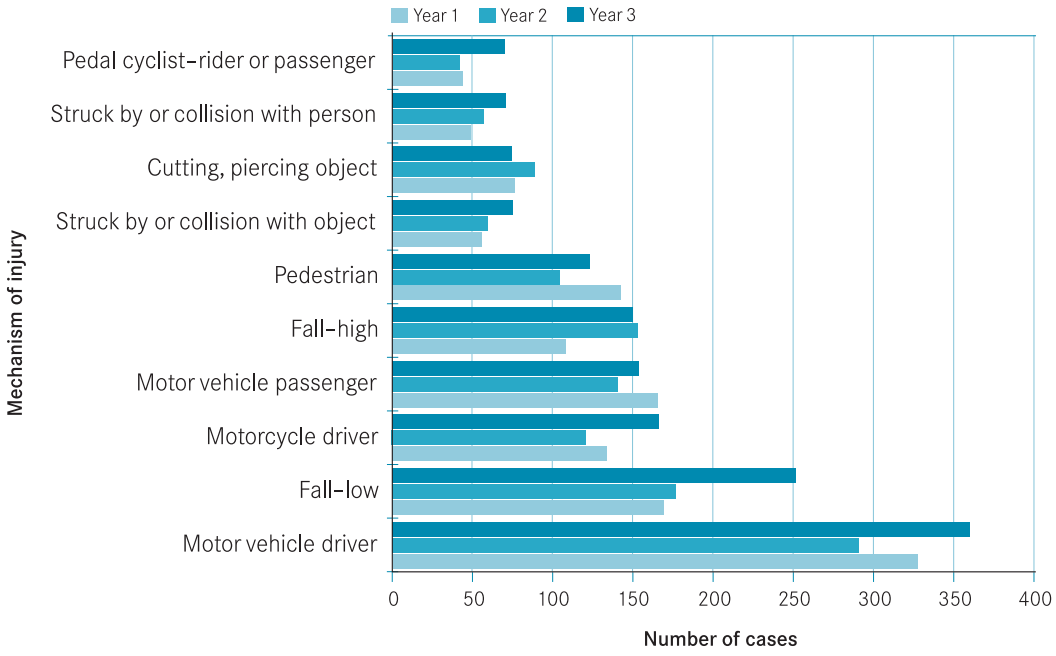
Cause and location

The most common location for the event leading to major trauma was a road, street or highway (52.1 per cent of all major trauma patients with a known location). As many road trauma victims sustain serious and multiple trauma, the preponderance of this type of trauma places an increased burden on the trauma service delivery system. The home was the next most common location of injury (20.7 per cent of major trauma patients with a known location). Over half of the at-home injuries were the result of a fall (60 per cent). Workplace settings (including farms) were a small, but significant, location of injury (8.8 per cent of all patients).

The ten most common mechanisms of injury are shown in Figure 4. Together these accounted for 88.9 per cent of all major trauma patients. Overall, 21.3 per cent of patients sustained their injury as a driver in a motor vehicle crash. These motor vehicle drivers were most commonly male (65.9 per cent of all injured drivers) and in the age group 15–24 years (31.8 per cent of all injured male drivers). Other mechanisms of road trauma were also common, consistent with road, street or highway being the most common location of injury. Compared to year one and year two figures, the total number of motor vehicle-related crashes resulting in major trauma increased during year three (see Figure 4); however, the percentage of motor vehicle crashes has decreased since year one.

The largest increase in the number of major trauma victims was in the low falls group. The reason for this is unclear. A low fall was the cause of injury for 15.1 per cent of patients, which is an increase from previous years (this might partly be due to the inclusion of data from St Vincent's Hospital). The majority of these patients (81.5 per cent) were aged over 55 years. At the broad population level, low falls in older people commonly result in a fractured neck of femur; however, the registry excludes patients with a fractured neck of femur as their sole injury and only eight of the older falls patients had this injury in combination with other injuries. Nonetheless, the relatively high incidence of falls in older people captured by the registry is consistent with the Commonwealth Department of Health and Ageing's ranking of falls as a priority injury prevention goal (National Injury Prevention Advisory Council 1999).

Figure 4: The ten most common mechanisms of injury in Victorian major trauma patients



Transport Accident Commission compensable patients

Information was obtained from hospital records about whether or not the patient was likely to be able to claim for their trauma care costs from the Transport Accident Commission (TAC). Overall, 46 per cent of patients were likely to be TAC-compensable. This percentage is compatible with the high proportion of road trauma patients (53.3 per cent).

The proportion of TAC patients receiving their care at a major trauma service is high (88.8 per cent). This is expected given the trauma triage guidelines suggest a low threshold for transfer to major trauma services in cases involving a high-speed mechanism (mechanism is not a reason for transfer in itself).

Injury intent

Overall, 87 per cent of all major trauma patients sustained their injuries during unintentional events. This is higher than figures reported in Queensland (Neale et al. 1998) and the United States (American College of Surgeons 2004). Intentional self-harm accounted for 3.7 per cent of all patients. This reflects the fact that while intentional self-harm causes many deaths (Steenkamp 2000), major injury from self-inflicted violent mechanisms requiring hospital care is relatively uncommon.

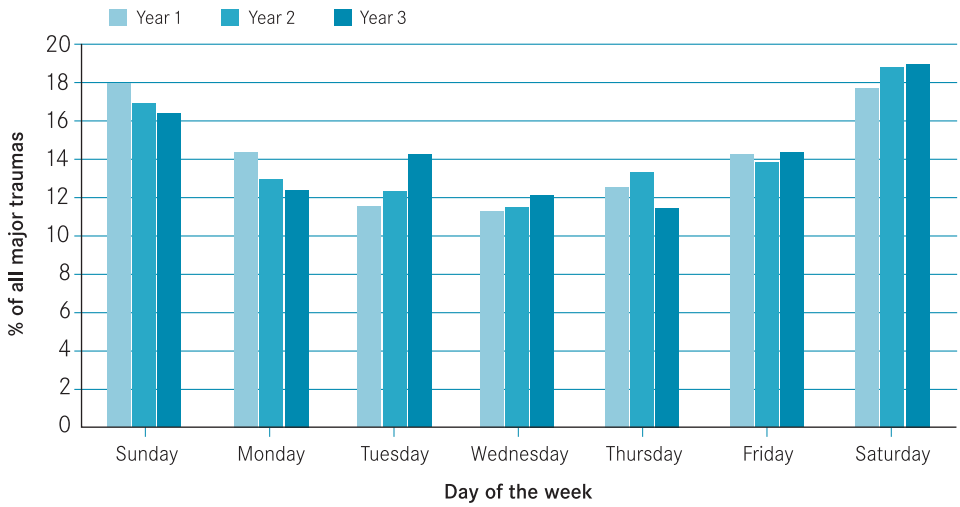
Time and day of injury

Injuries occurred more frequently on weekends, particularly Saturdays (18.9 per cent of all patients), than during the week. Injuries were also more common during the hours of 8 am to 4 pm (43.6 per cent of all patients). This is in contrast to year one and year two when injuries were more common during the hours of 4 pm to midnight.

KEY INDICATOR 3 – Time and day of injury

Injuries were most common on the weekends and during the hours of 8 am to 4 pm.

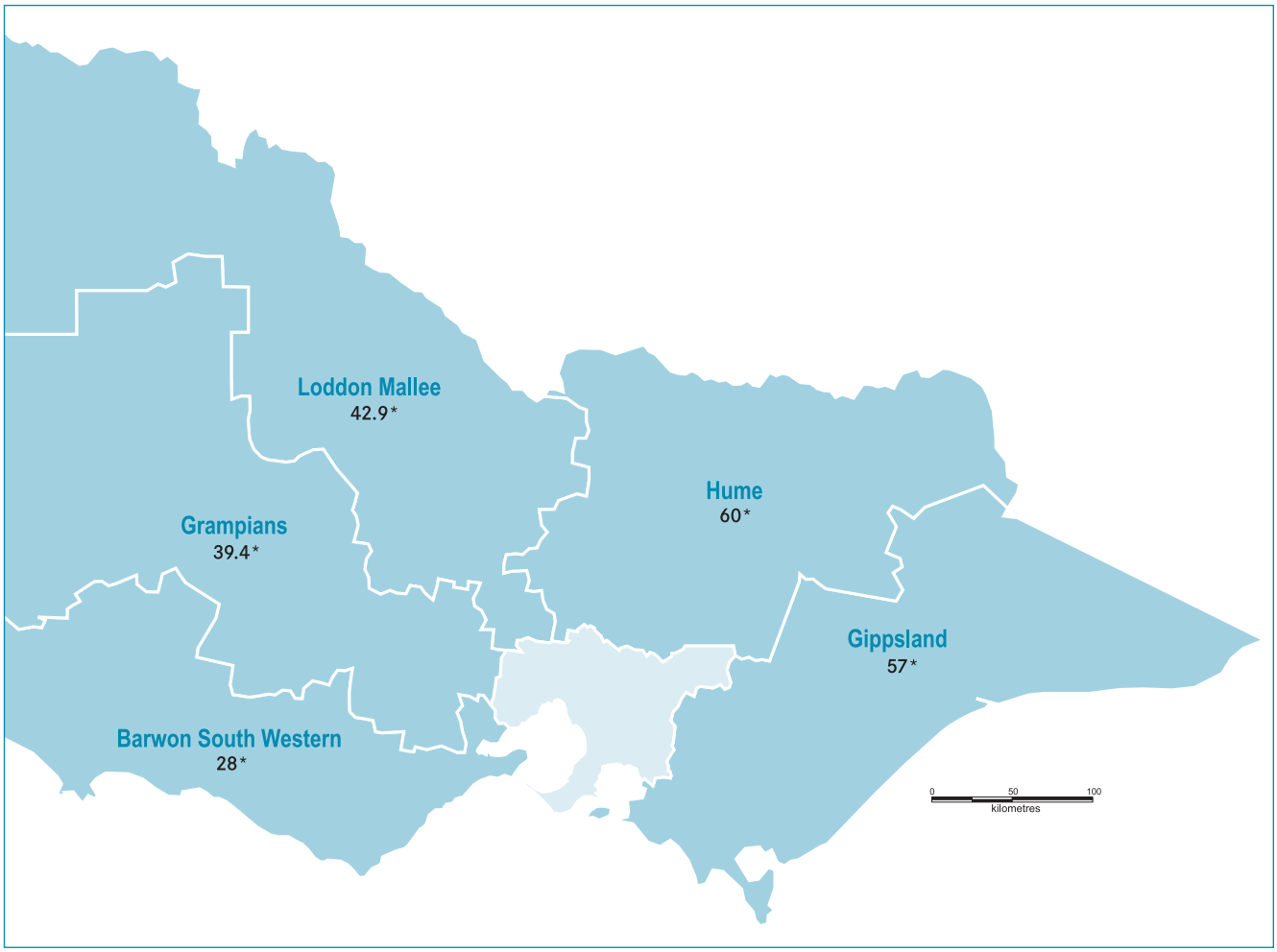
Figure 5: Day of injury for major trauma patients



Location of trauma injury

The following figures show the incidence of major trauma patients for each of the five regional areas of Victoria and metropolitan Melbourne. Figures 6 and 7 indicate a higher incidence of patients injured within the eastern regions of country Victoria and within southern metropolitan and north and west metropolitan Melbourne. This might be related to the types of roads in these areas and possibly to high tourist movement. It should also be noted that major regional cities are present in Barwon South West, the Grampians and Loddon Mallee regions. With linkage to the VicRoads data, it should be possible to determine whether there are particular sites within these regions resulting in high major trauma incidence. The low incidence rate in the eastern metropolitan area does not reflect the true rate due to the lack of ethics approval from the main hospitals within this region. It must also be noted there were a number of patients injured outside Victoria who received definitive treatment within the Victorian trauma system. These patients include 37 who were injured in New South Wales, three injured in Tasmania, one injured in South Australia and one injured in Western Australia.

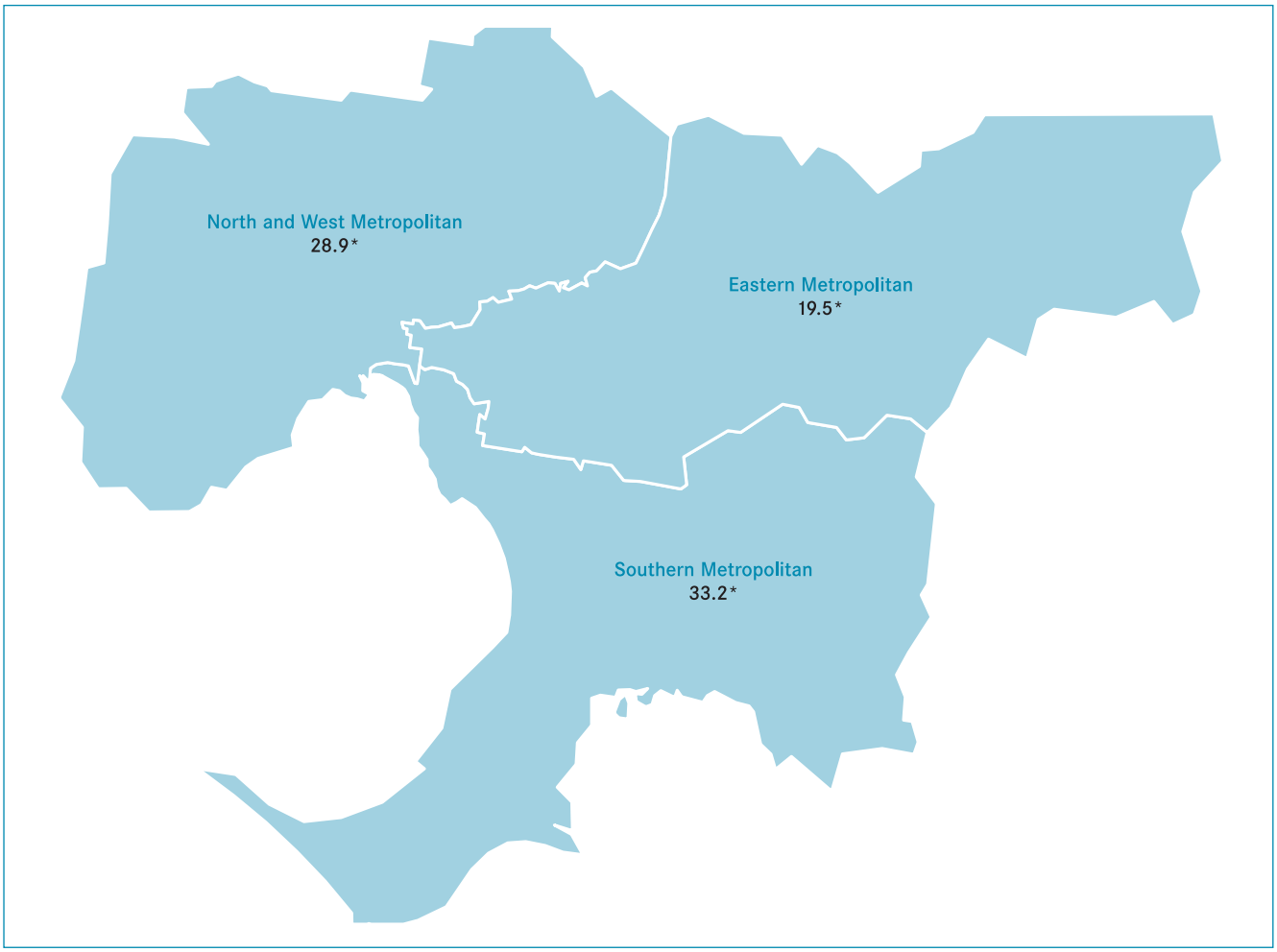
Figure 6: The incidence of major trauma patients in each region of Victoria



* Rates are per 100,000 population.

Note: One hundred and forty-eight trauma patients did not have an injury postcode and are not represented on the map (8.8 per cent).

Figure 7: The incidence of major trauma patients in each region of metropolitan Melbourne



* Rates are per 100,000 population.

Note: One hundred and forty-eight trauma patients did not have an injury postcode and are not represented on the map (8.8 per cent).

Trauma profile

Multiple trauma

The 1,684 patients sustained a total of 9,966 injuries. The distribution of the number of injuries across patients is: 23.6 per cent of patients had one to two injuries, 21.3 per cent had three to four injuries, and 54 per cent had five or more injuries (1.1 per cent of patients were not classified as having injuries because asphyxia and drowning do not always have an injury code). Road trauma victims commonly sustain multiple injuries and are responsible for the majority of polytrauma cases.

Type of trauma

Traumatic injury is generally classified into blunt, penetrating or burn injury types based on the mechanism of injury. Excluding burns patients, the majority of patients captured by the registry were in the blunt trauma category (90.4 per cent). This is consistent with data from the Australian National Trauma Registry Consortium (92 per cent), but less than the rate of blunt trauma in the United Kingdom (97.3 per cent) (Lecky et al. 2000) where burns are excluded from the total trauma population.

The profile of injury types has implications for the design of Victoria's trauma delivery systems. A low incidence of penetrating trauma reduces the need for urgent laparotomy and thoracotomy, while blunt head, chest and orthopaedic injuries, which constitute the majority of patient injuries, generally require critical care monitoring, supportive care and less time-critical surgery.

Injury severity

KEY INDICATOR 4 – Overall injury severity

Of all major trauma patients, 80.5 per cent had an ISS greater than 15.

Overall, 80.5 per cent of major trauma patients had an ISS greater than 15. This shows a downward trend from year one and year two. The median ISS for the three years has remained consistent at 20.

Significantly, there was a decrease in the number of patients with an ISS greater than 40 in year two (6.6 per cent) and year three (7.2 per cent) compared with year one (10.6 per cent) (Table 4). This decrease in injury severity could reflect an improvement in the trauma system. There have also been road safety interventions, including attempts to reduce speed in urban areas, which might have contributed. As the number of road deaths has decreased concurrently, it is likely this fall represents success in injury prevention.

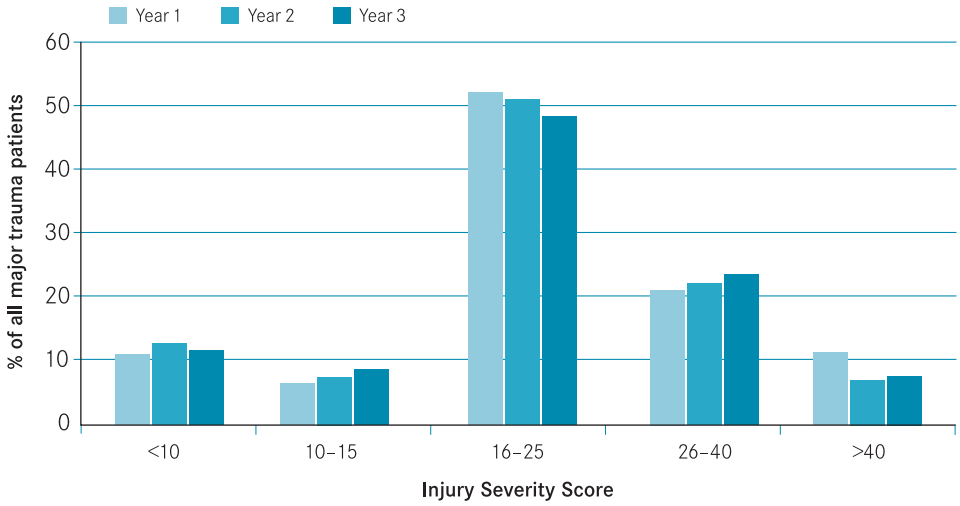
Table 4: Injury Severity Score of major trauma patients for each quarter

Percentage of patients by ISS		ISS >15 (%)	ISS >40 (%)
Year 1	July 2001 to June 2002	82.8	10.6
Year 2	July 2002 to June 2003	80.2	6.6
Year 3	July 2003 to June 2004	80.5	7.2

Injury severity (AIS and ISS levels)

Severe injuries are defined as those with an AIS severity code greater than two. Across all major trauma patients, the ISS ranged from one to 75, with a median of 20. The distribution of ISS shows that almost half of the major trauma patients had ISS scores in the range 16–25 (48.5 per cent). This reflects the 'ISS greater than 15' registry inclusion criterion for defining major trauma patients. Patients with an ISS less than 15 met the 'death' criteria, 'urgent surgery' or 'intensive care unit stay greater than 24 hours requiring mechanical ventilation' criteria.

Figure 8: Distribution of Injury Severity Scores across all major trauma patients



Head injury severity (GCS)

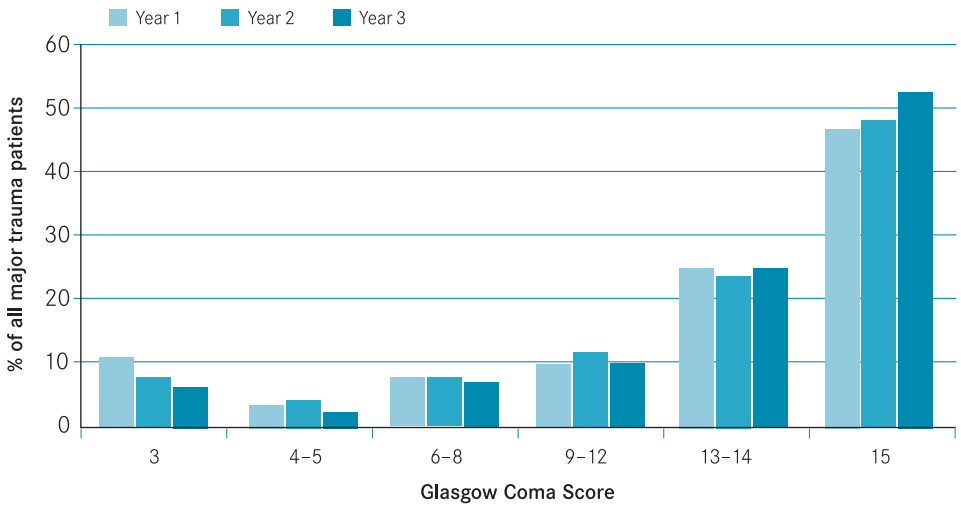
The median GCS on arrival at an emergency department was 15 (range: three to 15). Figure 9 shows the GCS of patients on arrival at an emergency department. Patients demonstrating a GCS less than nine are known to have poor outcomes.

For year three, the proportion of major trauma patients with a GCS less than nine was 14.9 per cent compared with 18.3 per cent in year two and 20.5 per cent in year one. The pre-hospital GCS is reported where no GCS was recorded in the emergency department or where the patient was sedated or intubated on arrival at the emergency department (Figure 9). Previously, many of the more severe head injuries were not included in Figure 9 because the patients were intubated in the pre-hospital setting. Using the pre-hospital GCS immediately prior to intubation now means these cases are included.

KEY INDICATOR 5 – Head injury severity

Of all major trauma patients, 14.9 per cent had a GCS less than nine.

Figure 9: The Glasgow Coma Score for all major trauma patients on arrival from scene to first emergency department[5]



5 If no GCS was recorded at an emergency department or the patient was intubated or sedated on arrival, the patient's pre-hospital GCS value was used. There were 42 patients with no GCS information (one patient with burns and 25 patients with an ISS less than 15).

How were the trauma patients distributed across the trauma system?

Along the continuum of patient care, the hospital of definitive care is defined as the hospital that provided the patient's definitive treatment for their injuries. Different complexities of trauma care are provided at each level, with the major trauma service usually providing the highest complexity of care.

In all three years, the data indicate the vast majority of patients received their definitive care at a major trauma service. This is a higher proportion than was expected in the ROTES report (Ministerial Taskforce on Trauma and Emergency Services & Department of Human Services Working Party on Emergency and Trauma Services 1999). The proportion has fallen slightly this year as a result of the inclusion of data from St Vincent's Hospital. A further 1.5 per cent of major trauma patients with spinal injury were transported to the Austin Hospital.

KEY INDICATOR 6 – Definitive trauma service level

	Percentage of major trauma patients (%)		
Trauma service level	**Year 1**	**Year 2**	**Year 3**
MTS	79.1	80.7	77.9
MeTS	14.2	12.1	14.6
MPCS	0.0	0.0	1.0
RTS*	5.4	6.4	5.5
UCS	0.0	0.0	0.1
PCS	1.3	0.8	1.0

MTS = major trauma service; MeTS = metropolitan trauma service;
MPCS = metropolitan primary care service; RTS = regional trauma service;
UCS = urgent care service; PCS = primary care service.

Pre-hospital care and quality indicators

This section describes the pre-hospital phase of care and provides quality indicators associated with this care. Volume 2 provides further breakdown of this data by type of ambulance service (that is, the Metropolitan Ambulance Service, the Rural Ambulance Victoria, and Air Ambulance Victoria). This section is limited by the extent to which the registry data collection processes were able to capture information from the hospital medical records, which may lead to biased data. VSTORM is working closely with the Metropolitan Ambulance Service, the Rural Ambulance Victoria, and Air Ambulance Victoria to ensure complete and accurate data capture. Ultimately, an electronic record will be the best solution. It is anticipated that the Victorian Ambulance Clinical Information System (VACIS) will be implemented in 2005, enabling electronic capture of data from the pre-hospital phase.

For all patients directly transported from the scene of injury by an ambulance service in year three (1,454 patients), the time and date of the received call were available for 1,161 patients (79.8 per cent). This compares with 76.2 per cent of patients in year two and 68.3 per cent in year one. The time and date of arrival at the hospital were available for 1,329 patients (91.4 per cent) in year three, compared with 90.3 per cent in year two and 87.1 per cent in year one. These figures suggest a steady improvement in the quality of pre-hospital data recording over the past three years.

Pre-hospital transit times

The median time from receipt of the ambulance call until arrival at the first hospital was 55 minutes (range: seven to 471 minutes) for non-entrapped patients and 76 minutes (range: 31 to 273 minutes) for entrapped patients.

Time at scene[6]

Overall, the median time at the scene for entrapped patients was 32 minutes (range: seven to 177 minutes) and 21 minutes (range: one to 260 minutes) for non-entrapped patients. There was considerable variation in the times 'at scene' both within a particular ambulance service and across different services. As would be expected, the at-scene time was generally shorter for non-entrapped patients for all three ambulance services. Generally, patients serviced by Air Ambulance Victoria had a longer scene time than other patients. This reflects the likely severity of traumatic injuries sustained by patients requiring air transport, as well as the distances associated with aviation ambulance services to regional and rural Victoria.

6 Scene time could only be calculated for patients with both a recorded time of arrival at scene and time of departure from scene. Although this information is recorded on ambulance patient care records, the registry data collectors were not always able to extract this information from the hospital medical records.

Quality assurance indicators

1. **Pre-hospital time >1 hour.** For this indicator, 41.4 per cent of the non-entrapped patients and 69.4 per cent of entrapped patients had a total time from receipt of the ambulance call to hospital admission of more than one hour. Patients with a pre-hospital time longer than the 'golden hour' are of concern because early definitive care improves patient outcomes (Petri, Dyer & Lumpkin 1995). The time taken for patients to get to hospital is under review. With increased use of helicopter transport and bypass of non-major trauma service hospitals, transport time would be expected to increase; however, this may result in decreased time to definitive treatment.
2. **Pre-hospital scene time >20 minutes.** Of the 958 non-entrapped blunt trauma patients with a calculated scene time, 57.8 per cent had a scene time of more than 20 minutes. This has increased from last year. Over time, scene time has increased, with more procedures being performed at the scene and increased use of helicopter transport (there is delay in waiting for the helicopter).
3. **Systolic blood pressure <100 mmHg on arrival and scene time >10 minutes.** Of the 25 non-entrapped penetrating injury patients with a blood pressure less than 100 mmHg on arrival at the scene and a calculated scene time, 62 per cent had a scene time of more than ten minutes, compared with 60 per cent in the previous year. The reason for the increase is unclear; however, the number of cases is small. The single most important determinant of penetrating trauma is time to definitive surgery. The Metropolitan Ambulance Service and Rural Ambulance Victoria have reinforced the importance of rapid transit to definitive care for this group of patients.
4. **GCS<9 at scene and O2 saturation <90 per cent after ten minutes.** Among the 120 head injured patients with a GCS less than nine at the scene of injury and a recorded oxygen saturation after ten minutes, 10.8 per cent had an oxygen saturation of less than 90 per cent. Hypoxaemia is recognised as a significant cause of secondary brain injury. Strategies for improving airway management are being trialled. The Rapid Sequence Intubation (RSI) trial has now commenced and will hopefully provide guidance as to the best form of airway management for this difficult group of patients.
5. **GCS<9 and systolic blood pressure <100 mmHg after ten minutes.** Among the 178 head injured patients with an at-scene GCS less than nine and a recorded systolic blood pressure after ten minutes at the scene, 21.9 per cent had a systolic blood pressure of less than 100 mmHg, compared with 26.7 per cent in year two and 34 per cent in year one. Hypotension is recognised as a significant cause of secondary brain injury. This issue is under constant review. Improved access to rural paramedics should improve this.
6. **No intubation with GCS<9.** Of the 194 patients with a pre-hospital GCS less than nine and known intubation status, 50.8 per cent did not have an endotracheal tube inserted at the scene. This is similar to previous years. The majority of these patients were injured in motor vehicle crashes. The issue of pre-hospital airway management in the pre-hospital setting is under review. As stated previously, a major trial is underway to determine whether intubation with paralysing drugs will improve outcome. It is not expected that intubation rates will increase while this trial is underway.

Transfers across the trauma system

This section describes the transfers across the trauma system and indicates how the Victorian state trauma system is performing.

Direct admissions and transfers to major trauma services

Table 5 describes the origin of the patients admitted to each major trauma service. At the Royal Melbourne and The Alfred hospitals, direct admissions from the scene of injury were more common than referrals from another hospital. In contrast, transfers to the Royal Children's Hospital from a referral hospital were more common than patients being admitted directly from the scene of injury. The latter observation was as expected given the trauma triage guidelines for paediatric trauma.

The increasing percentage of patients arriving at a major trauma service directly from the scene reflects the formal introduction of the trauma triage guidelines. For adult trauma patients, it is expected that 30–35 per cent of patients will be more than 30 minutes from a major trauma service and thus require transfer to a non-major trauma service hospital first for stabilisation prior to secondary transfer. The use of primary helicopter transfer will reduce the number of secondary transfers.

Table 5: Numbers of direct admissions and transfers to each major trauma service

Hospital	Year	No.	Direct from scene (%)	Transfer in from referral hospital (%)	Other (%)	Total (%)
The Alfred	1	701	60.8	34.4	4.9	100.0
	2	730	64.2	32.9	2.2	100.0
	3	791	69.3	28.8	1.8	100.0
Royal Melbourne Hospital	1	289	54.7	42.9	2.4	100.0
	2	295	60.3	38.0	1.7	100.0
	3	410	68.3	30.5	1.2	100.0
Royal Children's Hospital	1	112	27.7	68.8	3.6	100.0
	2	115	39.1	57.4	3.5	100.0
	3	111	39.6	59.5	0.0	100.0
Total	**1**	**1,102**	**55.8**	**40.1**	**4.1**	**100.0**
	2	**1,140**	**60.7**	**36.7**	**2.2**	**100.0**
	3	**1,312**	**66.5**	**31.9**	**1.4**	**100.0**

Mode of transport

Overall, the most common mode of transport for direct admissions to a major trauma service was a road ambulance provided by the MAS. There were 318 road transfers and 297 helicopter transfers during the reporting period.

The most common mode for referral admissions was road transportation. There were 113 road transfers and 73 helicopter transfers during the reporting period. As expected, the mode of transport to a regional trauma service or to an urgent care service was road ambulance provided by Rural Ambulance Victoria.

Transfers across the system

Overall, 543 major trauma patients were transferred, but complete information about all transfers and episodes of care was available for only 415 of these.[7] The majority of transferred patients (74.4 per cent) received their definitive treatment at a major trauma service. The highest number of transferred patients were first treated at a regional trauma service followed by a metropolitan trauma service. These data might be biased in that ethics approval (and hence, data collection) was granted at all regional trauma services, but not at all metropolitan trauma services, for July 2003 to June 2004. The patterns of transfer across the system indicate most patients were being transferred to a trauma service level with a higher designation unless there was a need for specialist care (for example, spinal cord injury in 93 patients).

KEY INDICATOR 7 – Transfers across the system

(543 patients)	Definitive hospital of care Number of transferred patients			
First hospital of care	**MTS**	**MeTS**	**RTS**	**UCS**
MTS	5	11	–	–
MeTS	108	35	–	–
MPCS	18	*	*	–
RTS	168	36	*	–
UCS	72	18	12	*
PCS	5	–	*	–
Other	28	9	–	–

** Less than 5 cases*

MTS	Major Trauma Service
MeTS	Metropolitan Trauma Service
MPCS	Metropolitan Primary Care Service
RTS	Regional Trauma Service
UCS	Urgent Care Service
PCS	Primary Care Service

7 For all other patients, although it was possible to identify transferred patients at the receiving hospital, there was no specific information from the referring hospital. This proportion of incomplete information from the referring hospital has reduced since year one (23.6 per cent for year three compared with 36.3 per cent for year two and 46.9 for year one). The reasons for there being no specific information from the referring hospital for year three were that ethics approval had not yet been received from the referring hospital before 30 June 2004 (48 hospitals), information about episodes of care can not be collected from patients treated either interstate (38 hospitals) or overseas (one hospital), and data were missing from some hospitals with established data collectors (three major trauma services, 12 metropolitan trauma services, four metropolitan primary care services, six regional trauma services, five regional urgent care services, and one regional primary care service). Note: 'Other' refers to patients transferred into Victoria from interstate and overseas, and those from a Victorian hospital that is not designated within the trauma system.

Specialist transfers

Sixty-five patients under the age of 16 years were transferred through to another trauma service level. The majority of these patients (83.1 per cent) had an ISS greater than 15 and were transferred to a major trauma service (93.8 per cent), predominantly to the Royal Children's Hospital.

Table 6 summarises the specialist transfers. On a proportional basis, more children were transferred with head injury* than adults. The majority of transferred patients with a head injury (278 patients) received their definitive treatment at a major trauma service (79.9 per cent). In comparison, a much lower proportion (53.8 per cent) of spinal cord injury patients were transferred to a major trauma service because many were transferred directly to Austin Health (a specialist metropolitan trauma service). This reflects the trauma triage guidelines which state patients with an isolated spinal injury should be transferred to Austin Health.

Table 6: Numbers of specialist transfers

	Children		Adults	
Type of trauma	**No. of patients**	**% transferred**	**No. of patients**	**% transferred**
Head injury*	74	54.1	697	34.1
Spinal cord injury	0	–	93	41.9
Both head and spinal cord injury	0	–	17	35.3

Note * A head injury was defined as a patient who received an injury to their head with an AIS severity score greater than two.

Hospital systems performance

Emergency department quality indicators

The following quality assurance indicators refer to the emergency department and hospital-specific phases of the major trauma patient care.

1. **Failure to activate trauma team at a major trauma service.** The trauma team was activated for 69.5 per cent of all patients arriving at a major trauma service emergency department. This rate varied across the major trauma service hospitals: 76.3 per cent at The Alfred, 62.7 per cent at the Royal Melbourne Hospital, and 46.4 per cent at the Royal Children's Hospital.[8] Of those patients who were not transferred to a major trauma service, the trauma team was activated for 77.8 per cent of all cases. This varied across the major trauma service hospitals: 81.9 per cent at The Alfred, 70.3 per cent at the Royal Melbourne Hospital, and 72.6 per cent at the Royal Children's Hospital. Full trauma team activation is not always necessary for stable transfer patients. Not all major trauma patients have a clear history or signs of major trauma on arrival (for example, intoxication and assault with major head injury).
2. **No intubation in patients with GCS<9.** Across all trauma service levels, 83 non-intubated patients presented to an emergency department with a GCS less than nine. Of these, eight patients (9.6 per cent) were not intubated during their emergency department stay. Of these eight patients, six were elderly low falls patients and one was a patient with a rapidly improving GCS. The other patient was promptly transferred from a small regional emergency department to a regional trauma service and intubated on arrival.
3. **Length of time from arrival at an emergency department >2 hours until a head CT scan.** Overall, the length of time from arrival at an emergency department until a head CT scan was performed in severe head injured patients (those with an AIS greater than two) was more than two hours in 147 patients (26.3 per cent) who had a severe head injury and accurate times recorded. This time to scan was longest at the metropolitan trauma services and shortest at the regional trauma services. Documentation of time to CT scan has improved, with 11 per cent undocumented or incomplete in year three.

   There are a number of reasons for prolonged time to CT scan: the patient may be too unstable to initially transfer them to CT scan, other patients may be on the CT scanner, or the scan may be unavailable due to technical or staffing problems. The high percentage of cases with a time of more than two hours is a concern and may result in sub-optimal patient outcomes.
4. **Penetrating torso trauma >1 hour to theatre.** There were 858 patients with an injury to their torso region. The trauma was penetrating in 73 patients and, of these, 63 had full time to theatre data available. Of these 63, 43 patients (68.2 per cent) had a time of more than one hour to theatre. It is a part of the treatment protocol at the major trauma services that a number of stable patients without obvious internal injury will be observed to determine whether operation is necessary. This will lead to 'delayed' operation in less severe cases. Two patients with haemodynamic instability waited more than one hour for theatre, one of whom died.

8 The significantly lower percentage of major trauma patients initiating a trauma team activation at the Royal Children's Hospital compared with the other major trauma services is affected by the fact that paging criteria, injury patterns and transfer patterns are different for children (compared with adult trauma patients).

Outcomes of major trauma

This section describes patient outcomes following major trauma. Outcome measures include hospital length of stay, discharge status and injury severity measures at discharge and six months post-injury. Unless otherwise stated, the data presented in this section relate to the hospital that provided definitive treatment.

Length of stay

Figure 10 shows a broad spread of length of stay, with a slight decrease over the past three years (8.8 days in year one, 8.7 days in year two, and 8.5 days in year three). The boxes show the majority of patients had a stay of between four and 18 days. Over the three years, 17 per cent of patients had a stay longer than 21 days.

Figure 10: Length of stay data compared with previous years

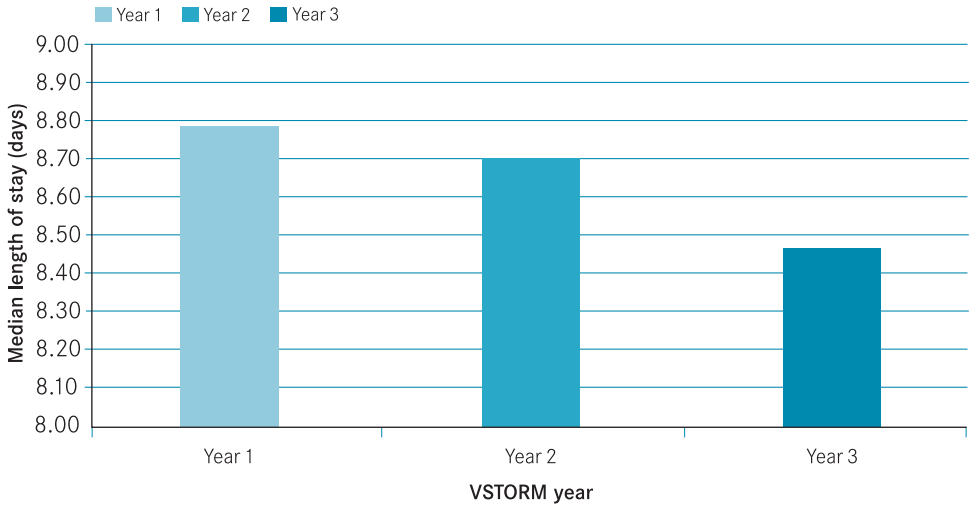
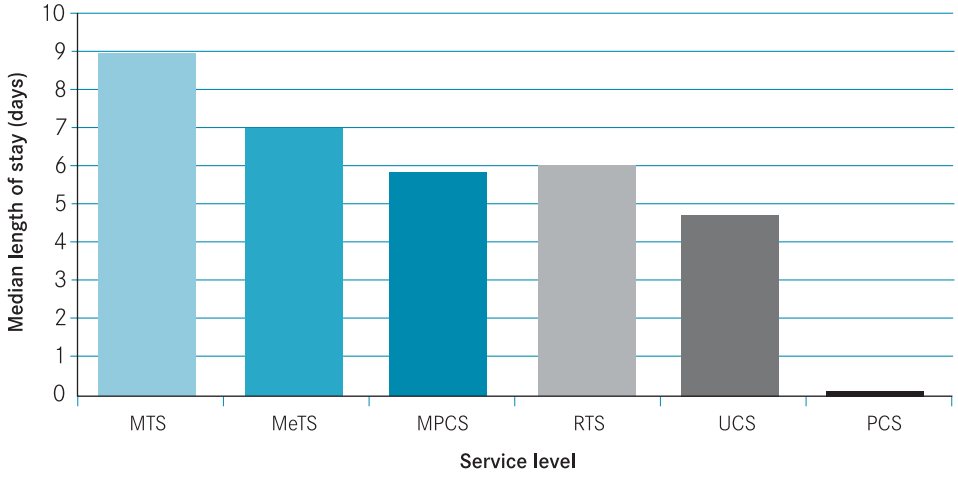


Figure 11 shows the length of stay in days for patients at different trauma service levels. Length of stay is longer at the major trauma service hospitals because the patients these hospitals treat have sustained more severe injuries and need more complex care.

Figure 11: Length of stay data by service level for year three



Discharge status

The majority of patients with a known outcome at their definitive hospital of care were discharged to home or rehabilitation. In year three, the majority of all patients were discharged to home, while the majority of major trauma service patients were most commonly discharged to a rehabilitation centre. This reflects the fact the more severely injured patients receive their definitive care at a major trauma service and these patients are likely to require ongoing trauma care. The percentage of major trauma service patients discharged to rehabilitation has remained stable at 45 per cent; however, there has been an increase in the percentage of major trauma service patients discharged home, from 35.8 per cent in year one to 36.8 per cent in year two to 40.3 per cent in year three.

KEY INDICATOR 8 – Discharge status

Discharge status from definitive hospital of care	% of all major trauma patients		
	Year 1	Year 2	Year 3
Home	39.1	39.7	42.1
Rehabilitation centre	41.0	40.4	39.5
Dead	14.6	13.0	12.5
Other hospital	2.9	4.0	3.0
Other	1.7	2.4	1.7
Nursing home	0.6	0.4	1.0
Special accommodation	0.1	0.1	0.2

Functional Measure

The Functional Measure (FM) is used to provide an estimate of the level of disability of major trauma patients at discharge from the acute hospital and six months following injury. The FM has been adapted from the Functional Independence Measure (FIMTM) for the National Trauma Database (American College of Surgeons) and includes items related to locomotion, feeding and expression.

Table 7 shows the overall level of disability at discharge as measured by the FM for patients since quarter two of year three (October to December 2003) when collection of these data from the adult major trauma services commenced. The vast majority of patients leave hospital performing the key activities of daily living (locomotion, feeding and expression) independently. Only a small number are in the totally dependent group and this number is falling. There are now only a small number of undocumented scores and future monitoring will allow accurate tracking of trends. In quarter two of year three, there were 64 patients for whom this information was not recorded, in quarter three of year three, there were 49 patients for whom this information was not recorded, and in quarter four of year three, there were 14 patients for whom this information was not recorded and seven for whom it was not applicable (children less than seven years of age).

Table 7: Functional measure at discharge (number and per cent)

Year and quarter	Independent +/- aid		Partial dependence		Total dependence		Deaths	
Y3 Q2	279	73.4%	41	10.8%	17	4.5%	43	11.3%
Y3 Q3	301	73.8%	39	9.6%	12	2.9%	56	13.7%
Y3 Q4	279	73.8%	48	12.7%	8	2.1%	50	13.2%

Table 8 shows the overall level of disability at six months post-injury experienced by major trauma patients according to the FM for year three quarters one, two and three patients. Only patients from The Alfred and the Royal Melbourne Hospital were followed up during this period. The vast majority of patients are performing the key daily tasks of expression, locomotion and feeding independently. There were no patients in the totally dependent group. In quarter one of year three, there were 136 patients who were either uncontactable[9] or unable to participate[10], in quarter two of year three, there were 113 patients who were either uncontactable or unable to participate, and in quarter three of year three, there were 88 patients of this type. The percentage of uncontactable patients is reducing (from 58 per cent in quarter one of year three to 33 per cent in quarter three of year three), but still remains a concern. VSTORM is trialling various approaches to improve the percentage of patients followed up. Given the fact the Victorian State Trauma Registry is a registry, it is anticipated a follow-up rate of 80 per cent would be satisfactory. The transient nature of patients who are most likely to suffer from major trauma (many are young adult males of lower socioeconomic status) makes follow-up difficult. The fact some patients change address as a result of the injury is also problematic.

9 Those patients who do not have any contact details, whose telephones have been disconnected, for whom a wrong number has been given, or who do not answer after four attempts

10 Those patients who are unable to participate due to a language barrier, who have moved interstate or overseas, or who are not interested in participating

Of the 83 patients who were uncontactable in quarter three of year three, 40 were discharged to rehabilitation (and therefore might have had some level of dependency) and measures are currently being implemented for better tracking of these patients. The other 43 were discharged to home and therefore would most likely be independent.

Table 8: Functional Measure at six months (number and per cent)

Functional measure at six months	Y3 Q1		Y3 Q2		Y3 Q3	
Independent +/- an aid	90	92.8%	150	93.8%	172	97.2%
Partial dependence	2	2.1%	7	4.4%	2	1.1%
Deaths after discharge	5	5.1%	3	1.8%	3	1.7%

Unexpected deaths

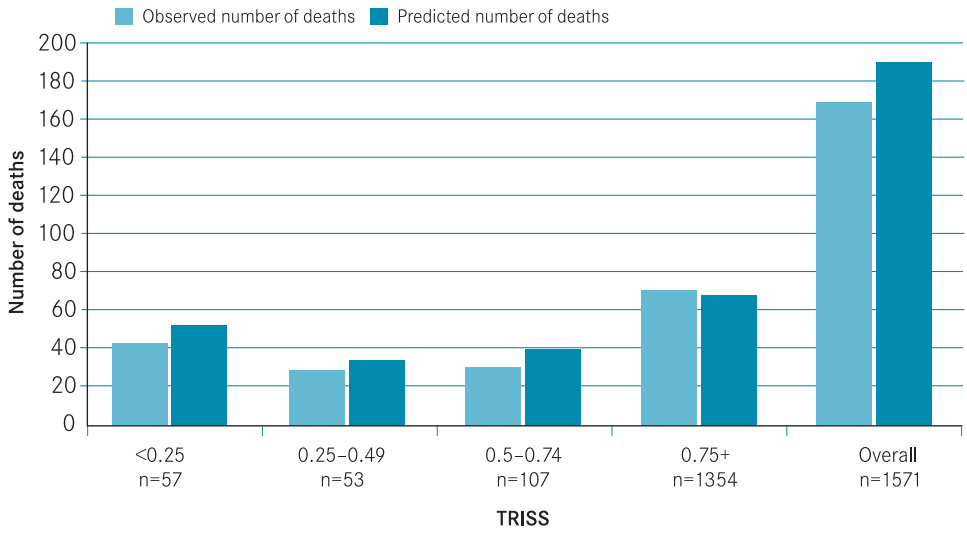
The standard international method of combining age and mechanism of injury, the TRISS can be used to estimate the rate of unexpected deaths (Boyd, Tolson & Copes 1987). The TRISS is an estimate of the probability of survival for individual patients. It is derived from injury severity and other measures of the patient's trauma. A TRISS less than 0.50 is taken to indicate a patient who could reasonably be expected to die.

The TRISS could be calculated in 93 per cent of surviving patients with blunt or penetrating injuries, and in only 87.2 per cent of the deaths with blunt or penetrating injuries. The ability to calculate TRISS is lower in the deaths because of a lack of recorded information about some of the physiological parameters in these patients. This may be due to situations such as pre-hospital intubation or poor documentation or loss of documentation. There are also some patients without adequate coronial data to estimate the ISS. For those patients with completed pre-hospital information, the pre-hospital physiologic parameters were substituted. This resulted in 7 per cent not having a valid TRISS.

A comparison of the observed and expected numbers of deaths, according to TRISS methodology, is shown in Figure 12. Similar to year one and year two figures, the overall observed number of deaths was significantly less than the expected number of deaths in year three. In every TRISS band, except 0.75+, the observed number of deaths was less than the expected number of deaths. Although the number of deaths was higher than expected in the 0.75+ TRISS band (70 versus 67), this was not a statistically significant difference. It is important to note the registry inclusion criteria for analysis only include non-major trauma patients if they die. This means the observation of a higher death rate in the low probability of death group is expected. A true comparison with international norms can only be made for those with an ISS greater than 15 (because the registry has complete information on this group). Ongoing monitoring of the ratio of observed and expected deaths will be an important trauma system process indicator.

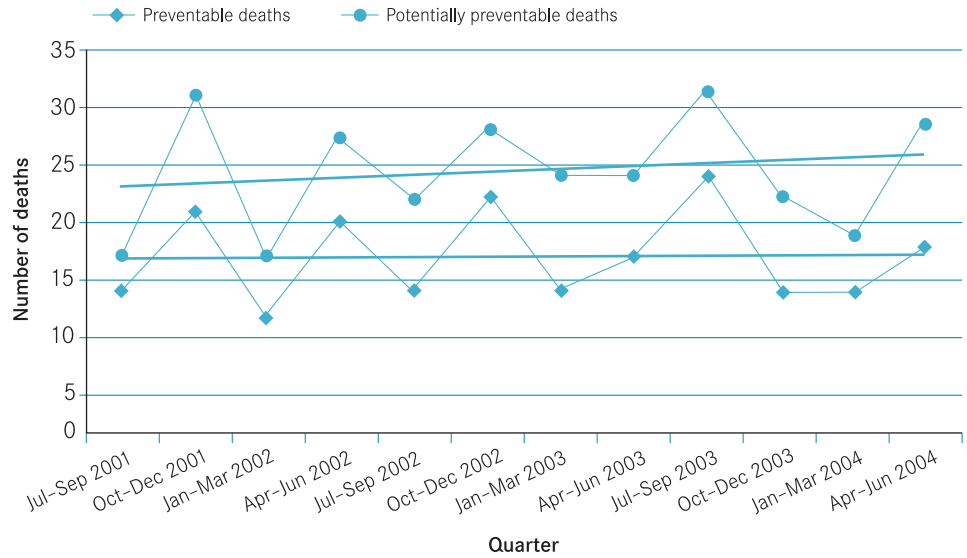
KEY INDICATOR 9 – Observed versus unexpected deaths

Figure 12: Comparison of the observed and expected (according to TRISS and including estimated TRISS) numbers of deaths



Using the Consultative Committee on Road Traffic Fatalities in Victoria methodology, the proportion of 'potentially preventable' deaths (TRISS greater than 0.50) as a percentage of all deaths with a TRISS value (170) is 58.8 per cent, and the 'preventable' deaths (TRISS greater than 0.75) is 41.2 per cent. The trend for 'potentially preventable' and 'preventable' deaths is shown in Figure 13 for each quarter since the registry's operation. The absolute number of 'potentially preventable' deaths has increased, while the number of actual 'preventable' deaths has remained the same. It is unlikely there will be a major decrease in this group of patients because the majority are elderly patients with major co-morbidities. In a mature trauma system, the major gains expected would be in greater reduction of the number of severely injured patients and long term morbidity.

Figure 13: Trends in the number of potentially and actual preventable deaths (including estimated TRISS)



Comparison of death rates across the major trauma services

The death rate was 12.5 per cent in year three, compared with 13 per cent in year two and 14.6 per cent in year one. This may reflect a decreased number of injuries in the more severe group (those with an ISS greater than 40) or improved management.

Comparison of death rates with an international standard

The z-score provides a direct comparison of the observed death rates with those that would be predicted based on the international standard derived from the Major Trauma Outcome Study (1995) (www.facs.org/trauma/ntdb.html). The z-score can only be calculated for patients with a known TRISS probability of survival (see Gabbe et al. 2003 for explanation of TRISS, including its deficiencies). The z-score for all major trauma patients with a TRISS probability of survival was 4.42 for those patients with an ISS greater than 15. This indicates the Victorian (in-hospital) major trauma death rate is significantly better than expected. The positive value indicates more survivors than expected.

The w-score is an estimate of the number of lives per 100 treated patients that could have been saved or lost under the system, compared with the Major Trauma Outcome Study norms (Boyd et al. 1987). A w-score of zero indicates no difference between the two, a negative value indicates lives saved, and a positive value indicates lives lost. Overall, and on all TRISS bands except the 0.75+ band, the Victorian trauma system saved more lives than expected compared with the Major Trauma Outcome Study norms. As explained, the higher number of deaths in the high probability of survival group would be expected given that the vast majority of less severe injuries are not included in the registry.

Table 9: w-score

TRISS group	Number	w-score
<0.25	57	-16.2
0.25–0.49	53	-8.0
0.50–0.74	107	-7.6
0.75+	1,354	+.24

Death among patients not transferred

There were 69 patients not transferred to a major trauma service who subsequently died. They had a median age of 78 years, a median ISS of 17, and a median length of hospital stay of 3 days (range: zero minutes to 55 days). Of these 69 patients not transferred to a major trauma service, ten died within an hour of arrival at hospital.

Limitations and data caveats

The information presented in this report provides data for ongoing monitoring of the Victorian trauma system; however, it is limited by the coverage of the trauma system: the estimated capture is more than 90 per cent of all major trauma patients. Until there is full coverage of all patients from every facility, the registry will not be able to provide definitive figures for monitoring the system.

Hospital capture

This incomplete coverage also has implications for monitoring all episodes of patient care. There are gaps in the data records where a patient's first or definitive hospital of care is one which does not contribute complete data to the registry. This might be due to delay in approval from the health service ethics committee or lack of data collectors. Complete information about all transfers and episodes of care was available for only 415 of the transferred patients. For all other patients, although it was possible to identify transferred patients at the receiving hospital, there was no specific information from the referring hospital.

Hospital records

The number of patients for whom information on all episodes of care was available in the VSTORM database limits the dataset. A major factor is that patient care records are not always available in the hospital medical records. When this situation occurred, an attempt was made to obtain the patient care record directly from the ambulance service. The planned introduction of an electronic pre-hospital record should greatly improve the collection of pre-hospital data.

TRISS

The TRISS can be used to measure the performance of the system in terms of death rates. Currently, the value of TRISS for monitoring the Victorian state trauma system is limited by the number of patients for whom no value can be calculated. As is usual practice, the TRISS probability of survival has been calculated from variables recorded at the definitive emergency department. Where a patient had no emergency department TRISS value, the patient's pre-hospital TRISS value was used. The major reason for an inability to calculate TRISS in the more serious patients and deaths was pre-hospital intubation. There are some potential solutions to this issue which VSTORM will develop as the database increases in size (Gabbe et al. 2003). Aside from risk adjustment for known predictors of poor outcome, one of the potential scoring methods that will be explored is the International Classification of Disease-based Injury Severity Score (ICISS), which uses the ICD-10 coding system to calculate probability of survival for injury codes and then converts these into an injury severity score for trauma patients. Collaborative links with the National Injury Surveillance Unit have been established to assist with this.

Data limitations and shortfalls

A key component of a monitoring system such as that undertaken by the registry is monitoring outcomes. This report describes deaths and discharge status from the hospital of definitive care as two important outcome measures.

Generally, data are reported either for all patients (across the trauma service) or broken down according to trauma service level. In the former data tabulations, information is obtained on all patients. When patients are presented according to their hospital of first care or definitive care, the data are taken from these hospitals' records exclusively, excluding cases with missing information. Because of the lack of complete data, the trauma service level-specific analyses have fewer patients than the analyses of all patients.

Conclusions

The registry's overall goal is to collect information about all patients from every hospital and health care facility managing trauma patients across Victoria. Data are presented on 1,684 major trauma patients treated at 132 hospitals over the 12-month period July 2003 to June 2004. It is estimated that this corresponds to more than 90 per cent of all major trauma patients presenting to hospitals in Victoria.

The overall rate of major trauma (presenting to hospitals) is 34 patients per 100,000 population and the death rate (both in-hospital and at-scene) is 21.3 deaths per 100,000 population. Open deaths were included in the classification for years two and three, but were not included in year one. Of all major trauma patients according to the ROTES definition, 80.5 per cent had an ISS greater than 15, 7.2 per cent had an ISS greater than 40 and 14.9 per cent had a GCS less than nine. The overall death rate from major trauma is decreasing. The sustainability of this trend and the reasons for it will become clearer over time.

The data presented in this report provide evidence that the trauma triage guidelines are largely being followed. There was 77.9 per cent of all major trauma patients receiving their definitive care at a major trauma service. This is slightly lower than in years one and two due to the inclusion of data from St Vincent's Hospital. A further 1.5 per cent were transferred to Austin Health for definitive spinal care. Still, it is likely this can be increased to 85–90 per cent with better education and training. Evidence from the Consultative Committee on Road Traffic Fatalities would suggest an improved outcome for major trauma patients treated at a major trauma service. No patient received his or her definitive care at either a metropolitan or rural primary care service. The patterns of transfer across the system indicate patients are being transferred to a trauma service with a higher designation unless there is a need for specialist care (for example, spinal cord injury).

An almost equal number of patients were discharged to home as to a rehabilitation centre from their hospital of definitive care. Major trauma service patients were most commonly discharged to a rehabilitation centre. All others were most commonly discharged to home. This may reflect the fact a higher proportion of very severely injured patients received their care at a major trauma service.

Overall, 12.5 per cent of all major trauma patients died compared with 13 per cent in year two. This death rate is similar to international reports. Adjusting for injury severity, the system is functioning at a high level. The introduction of disability measures at discharge and six months show only a small number of severely disabled patients out of the large number treated. VSTORM is trialling improved methods of measurement for this group.

The data presented in this report further strengthen the basis for future monitoring of the Victorian state trauma system. The registry is now sufficiently robust to provide epidemiologic and outcome data to inform system users, and to aid future improvement of the trauma system.

References

Australian Bureau of Statistics 2005 www.abs.gov.au

Boyd CR, Tolson MA, Copes WS. 2003 Evaluating Trauma Care: the TRISS Method. *Journal of Trauma-Injury Infection & Critical Care*, vol. 55, no 2, pp 236-240

Cameron, PA, Dziukas, L, Hadj, A, Clark, P & Hooper, S 1995, 'Major trauma in Australia–a regional analysis', *Journal of Trauma*, vol. 39, pp. 545–52.

Gabbe, B, Cameron, P & Finch, C 2003, 'Is the Revised Trauma Score still useful?', *Australian and New Zealand Journal of Surgery*, vol. 73, pp. 944–48.

Gabbe, B, Cameron, P & Wolfe, R 2003, 'TRISS: Does it get better than this?' *Academic Emergency Medicine*, vol. 11, pp. 181–6.

Jackson, G, Babbel, R & Papastamopoulos, D 2001, *Major trauma data review: modelling the impact of the trauma triage guidelines*, Victorian Department of Human Services, Melbourne.

Lecky, F, Woodford, M & Yates, D 2000, 'Trends in trauma care in England and Wales 1989–97. UK Trauma Audit and Research Network', *The Lancet*, vol. 355, no. 9,217, pp. 1,771–5.

Major Trauma Outcome Study (1995) www.facs.org/trauma/ntdb.html

Ministerial Taskforce on Trauma and Emergency Services and the Department of Human Services Working Party on Emergency and Trauma Services 1999, *Review of trauma and emergency services – Victoria 1999*, Victorian Department of Human Services, Melbourne.

National Injury Prevention Advisory Council 1999, *Directions in injury prevention*, Department of Health and Aged Care, Canberra, ACT, Australia pp. 10–12.

National Trauma Data Bank™ 2004 Report Version 4. American College of Surgeons, Chicago, USA 2004

National Trauma Registry Consortium Report : 2002 A collaboration initiative of the Royal Australasian College of Surgeons, the Centre of National Research on Disability and the Australasian Trauma Society. National Trauma Registry Consortium, University of Queensland, Herston, Queensland, Australia

Neale, R, Kassulke, D & McClure, R 1998, *Queensland Trauma Registry 1998 Report*, Brisbane, Queensland, Australia pp. 1–17.

Peeters, A, Smith, K, Cameron, P, McNeil, J & Meyer, A 1999, *An estimate of the impact of trauma triage and transfer guidelines on the resources of Ambulance Service Victoria*, Monash University, Melbourne.

Peeters A, Smith K, Cameron P & McNeil J 2001, 'Predicted impact on Victoria's ambulance services of a new major trauma system', *ANZ Journal of Surgery*, vol. 71, no. 12, pp. 747–52.

Petri, RW, Dyer, A & Lumpkin, J 1995. The Effect of Prehospital Transport Time on the Mortality from Traumatic Injury, *Prehospital and Disaster Medicine*, vol. 10, pp. 24–9.

Senkowski, GK & McKenney, MG 1999, 'Trauma scoring systems: a review', *Journal of the American College of Surgeons*, vol. 189, no. 5, pp. 491–503.

Steenkamp, M & Harrison J 2001, *Suicide and hospitalised self-harm in Australia*, Australian Institute of Health and Welfare, Canberra. AIHW Cat No INJ-30.

South West Sydney Area Health Service Regional Trauma Registry Report on 5 Years 1995 to 1999, 2000 A project by the Trauma Department, Liverpool Hospital, Sydney, New South Wales, Australia

Publications and presentations

Accepted for publication

Cameron, P, Finch, C, Gabbe, B, Collins, L, Smith, K & McNeil, J 2004, 'Developing Australia's first statewide trauma registry – what are the lessons?' *Australian and New Zealand Journal of Surgery*, vol. 74, no. 6, pp. 424–8.

Dowrick, AS, Gabbe, BJ, Williamson, OD & Cameron, PA in press, 'Outcome instruments for the assessment of the upper extremity following trauma: a review', *Injury*.

Dowrick, A, Gabbe, B & Williamson, O in press, 'Does the presence of an upper extremity injury affect outcomes following major trauma', *Journal of Trauma*.

Gabbe, B, Cameron, P, Wolfe, R, Simpson, P, Smith, K & McNeil, J in press, 'Pre-hospital prediction of intensive care unit stay and mortality in blunt trauma patients', *Journal of Trauma*.

Gabbe, B, Magtengaard, K, Hannaford, A & Cameron, P in press, 'Is the Charlson Comorbidity Index useful for predicting trauma outcomes', *Academic Emergency Medicine*.

Gabbe, B, Finch, C, Cameron, P & Williamson, O in press, 'The incidence of serious injury and death during sport and recreation activities in Victoria, Australia', *British Journal of Sports Medicine*.

Gabbe, B, Cameron, P, Wolfe, R, Simpson, P, Smith, K & McNeil, J in press, 'Predictors of mortality, length of stay and discharge destination in blunt trauma', *Australian and New Zealand Journal of Surgery*.

Williamson, O, Cameron, P & McNeil, J 2004, 'Medical registry governance and patient privacy', *Medical Journal of Australia*, vol. 181, no. 3, pp. 125–6.

Publications submitted

Cameron, P, Gabbe, B, McNeil, J, Finch, C, Smith, K, Cooper, J, Judson, R & Kossman, T, 'The trauma registry as a state-wide improvement tool'. Provisional acceptance from the *Journal of Trauma*.

Gabbe, B, Williamson, O, Cameron, P & Dowrick, A, 'Trauma registries – beyond death as an outcome measure'. Submitted to *Academic Emergency Medicine*.

Wolfe, R, McKenzie, D, Black, J, Simpson, P, Gabbe, B & Cameron, P, 'Development of prognostic models for binary outcomes: a trauma case-study with pre-specified performance criteria'. Submitted to the *Clinical Journal of Epidemiology*.

Published abstracts

Cameron, P, Gabbe, B, Finch, C, Smith, K & McNeil, J 2004, 'VSTORM as a quality assurance tool', *Proceedings of the Royal Australasian College of Surgeons Annual Meeting*, Melbourne.

Gabbe, B, Cameron, P, Wolfe, R, Simpson, P, Smith, K & McNeil, J 2004, 'Pre-hospital prediction of intensive care unit admission and mortality in blunt trauma patients', *Proceedings of the 10th International Conference of Emergency Medicine*, Cairns.

Glossary

Abbreviated Injury Scale (AIS)	A numerical method for ranking and comparing injuries by severity and for standardising the terminology used to describe injuries. It is a measure of the threat to life of an injury. The scale ranges from one (minor injury) to six (maximum severity). AIS=6 and AIS=5 scores represent 'maximum severity' and 'critical' injuries respectively.
Charlson Comorbidity Index	Assigns weights (0–6) to co-morbid conditions and has been used to predict mortality and morbidity in cohorts of hospitalisations. The index has been modified to be based on ICD-9 codes[11] and ICD-10 codes.
coronial cases	A coronial case is a case recorded on the National Coroners Information System (NCIS) database. The database has information about every death reported to an Australian coroner since July 2000 (January 2001 for Queensland). Each coronial case is assigned a case number in the coronial database. As long as a case is under investigation it is marked as 'open', which means no identifying information is available. When an investigation is finished, the case is marked as 'closed' and the identifying information is available.
Functional Measure (FM)	A measure that has been used to measure the degree of disability during the medical rehabilitation, discharge and follow-up of trauma patients. The FM has been adapted from the Functional Independence Measure (FIMTM) for the National Trauma Database (American College of Surgeons). The FM includes three items (self-feeding, communication and locomotion), scored using a four-point ordinal scale. The use of this modified version of the FIMTM has not been validated to date.
Glasgow Coma Score (GCS)	A measure of the level of the consciousness of a patient and an indicator of the severity of a head injury. The scale ranges from three (unconscious) to 15 (normal functioning), with a score less than nine usually indicating a severe head injury. When this variable is used for calculating trauma scores, as a default, the emergency department GCS values are used. If there is no GCS recorded at the emergency department or the patient was intubated or sedated on arrival, the patient's pre-hospital GCS value is used.
hospital of definitive care	For each patient, this is defined as the hospital at the highest service level within the tiered trauma system structure where the patient was treated.

11 Librero, J, Peiro, S & Ordinana, R 1999, 'Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days', Journal of Clinical Epidemiology, vol. 52, pp. 171–9.

Injury Severity Score (ISS)	Used to define injury severity for comparative purposes and a useful tool for evaluating trauma outcomes. It incorporates both anatomical and severity indices and is derived from the Abbreviated Injury Scale for anatomic regions. The ISS has been demonstrated to be an important predictor of injury severity and mortality. The scale ranges from one (minor injury) to 75 (mortal injury). Generally, an ISS greater than 15 is taken to be indicative of major trauma because mortality in this group has been shown to be more than 10 per cent.
maximum AIS	Used as a proxy measure of injury severity. For each patient, all AIS scores for all injuries are ranked from lowest to highest. The maximum AIS is the highest AIS given to any of the injuries sustained by a patient, regardless of body region.
M-statistic	Used to compare the severity of injuries in a database with the Major Trauma Outcome Study database (international standard). Values range from zero to. If the M-statistic is greater than 0.88, then the injury severity distribution in the two datasets is similar. An M-statistic greater than 0.88 implies comparison of the two datasets is reasonable because they relate to patients with similar injury severities.
Major Trauma Outcome Study (MTOS)	A retrospective descriptive study of injury severity and outcome, coordinated through the American College of Surgeons' Committee on Trauma. Since 1982, this database has been continually updated and now contains 730,000 cases from 268 trauma centres across 36 states. The MTOS database is the international standard against which all other trauma databases are often compared.
Revised Trauma Score (RTS)	An injury severity measure that is derived from the Glasgow Coma Scale, systolic blood pressure and respiratory rate. Reliance on the respiratory rate and the GCS prevents calculation of the RTS for intubated patients. In such cases, the RTS is calculated from information taken at the scene prior to intubation. The raw RTS ranges from zero to 12, with higher values suggesting a more stable patient. The RTS can be weighted for research and prediction purposes. The maximum weighted RTS is 7.84, corresponding to a stable patient. RTS less than two is associated with a 70 per cent or more predicted probability of death (Senkowski & McKenney 1999).

trauma service level	A tier in the Victorian trauma service's trauma system structure. Different complexities of care are provided at each level, with the major trauma services providing the highest complexity of care. Major trauma services are The Alfred, the Royal Melbourne Hospital and the Royal Children's Hospital. Metropolitan trauma service hospitals are at the second tier of the state trauma service for metropolitan Melbourne. Metropolitan primary care service hospitals are at the third and lowest tier of the state trauma service for metropolitan Melbourne. A regional trauma service is a hospital at the highest tier of the state trauma service in rural and regional Victoria. Urgent care service hospitals are at the second tier of this service and primary care service hospitals are at the third and lowest tier.
TRISS	An estimate of the probability of survival of individual patients. It is derived from the patient's age, the Revised Trauma Score, the mechanism of injury and the Injury Severity Score. The TRISS probability of survival is calculated from variables recorded at the definitive emergency department. When the TRISS probability of survival components are missing from the emergency department records, the patient's pre-hospital parameters are used.
Victorian Admitted Episodes Database	A database maintained by the Victorian Department of Human Services, which records details of all hospital admissions across the state
VSTORM	The Victorian State Trauma Outcome Registry and Monitoring (VSTORM) group, which coordinates the Victorian State Trauma Registry and is based at the Department of Epidemiology and Preventive Medicine at Monash University
w-score	A score used to describe the difference in the number of deaths between the test dataset and the normative dataset in clinically relevant terms. The w-score estimates the number of deaths more or less than expected per 100 patients treated.
z-score	A score used to compare a dataset with the international Major Trauma Outcome Study standard to determine whether the actual number of survivors recorded in the test dataset is equivalent to the predicted number of survivors in the MTOS dataset. Values greater than two standard deviations are indicative of a significant difference between the databases, with a positive value indicating more survivors than expected and a negative value indicating fewer survivors than expected.

Appendix 1: The VSTORM group

The VSTORM group based at the Department of Epidemiology and Preventive Medicine at Monash University coordinates the registry.

The VSTORM chief investigators are:

- Professor John McNeil (Head of Department of Epidemiology and Preventive Medicine, Monash University)
- Professor Peter Cameron (Head, Victorian State Trauma Registry, Department of Epidemiology and Preventive Medicine, Monash University)
- Dr Karen Smith (Project Manager, Strategic Planning, Metropolitan Ambulance Service).

All chief investigators are also members of the VSTORM Steering Committee.
Other members of the 2003–04 VSTORM Steering Committee, all of whom have expertise in epidemiology, trauma management or related areas, include:

- Associate Professor Rodney Judson (Director of Trauma, Royal Melbourne Hospital)
- Mr Chris Atkin (Senior Trauma Surgeon, The Alfred)
- Mr Bill Barger (Manager, Metropolitan Ambulance Service Victoria)
- Dr Belinda Gabbe (National Health and Medical Research Council Fellow, Department of Epidemiology and Preventive Medicine, Monash University)
- Dr Warwick Butt (Staff Specialist in Intensive Care, Royal Children's Hospital)
- Professor Joan Ozanne-Smith (Chair of Injury Prevention, Monash University Accident Research Centre)
- Associate Professor David Taylor (Director of Emergency Medicine Research, Royal Melbourne Hospital)
- Mr Tony Walker (Manager Clinical Services, Rural Ambulance of Victoria)
- Mr Owen Williamson (Senior Lecturer, Department of Epidemiology and Preventive Medicine, Monash University).

During the third year of operation, the registry's staff included:

- Dr Lisa Collins (Project Coordinator), until December 2003
- Mr Steven White (Database Manager), until December 2003
- Ms Mimi Morgan (Project Coordinator), from December 2003
- Ms Sue McLellan (Data Coordinator), ongoing
- Mr Andrew Hannaford (Database Manager), from April 2004
- various casual data entry clerks.

Ms Mimi Morgan (Project Coordinator) and Mr Andrew Hannaford (Database Manager) prepared this report.

Appendix 2: Hospitals and health services with ethics committee approval for the period July 2003 to June 2004

Collection of patient level data from each of the hospitals and health services is conducted under strict National Health and Medical Research Council guidelines and national and Victorian privacy legislation. Accordingly, full ethics committee approval is required from each hospital and health service contributing to the registry before data collection in that setting.

Ethics committee approval for the registry was initially obtained from the Department of Human Services and Monash University ethics committees and has also been granted by the National Coroners Information System (for trauma-related deaths). Approval for trauma data collection has also been actively sought from all Victorian hospitals and major health services (public and private) in both metropolitan and regional and rural areas. By 30 June 2004, registry data collection was approved at 132 hospitals and health services. These 132 hospitals and health services are listed in the following table.

Trauma service level	Hospital
Major trauma service	The Alfred
	Royal Children's Hospital
	Royal Melbourne Hospital
Metropolitan trauma service	Austin Health
	Dandenong Hospital
	Monash Medical Centre (Clayton)
	Mornington Peninsula Hospital (Frankston)
	Northern Hospital
	St Vincent's Hospital
	Western Health (Footscray)
Metropolitan primary care service	Epworth Hospital
	Mayne Health (Knox Private Hospital)*
	Monash Medical Centre (Moorabbin)
	Mornington Peninsula Hospital (Rosebud)
	Sandringham and District Memorial Hospital
	Western Health (Sunshine)
	The Mercy Hospital, Werribee
	Williamstown Hospital*
Barwon South West Region	
Regional trauma service	Barwon Health – Geelong Hospital
	South West Health Care (Warrnambool)
	Western District Health Service (Hamilton)
Urgent care service	Casterton Memorial Hospital
	Colac Community Health Services (Colac)
	Coleraine District Health Services
	Hesse Rural Health Service (Winchelsea)

	Lorne Community Health
	Moyne Health Services
	Otway Health and Community Services
	Portland and District Hospital
	South West Health Care (Camperdown)
	Terang and Mortlake Health Service (Terang)
	Timboon and District Healthcare Service
Primary care service	Balmoral Bush Nursing Centre
	Cobden District Health Services
	Colac Community Health Services (Birregurra)
	Dartmoor and District Bush Nursing Centre Inc.
	Hesse Rural Health Service (Rokewood, Beeac)
	Heywood Rural Health
	South West Health Care (Lismore)
	Terang and Mortlake Health Service (Mortlake)
	Western District Health Service (Penshurst)
Loddon Mallee Region	
Regional trauma service	Bendigo Health Care Group
	Ramsay Health Care – Mildura Base Hospital
Urgent care service	Cohuna District Hospital
	Echuca Regional Health
	Kerang and District Hospital
	Kyabram and District Memorial Community Hospital
	Kyneton District Health Service
	Maryborough District Health Service
	Swan Hill District Hospital
Primary care service	Boort District Hospital
	Dingee Bush Nursing Centre Inc.
	Inglewood and District Health Service
	Lockington and District Bush Nursing Centre
	Mallee Track Health and Community Service
	Managatang and District Hospital
	McIvor Health and Community Services
	Mt Alexander Hospital
	Robinvale District Health Services
	Rochester and Elmore District Health Service
	Sea Lake and District Health Service Inc.
Gippsland Region	
Regional trauma service	New Latrobe Regional Hospital
Urgent care service	Bairnsdale Regional Health Service
	Bass Coast Regional Health (formerly Wonthaggi and District Hospital)
	Central Gippsland Health Service (Sale)

	Gippsland Southern Health Service (Leongatha, Korumburra)
	Orbost Regional Health
	South Gippsland Hospital
	Warley Hospital
	West Gippsland Health Care Group (Warragul)
	Yarram and District Health Service
Primary care service	Buchan Bush Nursing Association
	Cann Valley Bush Nursing Centre
	Dargo Bush Nursing Centre Inc.
	Gelantipy District Bush Nursing Centre Inc.
	Heyfield Hospital Inc.
	Mallacoota Medical Centre
	Neerim District Soldiers Memorial Hospital
	Omeo District Hospital
	Swift's Creek Bush Nursing Centre Inc.
Grampians Region	
Regional trauma service	Ballarat Health Services
	Wimmera Health Care Group (Horsham)
Urgent care service	East Grampians (Ararat)
	East Wimmera Health Service (St Arnaud)
	Edenhope and District Memorial Hospital
	Hepburn Health Service (Daylesford)
	Stawell Regional Health
	Rural Northwest Health (Warracknabeal)
	St John of God Health Care Ballarat
	West Wimmera Health Service (Nhill)
Primary care service	Ballan and District Soldiers' Memorial Bush Nursing Hospital
	Beaufort and Skipton Health Service (Beaufort, Skipton)
	Djerriwarrh Health Services (Bacchus Marsh)
	Dunmunkle Health Services (Rupanyup)
	West Wimmera Health Service (Rainbow, Jeparit, Kaniva)
	Rural Northwest Health (Hopetoun)
	East Wimmera Health Service (Birchip, Charlton, Donald, Wycheproof)
	Elmhurst Bush Nursing Centre Inc.
	Harrow Bush Nursing Centre
	Hepburn Health Service (Creswick)
	Lake Bolac Bush Nursing Centre
	Wimmera Health Care Group (Dimboola)

Hume Region	
Regional trauma service	Goulburn Valley Health (Shepparton)
	Wangaratta District Base Hospital
Urgent care service	Alpine Health (Bright, Mt Beauty, Myrtleford)
	Benalla and District Memorial Hospital
	Cobram District Hospital
	Kilmore and District Hospital
	Mansfield District Hospital
	Nathalia District Hospital
	Numurkah District Health Service
	Seymour District Memorial Hospital
	Upper Murray Health and Community Services
	Wodonga Regional Health Service
	Yarrawonga District Health Service
	Yea and District Memorial Hospital
Primary care service	Beechworth Health Service
	Chiltern Bush Nursing Hospital
	Euroa Hospital
	Falls Creek Medical Centre
	Mt Hotham Medical Centre
	Nagambie hospital Inc.
	Tallangatta Hospital
	Violet Town Bush Nursing Centre
	Walwa Bush Nursing Hospital

* This hospital has not been included in the results of this report due to incomplete data.