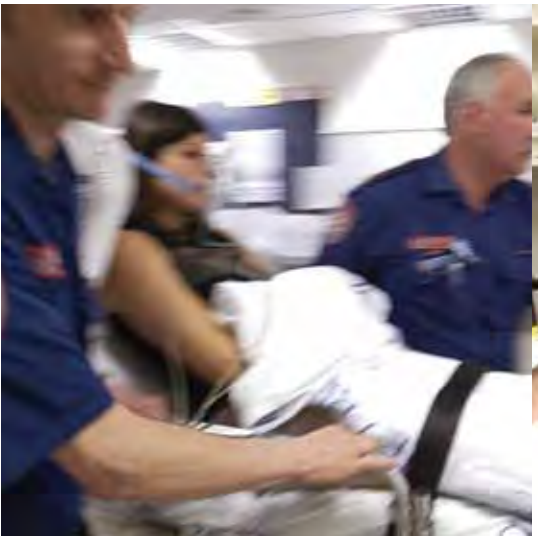
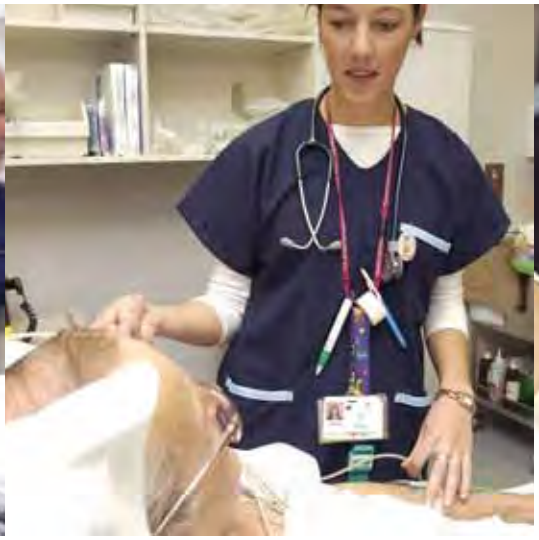
Victorian State Trauma Registry
1 July 2002–30 June 2003

Summary report


Victoria
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Victorian State Trauma Registry
1 July 2002–30 June 2003

Summary report

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

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Foreword

Annual Report of the Victorian State Trauma Registry 2002-2003

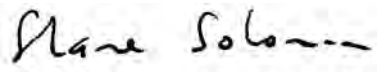
I am pleased to introduce the second annual report of the Victorian State Trauma Registry. I have followed with great interest the development of this project established by the Department of Human Services (the Department) and the Victorian Trauma Foundation (VTF) since February 2001.

The Victorian State Trauma Registry, undertaken by the Victorian State Trauma Outcome Registry and Monitoring group (VSTORM) from Monash University, provides extensive trauma specific data and serves as a great resource to those within the Victorian State Trauma System (VSTS) and broader healthcare arena.

Established as a result of the *Ministerial Review of Trauma and Emergency Services – Victoria 1999*, the VSTS aims to reduce preventable death and permanent disability and improve patient outcomes. This project plays a key role in achieving this aim through monitoring and evaluation of both system requirements and achievements.

Publication of the second annual report provides the first opportunity to compare trauma specific data, identify trends and note the significant impacts the introduction of the VSTS has had on trauma service provision.

I trust the report will be useful in enhancing and informing the VSTS and look forward to the delivery other significant milestones.



Shane Solomon
Executive Director
Metropolitan Health and Aged Care Services

Executive summary

A system of trauma care in Victoria has now been in place since 2000. It is not possible to have an effective trauma system without formal monitoring and feedback processes. The state trauma registry was commissioned by the Department of Human Services (DHS) as a base component of this system.

This is the second annual report from the Victorian State Trauma Registry. Over ensuing years, the Victorian State Trauma Registry will provide valuable information for monitoring the performance of the State's trauma system. Data collected during the first two years will provide a baseline to monitor trends in trauma incidence, severity, management and outcomes.

The overall goal of the registry is to collect information on all patients from every hospital and health care facility managing trauma patients across Victoria. Data is presented on 1,379 major trauma patients treated at 129 hospitals over the 12-month period July 2002–June 2003. It is estimated that this corresponds to over 90 per cent of all major trauma patients in Victoria. This coverage reflects the lack of ethics committee approvals, and later approvals, from some hospitals, for the registry data collection during its second year of operation. Further discussion of the significance of this issue can be found under limitations and data caveats at the end of the report.

The overall rate of major trauma (presenting to hospitals) is 28.0 patients per 100,000 population, which is a decrease of 2 patients per 100,000 compared to last year. The overall major trauma death rate (both in-hospital and at-scene) is 23.3 deaths per 100,000 population. Seventy-nine per cent of all major trauma patients had an Injury Severity Score (ISS) >15 (including those who died), and 25.6 per cent had a Glasgow Coma Score (GCS) <9[1].

The data presented in this report provides evidence that the new triage guidelines have been implemented successfully. Eighty-two per cent of all major trauma patients received their definitive care at a Major Trauma Service (MTS). No patient received their definitive care at either a metropolitan or rural primary care service. The patterns of transfer across the system indicate that 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).

Almost equal numbers of patients were discharged to home or a rehabilitation centre from their hospital of definitive care. There appears to have been a decrease in patients discharged to rehabilitation Centres compared to year 1 data. This may reflect the decrease in the number of very severely injured trauma patients (ISS> 40).

Overall, 12.7 per cent of all major trauma patients died. This death rate is similar to those reported internationally, e.g. trauma systems in United Kingdom and United States of America (USA).

The data presented in this second annual report provides further baseline data from which future monitoring of the Victorian trauma system can be undertaken. Eight hospitals currently are not contributing to the state wide registry. The DHS is assisting the Victorian State Trauma Outcome Registry and Monitoring (VSTORM) Group in resolving this matter.

This registry represents an important opportunity to improve the outcome of trauma victims and has already demonstrated significant changes to the trauma system.

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 25 patients with no information of GCS.

About this report

This is the second annual report from the Victorian State Trauma Registry. The report begins with the rationale for establishing this registry and provides an overview of the progress made during the second year of its implementation.

Over ensuing years, the Victorian State Trauma Registry will provide valuable information for monitoring the performance of the State's trauma system. Data collected during the second year, is compared with the first year baseline data.

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 that were treated during July 2002–June 2003. Key indicators of system performance are presented and the profile of Victorian trauma patients described. Most of the data in this volume is presented across the whole trauma system and corresponds to patient level data. When the data is aggregated across the trauma service levels, this 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. A glossary of terms is provided at the end of the report. Limitations of the present data are also highlighted in this volume.

Volume two provides additional data for readers who are interested in further tabulations of the registry data. Many of these tabulations break down 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 data from year 1 (major trauma patients treated during the July 2001-June 2002 period) has been updated, and a * in a table cell indicates a count of one to five cases (either patients or episodes of care). The actual numbers within these cells are not provided to ensure that full confidentiality of individuals is maintained, in accordance with privacy requirements.

Why a Victorian State Trauma Registry?

Injury is the leading cause of death in people aged 1–44 years in Victoria (Ministerial Taskforce on Trauma and Emergency Services and the DHS Working Party on Emergency and Trauma Services, 1999). (Hereafter, this taskforce report will be referred to as the ROTES report). Broadly, major trauma is defined as those injuries with the highest severity in terms of requiring time critical specialist care. It has previously been estimated, using International Classification of Disease (ICD) ICD-9 discharge data, that there are approximately 1,700 major trauma patients annually in Victoria (Jackson, Babbel, & Papastamopoulos, 2001). A similar estimation was presented in a report by Peeters, Smith, Cameron et al (1999)[2]. Based on data presented in the first and second annual reports, the true number of major trauma patients that arrive alive to hospital in 2001-2003 appears to be closer to 1,400-1,500 per annum.

Based on recommendations from a ministerial review of trauma and emergency services (ROTES report, 1999), a new system of trauma care was introduced to Victoria in 2000. This review recognised that it is not possible to have an effective trauma system without a formal monitoring and feedback process. It was also strongly recommended that 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 DHS commissioned the development of the Victorian State Trauma Registry.

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

The Victorian State Trauma Registry aims to collect information on all patients from every hospital and health care facility managing trauma patients across the State. In its second year of operation, the registry collected information from 129 facilities (Appendix 2).

The purpose of the registry data collection is to monitor the state wide system of trauma management in order to reduce preventable deaths and permanent disability from major trauma. Ongoing registry data will be necessary to determine the extent to which these anticipated reductions have been achieved.

2 This report was subsequently published (Peeters, Smith, Cameron et. al., 2001)

What has been achieved during the second year?

The second year of the Victorian State Trauma Registry has seen many achievements in registry implementation, quality and performance. VSTORM now provides extensive coverage of all major trauma across the state and provides data to policy makers in a timely manner.

Capture Rate

The registry has established formal working relationships with more than 137 (94.4 percent of the total) hospitals and health care facilities across Victoria, of which 129 provided data for the period July 2002–June 2003. The implemented data collection processes have shown good tracking of trauma patients across Victoria. Linkages of episodes of care across hospitals with both ambulance and coronial data sources has meant that patients can be monitored from the time of call to the ambulance service, to their discharge from the definitive hospital of care.

Education

The information generated from the registry has also had an important role in informing agencies about the status of the trauma system, providing an educative role. For example, gaps in the collected data have been fed back to the relevant hospitals and the staff informed about the importance of good data recording. Similarly, the registry has helped hospitals with documentation of important aspects of care, including monitoring of the GCS.

Data Collection

Submission of electronic trauma data through to the registry has been further developed during 2003. All MTS submit data electronically and this is about to commence for each of the five regions.

Quality Assurance

Quality control processes have been extensively developed during the second year of the registry's operation, including the formation of a quality assurance subcommittee for VSTORM. Extensive daily quality assurance processes include data management, recording and checking of incoming completed paper-based data forms and electronic data, identifying incomplete and inaccurate data, contacting data collectors immediately to address the inadequacies, and running both range and consistency checks. Completeness of prehospital data has been improved through greater linkages with the Victorian ambulance services.

Cross-validating registry data with other sources to ensure the highest patient capture rates possible has been an important internal audit process. Where discrepancies have been identified, further tracking of patients and episodes of care has been undertaken to ensure that the registry contains all relevant information on patients. The registry has also been able to inform other sources about data gaps. For example, the registry has identified fatalities that were missing from the coronial records database.

The development phase has highlighted a number of problems with the data collection processes initially planned. These have been dealt with proactively and refinements made as soon as an issue has been identified. Systems have now been established to more effectively link registry data with ambulance records and coronial databases, in the future. Data collection is an ongoing challenge. Data collection processes are undergoing review to ensure even more streamlined flagging and reporting systems in 2004. Not withstanding these problems, the registry has demonstrated a high patient capture rate during its second year of operation and improved data quality.

The VSTORM steering committee has reviewed available comorbidity measures and will implement the Charleson Index (see Glossary) from 2004. This should significantly assist with risk adjusted outcome measurement.

Identification of major trauma patients in a consistent manner across hospitals has been difficult, but the process will be standardised in 2004.

During 2003, four peer-reviewed journal articles were accepted for publication, with a further two being submitted and a number in preparation. A list of these publications is provided at the end of this report.

Protocols for external requests to access Registry data have also been developed and are strictly monitored by the VSTORM Steering Committee. No patient level identifying data has been provided to third parties. Summary or consolidated data is provided only.

Finally, data collected by the registry has also been used to help develop local prediction rules for Intensive Care Unit (ICU) admission. Such prediction rules are useful in guiding pre-hospital triage. Development, to date, has identified the motor component of the GCS as the most powerful predictor of an ICU stay. Further work is occurring to assess the ability of ambulance officers to accurately identify severely injured patients.

The complexity of the registry data collection process reflects the complexity of the Victorian trauma service where 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 Victorian State Trauma 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 across the entire continuum of care, including pre-hospital services, emergency department, hospital admission and surgery, and will in the future expand to collect data on rehabilitation outcomes and long-term quality of life. It also includes data from each phase of treatment at all health care facilities across the State, including both pre-hospital and post discharge data.

Eligible patients

To ensure that 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. All trauma patients with injury as their principal diagnosis, irrespective of age, and who meet any of the VSTORM criteria are captured by the registry (Table 1). The first four criteria are based on those recommended in the ROTES report (1999); the others 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 are mechanically ventilated after admission.
3. Significant injury to two or more Injury Severity Score (ISS) body regions (corresponding to Abbreviated Injury Score (AIS) AIS>2 in two or more body regions) or ISS>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 greater than 24 hours.
6. All patients with injury as principal diagnosis whose length of stay is 3 days or more – *unless meets 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 meets 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 MTS and data collectors employed on a casual basis collect data at the MTS and Metropolitan Primary Care Services (MPCS). Regional trauma data collection is the responsibility of Regional Data 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 MTS prospectively identify trauma patients by checking the hospital information system, emergency department admission records, ICU admission records and ward rounds with the trauma service daily. The metropolitan and regional data collectors undertake retrospective data collection. Regional coordinators have established individual flagging mechanisms in their hospitals of responsibility and are notified when a trauma patient is received at a regional or primary injury service. Frequent phone calls are also made by the regional trauma coordinators to the services within their region to maintain contact and profile for the registry. The metropolitan data collectors identify trauma patients by either manually checking ED registries, checking ICU registries, or by retrospectively running reports using ICD 10 codes to identify patients with injury as principal diagnosis. These reports are set up to include length of stay, ICU admission, and outcome (to identify transfers and deaths).

Relevant data is extracted from the medical records maintained at the hospitals/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 second year, The Alfred and Royal Melbourne hospitals provided this information to the registry electronically.

Registry Training

To ensure that all trauma data coordinators and collectors designated to collect data for the registry collect standardised data, formal training sessions and workshops are conducted regularly by VSTORM. This includes training in registry procedures, data collection/extraction processes and definitions of data variables. Abbreviated Injury Scaling (AIS 90, Update 98) training courses are periodically offered 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 that the trauma patient data captured by the registry is complete and that data is as accurate as possible. Quality control measures include training of trauma coordinators and data collectors and random audits of data collection forms with hospital records. Validation rules have been put in place and missing data is continually addressed.

Extensive data checks are performed before the data is 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), attempts are made to complete the data records from other relevant sources. Alternatively, data fields are noted as being 'not documented' in the original data records. The data checking process then involves examining the completeness and accuracy of all data elements. For example:

Injury data: To ensure consistency, the codes for human intent, injury cause, activity, place and type are crosschecked with the text described for the 'incident details'. Discrepancies are followed up through the patient's medical record if necessary.

Date/time of injury: Due to the importance of collecting information across each patient's entire continuum of care, the date and time of injury are checked to ensure that they strictly correspond to the order of care provided to the patient. For example, the date and time of the ambulance call, time to arrive at the scene, time to depart, time to arrive at hospital and the time recorded for all observations and procedures, 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.

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

Before the data captured on paper-based data forms is entered onto the computerised database, it is thoroughly checked for completeness and accuracy. When missing or inaccurate data is identified, the relevant data collector is contacted and asked to provide the missing/accurate data to complete the data set. A paper record of all data changes made electronically to the registry is kept. The data collector is also sent a feedback list of common mistakes/issues arising during data collection and how to correct these.

Validation rules have been built into the electronic data entry system. These require certain data items to 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 (NCIS) based at the Monash University National Centre for Coronial Information. 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 that all patients meeting 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 has been established under the guidelines of the National Health and Medical Research Council (NHMRC) to ensure that confidentiality and privacy for all patients is maintained at all times. Ethics committee approval was obtained from each hospital and health service before any data on trauma patients was collected (Appendix 2). Ethics committee approval was also obtained from the DHS, Monash University and the NCIS ethics committees.

As the registry involves the collection of personal details of patient care, it is imperative that confidentiality is maintained at all times. All paper-based data forms and the electronic database are securely stored as outlined in the study's protocol. Paper-based forms are stored in locked filing cabinets. Personal identifying information is stored separately to the main body of the data collection form.

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

How many major trauma patients were there during July 2002–June 2003?

This section provides information about the number of major trauma patients (both hospital patients only and deaths at the scene of injury) that occurred in Victoria during the 12-month period 1 July 2002 to 30 June 2003. This data is limited by the fact that not all Victorian trauma hospitals contributed to the data collection during this period. An estimate of the registry coverage is also provided.

Major trauma patients

There were 1,379 major trauma patients recorded by the registry in Victoria over the 12-month period. The number of major trauma patients during 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 both years.

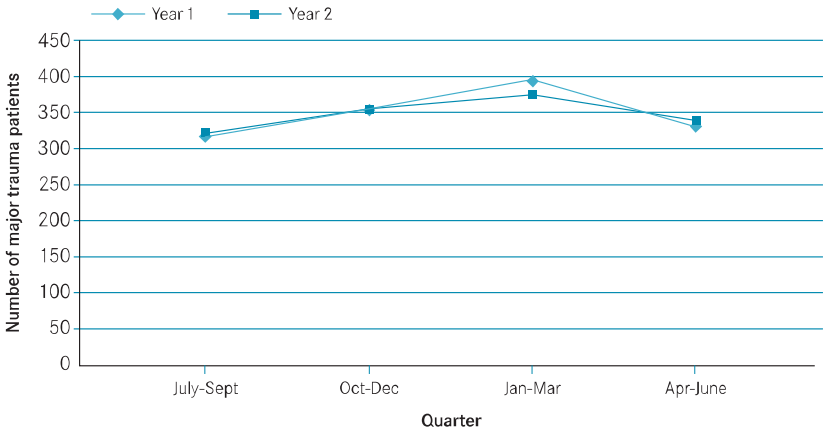
The overall annual rate of in-hospital major trauma in Victoria is 28.0 per 100,000 population[3]. This is a small downward trend compared to the first year overall annual rate of 29.8 major trauma patients per 100,000 population.

3 This rate is based on the 'Australian Demographic Statistics' for 2003 of 4,929,800.

KEY INDICATOR 1 – Number of major trauma patients

There were 1,379 major trauma patients recorded by the Registry during July 2002 - June 2003

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



Episodes of care

The 1,379 patients required a total of 1,701 hospital care episodes. The majority (1,076; 78.0 per cent) required only one episode of care; 284 (20.6 per cent) experienced two episodes of care, and 19 (1.4 per cent) patients had three episodes of care. Forty-nine per cent (n=679) of patients had an ICU admission. For all hospitals and health services, the ICU admissions were identified as patients with an ICU length of stay >0 minutes, or was identified from the disposition from the emergency department. Thirty-nine per cent (n=533) of patients had an ICU length of stay, requiring mechanical ventilation of greater than 24 hours. Seasonal variation has resource implications in terms of ICU beds, on call and theatre arrangements. This will continue to be monitored over the following years.

Deaths

Overall, the registry recorded 175 deaths in the 1,379 major trauma patients.
This corresponds to an overall death rate of 12.7 per cent amongst 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, but will be overcome in this registry in the future with the collection of post-discharge outcome data from all patients.

KEY INDICATOR 2 – Death rates

The overall death rate due to major trauma in Victoria is 23.3 deaths per 100, 000 population[4].

The rate of in-hospital major trauma deaths is 12.7 per cent of all patients.

4 This rate is based on the 'Australian Demographic Statistics' for 2003 of 4,929,800.

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

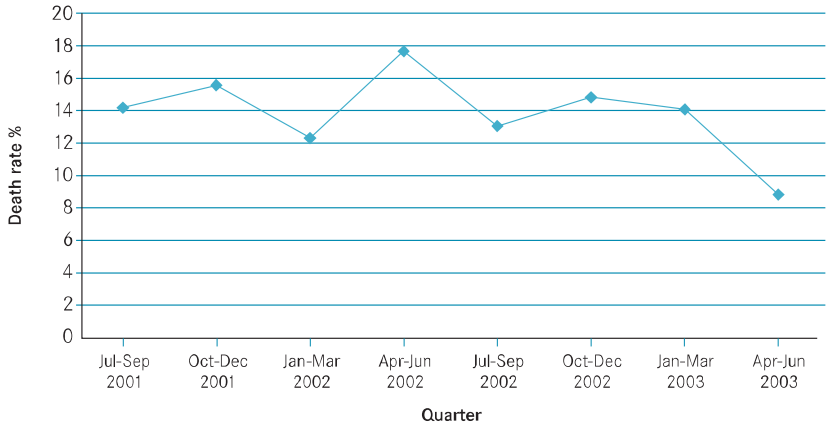


Table 3: Difference in death rate of major trauma patients for each quarter relative to first year

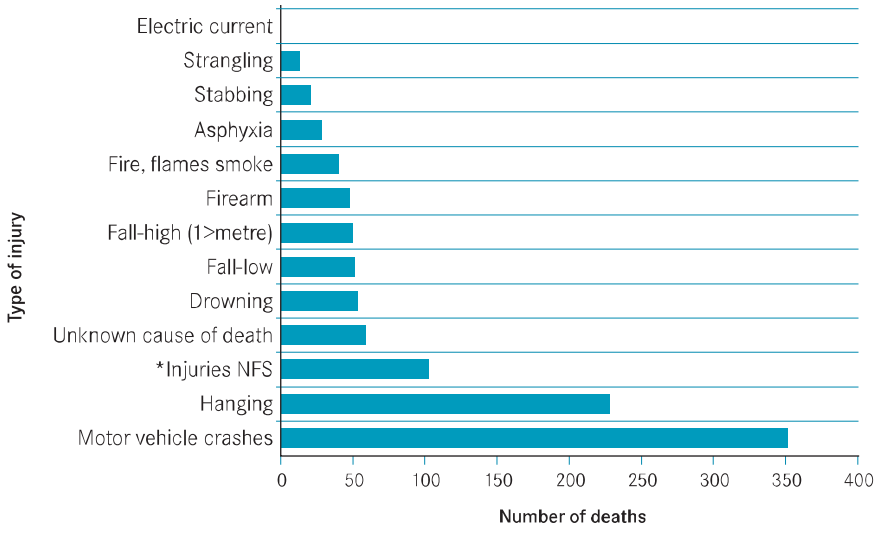
	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Differences in death rates	-0.8%	-0.9%	+1.6%	-9.1%

Note: A negative value is a drop in death rate, and a positive value is an increase in death rate compared to the same quarter in year 1.

The significant drop in death rate in year 2 is possibly due to improved trauma management but may also be secondary to a reduction in injury severity among major trauma patients. This will become clearer as more data becomes available.

The National Coroners Information System (NCIS) recorded 1039 trauma deaths from July 2002 to June 2003 in Victoria. At the time of writing this report, coronial investigations were closed (completed) on 68.7 per cent of these deaths. Only 66 of the 175 deaths registered in VSTORM were reported in the Coroner's database. Of the remaining 109 VSTORM deaths some can be expected to be found among the 325 open coronial cases, while others may be not be on the NCIS database. Assuming that only some of the trauma deaths recorded by VSTORM are among the open coroner's cases, the estimated number of trauma deaths in Victoria, at the scene or in hospitals, is 1,100 cases per year. This number can be qualified when the open coroner's cases have been closed.

Figure 3: NCIS Trauma Deaths 2002-2003**



* Injuries Not Further Specified (NFS) includes deaths as a result of head, chest or multiple injuries with no further specification.

** All traumatic deaths reported to the Coroner are included.

The major causes of death are motor vehicle crashes (33.8 per cent), hangings (21.7 per cent) and falls (high and low) (10.0 per cent). As most of the patients who die from hanging, drowning or asphyxia do not reach the hospitals alive, these cases will generally not be included on the VSTORM database (only two attempted hangings were recorded in year 2). Many of the high falls are due to suicide, while low falls generally take place in elderly patients. The low numbers of stabbings and firearm injuries in the NCIS database are consistent with the low numbers in the VSTORM database.

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). Despite not all hospitals having ethics approval for the registry, 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 MTS are included in the registry. Estimated from Victorian Admitted Episode Database (VAED) data, the number of major trauma patients not included in the registry because of lack of ethics approval, would be less than 50 patients annually.

Based on the data presented in the first and second annual reports, the true number of major trauma patients appears to be closer to 1,400-1,500 per annum. Future monitoring of the trauma system will be able to confirm this over time.

Reason for inclusion in the registry database

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 >15

3) ICU >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 also counted within the ISS >15, ICU >24 hours or urgent surgery reasons, even if these criteria were also met.

Overall, the distribution of the 1,379 registry patients according to this hierarchical classification is:

- 12.7 per cent of patients died[5]
- 69.3 per cent of patients had an ISS >15
- 7.8 per cent of patients spent >24 hours in ICU with mechanical ventilation
- 10.2 per cent of patients required urgent surgery.

5 66.9 per cent of these had an ISS> 15.

Demographic profile of the major trauma patients

Consistent with other international and local trauma registries and injury surveillance systems (Neale, Kassulke & McClure, 1998; American College of Surgeons, 2002; Trauma Department Liverpool Hospital, 1995–1999; Cameron et al., 1995), the majority of injured patients were male (73.7 per cent). The predominance of males was consistent across all age groups.

20.9 per cent were young adults (aged 15–24 years); 17.8 per cent were aged over 65 years. There were relatively few paediatric (aged 0–14 years) major trauma patients (8.2 per cent of the total).

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

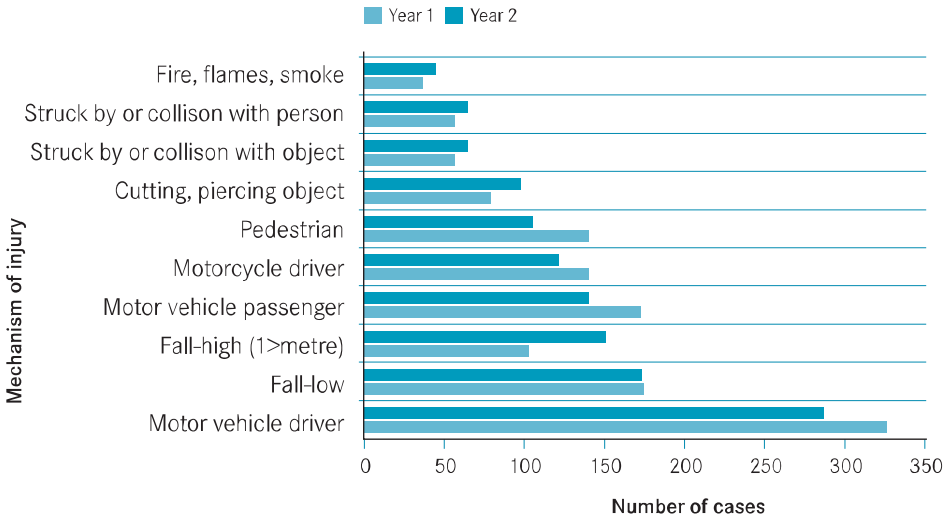
Cause and location

The most common location for the events leading to major trauma was a road, street or highway (56.1 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 (20.2 per cent of major trauma patients with a known location). Over half of these injuries were associated with falls (56.7 per cent). Workplace settings (including farms) were a small, but significant, location of injury (9.2 per cent of all patients).

The ten most common mechanisms of injury are shown in Figure 4. Together, these account for 88.3 per cent of all major trauma patients. Overall, one in five (20.5 per cent) patients sustained their injury as a driver in a motor vehicle crash. These motor vehicle drivers were most commonly male (70.0 per cent of all injured drivers) and in the age group 15–24 years (26.3 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 figures, the number of motor vehicle related crashes resulting in major trauma decreased during year two (see Figure 4). However, the large number of injuries resulting from motor vehicle accidents highlights the need for continuing injury prevention strategies. The decrease in number of major trauma cases resulting from motor vehicle crashes is consistent with a decrease in road deaths during the same period. However, the "serious injury" rate used by police (determined by hospital admission rate) did not fall in this period. This may suggest a change in admission practice or a change in injury patterns. Slower speed and use of safety devices, such as airbags, may result in less major trauma cases per road crash victim.

12.2 percent of patients sustained their injuries as the result of a low fall. The majority of these patients (71.4 per cent) were aged over 55 years. At the broad population level, many falls in older people result in fractured necks of femur. However, the registry excludes patients with fractured neck of femurs as their sole injury and only four of the older falls patients had this injury in combination with other injuries. Nonetheless, the relatively high rate of falls in older people in our data is consistent with their ranking as a priority injury prevention goal by the Commonwealth Department of Health and Ageing (National Injury Prevention Advisory Council, 1999).

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



Transport Accident Commission (TAC) 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 TAC. Overall, 47.6 per cent of patients were likely to be TAC-compensable. This percentage is compatible with the high proportion of road trauma patients (56.1 per cent).

The proportion of TAC patients receiving their care at a MTS is high (86.5 per cent). This is expected given that the trauma triage guidelines suggest transfer to major trauma services with high speed mechanisms.

Injury intent

Overall, 86.6 per cent of all major trauma patients sustained their injuries during unintentional events. This is higher than that reported in both Queensland (Neale et al., 1998) and USA figures (American College of Surgeons, 2002). Intentional self-harm accounted for 4.1 per cent of all patients. This reflects the fact that while intentional self-harm causes many deaths (Steenkamp, 2000), injury from self-inflicted violent mechanisms requiring hospital care is relatively uncommon.

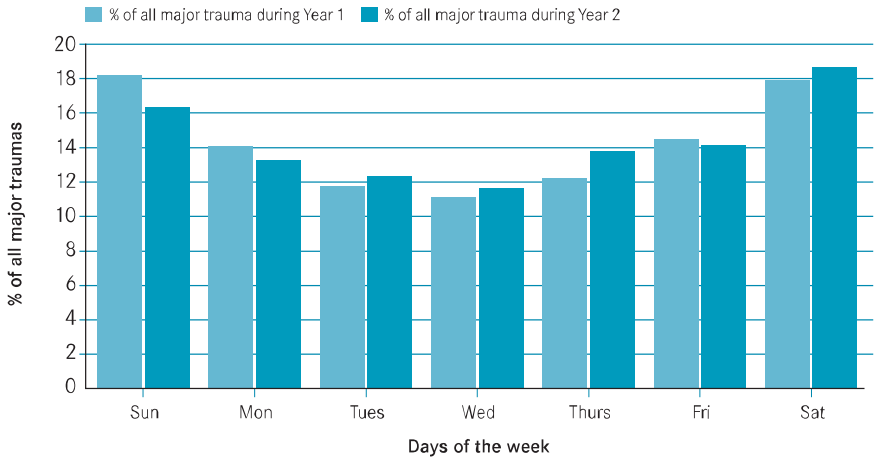
Time and day of injury

Injuries occurred more frequently on weekends, particularly Saturdays (18.6 per cent of all patients), than during the week. Injuries were also more common during the hours of 4pm to 12 midnight (41.9 per cent of all patients). This has significant implications for service provision because the busiest times for immediate trauma care are outside normal working hours, when less senior staff are available.

KEY INDICATOR 3 – Time and day of injury

Injuries were most common on the weekends and during the hours of 4 pm and 12 am

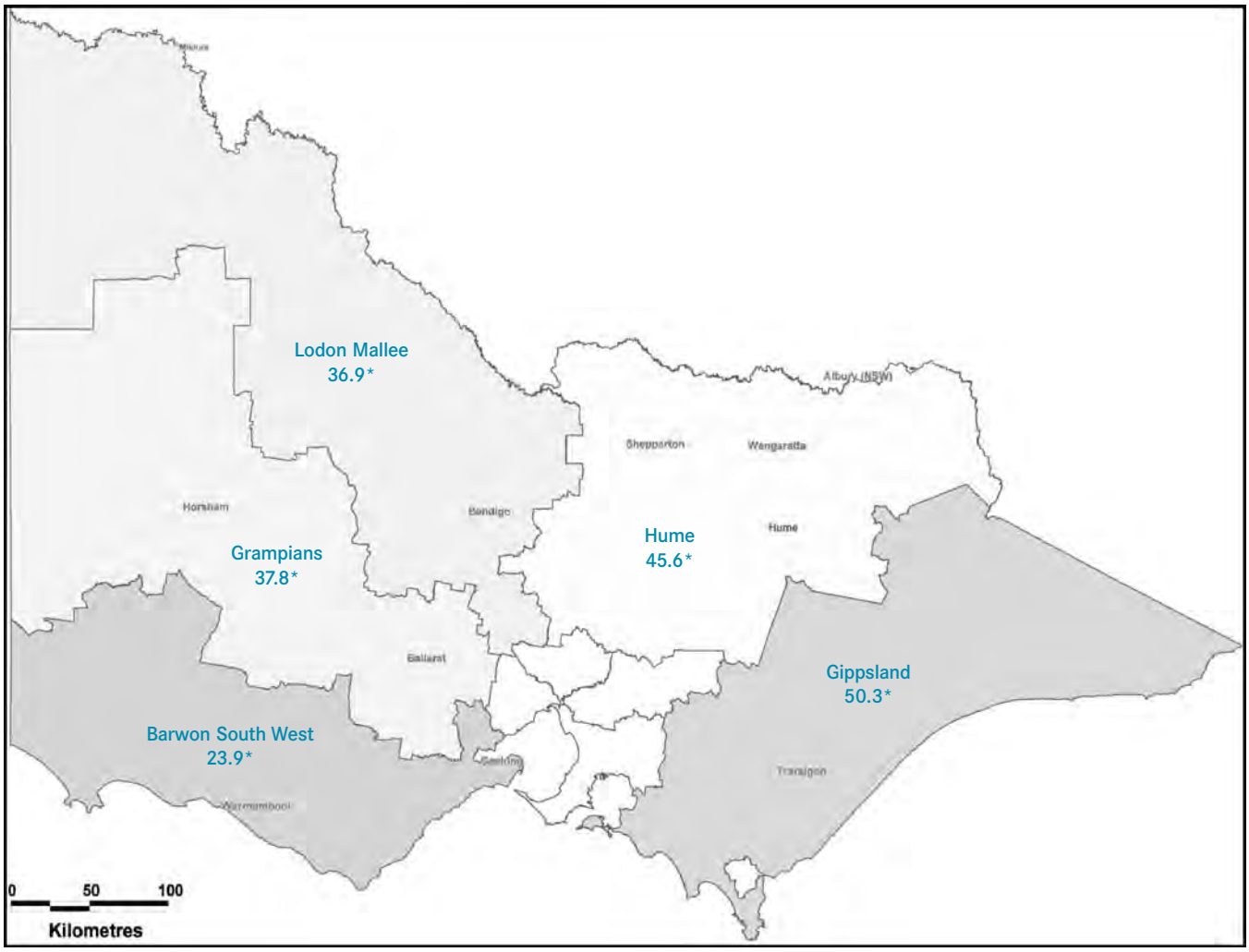
Figure 5: Day of injury for major trauma patients



Location of trauma injury

The following figures show the incidence rate of major trauma patients for each of the 5 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 the south and west of metropolitan Melbourne. This may be related to the types of roads in these areas and possibly high tourist movement. 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 Eastern Health. 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 included sixteen who were injured in New South Wales, three injured in Tasmania, two in Queensland, one injured in South Australia, one injured in Australian Capital Territory and two patients from overseas.

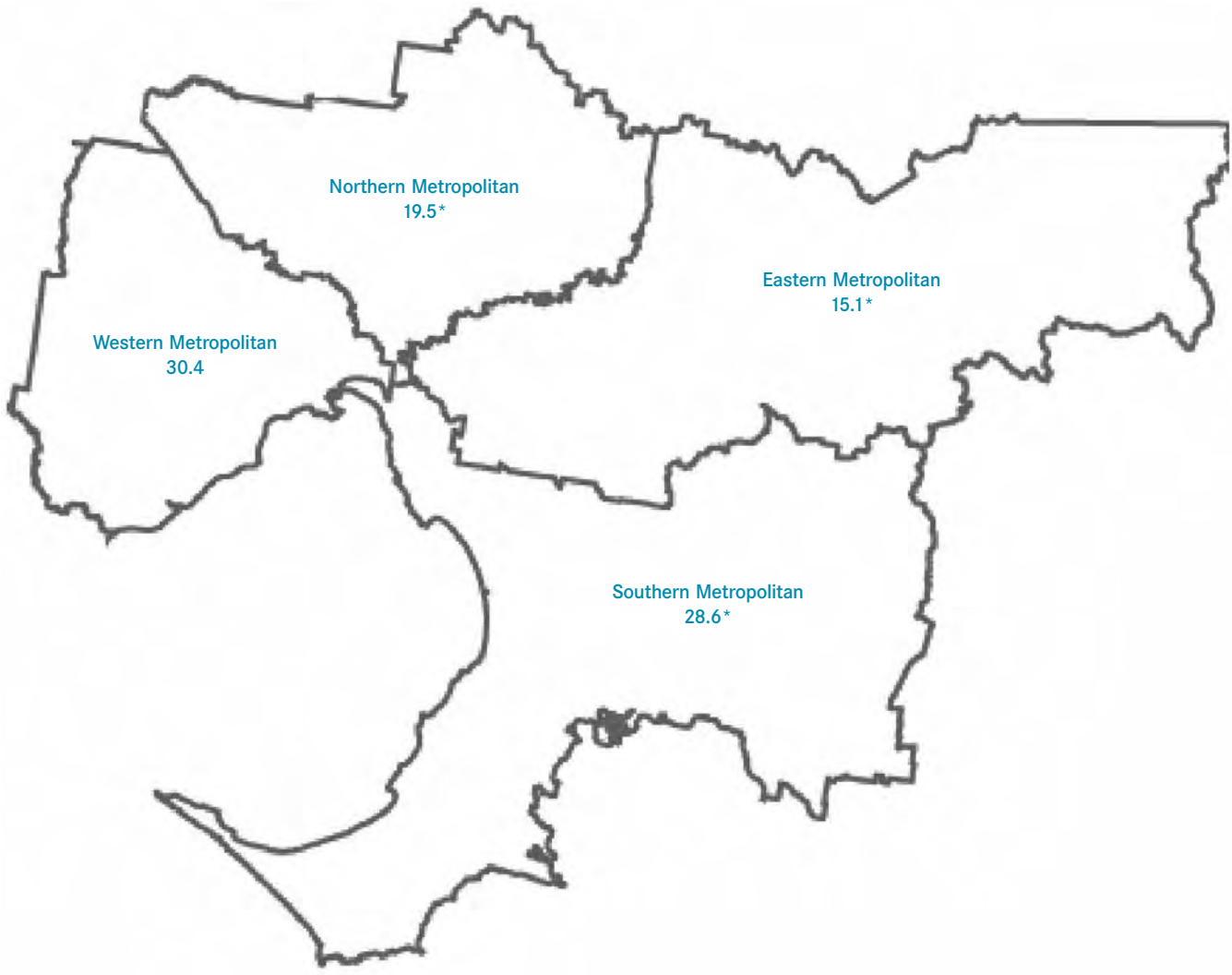
Figure 6: The incidence of major trauma patients in each region of Victoria



*rates are per 100,000 population

Note: 49 Trauma Patients who received their care at a MTS but had no injury postcode are not represented on the map (3.6 per cent).

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



*rates are per 100,000 population

Note: 49 Trauma Patients who received their care at a MTS but had no injury postcode are not represented on the map (3.6 per cent).

Trauma injuries sustained

Multiple trauma

The 1,379 patients sustained a total of 6,912 injuries. The distribution of the number of injuries across patients was: 27.4 per cent of patients with 1–2 injuries; 25.9 per cent with 3–4 injuries; and 46.7 per cent with five or more injuries. Road trauma victims commonly sustain multiple injuries and are responsible for the majority of poly-trauma cases.

Type of trauma

The vast majority were blunt trauma patients (87.9 per cent of the total). As previously reported in another Australian study (Trauma Department Liverpool Hospital, 1995–1999), the rate of penetrating injury was low (7.8 per cent of all patients). This 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. Blunt head, chest and orthopaedic injuries, which make up the majority of patients, generally require critical care monitoring, supportive care and less time-critical surgery. These patterns are different from many US trauma centres, where penetrating trauma is much more common than in Australia (Cameron et al., 1995; American College of Surgeons, 2002).

Injury severity

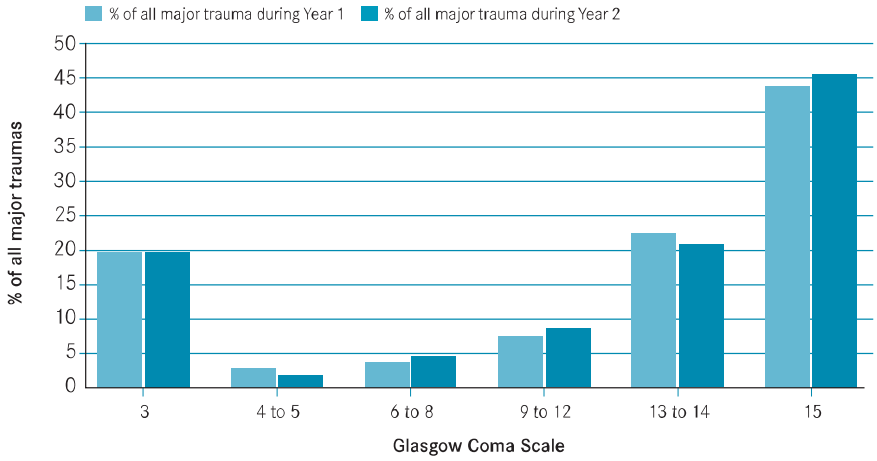
Head injury severity (GCS)

The median GCS on arrival in an emergency department was 14 (range: 3–15). The following figure shows the GCS distribution in patients on arrival in an emergency department. This was similar to the previous year.

KEY INDICATOR 4 – Head injury severity

25.6 per cent of all major trauma patients had a GCS<9

Figure 8: The Glasgow Coma Score for all major trauma patients on arrival from scene to first emergency department[6]



6 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 25 patients with no GCS information.

Injury severity (AIS and ISS levels) (Figures 9 and 10)

Severe injuries are defined as those with an AIS severity code >3. Across all major trauma patients, the ISS ranged from 1–75, with a median of 20. The distribution of ISS shows that over half of the major trauma patients had ISS scores in the range 16–25 (52.5 per cent). This reflects the ISS>15 registry inclusion criterion for defining major trauma patients. Patients with an ISS<15 were generally identified as major trauma patients by meeting the 'urgent surgery' criterion.

Overall 79.2 per cent of major trauma patients had an ISS>15. Significantly, there has been a 50 per cent drop in the patients with an ISS>40 from Year 1 to Year 2. This correlates with a fall in severe road trauma in 2002-2003. In the annual report from 2001-2002 the proportion of patients with a GCS<9 were only 13.1 per cent of major trauma patients compared to 25.6 per cent in this annual report. This change in proportion is mainly due to a change in methodology where the prehospital GCS is reported if there is no GCS recoded in the emergency department or the patient was sedated or intubated at arrival at the emergency department.

KEY INDICATOR 5 – Overall injury severity

79.2 per cent of all major trauma patients had an ISS>15

Figure 9: Distribution of Injury Severity Scores across all major trauma patients

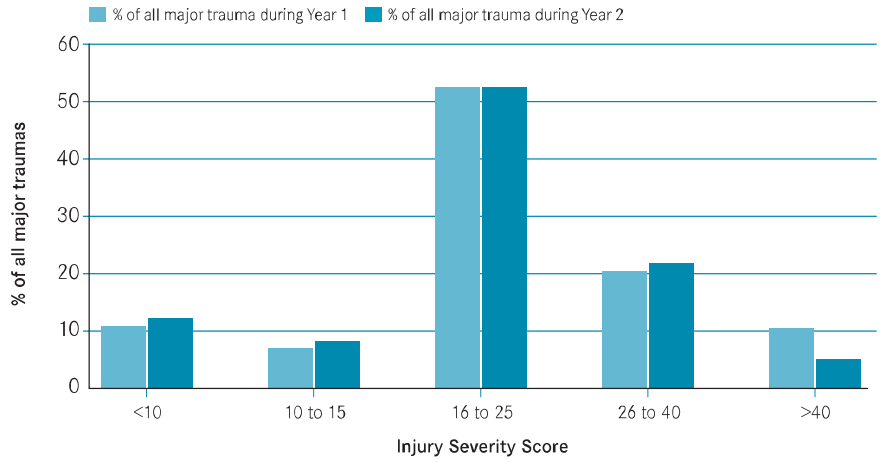


Table 4: Injury Severity Score of major trauma patients for each quarter

	Year 1 (July 01 to June 02)				Year 2 (July 02 to June 03)			
Injury Severity Score	**Q1 (%)**	**Q2 (%)**	**Q3 (%)**	**Q4 (%)**	**Q1 (%)**	**Q2 (%)**	**Q3 (%)**	**Q4 (%)**
ISS > 15	84.1	81.8	81.2	80.4	76.6	79.5	78.5	75.7
ISS > 40	9.6	10.2	10.9	9.8	5.0	4.8	6.4	4.2

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 MTS usually providing the highest complexity of care.

Year 1 and Year 2 data both indicate the vast majority of patients received their definitive care at MTS. This is a higher proportion than was expected in the ROTES report (1999).

KEY INDICATOR 6 – Definitive trauma service level

Trauma service level	% of major trauma patients	
	Year 1	Year 2
MTS	79.6	81.7
MeTS	13.7	11.0
MPCS	0.0	0.0
RTS	5.1	6.2
RUCS	1.6	1.1
RPCS	0.0	0.0

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 (i.e. Metropolitan Ambulance Service (MAS), Rural Ambulance Victoria (RAV), and Air Ambulance Victoria (AAV)). 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 MAS, RAV and AAV to ensure complete and accurate data capture. Ultimately, an electronic record may be the best solution.

For all patients directly transported from the scene of injury by an ambulance service (n=1024), 780 (76.2 per cent) in Year 2 compared to 68.3 per cent in Year 1, had both the time and date of the received call available. Similarly, 925 (90.3 per cent) patients in Year 2, compared to 87.1 per cent in Year 1, had both time and date of arrival at the hospital available.

Pre-hospital transit times

The median time from receipt of the ambulance call until the time of arrival at the first hospital was 50 minutes (range: 3–351 minutes) for non-entrapped patients and 71 minutes (range: 16–254 minutes) for entrapped patients.

Time at scene

Overall, the median time at the scene for entrapped patients was 30 minutes (range: 7–145 minutes) and 17 minutes (range: 0–158 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 than entrapped patients for all three ambulance services. Generally, patients serviced by AAV had a longer scene time than other patients. This reflects likely severity of traumatic injuries sustained as well as the distances associated with aviation ambulance services to regional and rural Victoria.

Quality assurance indicators

1. **Pre-hospital time >1 hour.** 20.4 per cent of the non-entrapped patients and 28.8 per cent of entrapped patients had a total time from receipt of the ambulance call to hospital admission >1 hour. Patients with a pre-hospital time more than the 'golden hour' are of concern, as early definitive care improves patient outcomes (Petri, Dyer, & Lumpkin, 1995).
2. **Pre-hospital scene time >20 minutes.** Of the 457 non-entrapped blunt injury patients with a calculated scene time, 40.3 per cent had a scene time >20 minutes.
3. **Systolic blood pressure <100 mmHg on arrival and scene time >10 minutes.** Of the 25 non-entrapped penetrating injury patients with a BP <100 mmHg on arrival at the scene, with a calculated scene time[7], 60.0 per cent had a scene time of greater than 10 minutes. The single most important determinant of penetrating trauma is time to definitive surgery.
4. **GCS<9 at scene and O2 saturation <90 per cent after 10 minutes.** Amongst the 96 head injured patients with a GCS <9 at the scene of injury and a recorded O2 saturation after 10 minutes, almost one-sixth (14.6 per cent) had an O2 saturation <90 per cent. Hypoxaemia is recognised as a significant cause of secondary brain injury.
5. **GCS<9 and systolic blood pressure <100 mmHg after 10 minutes.** Amongst the 135 head injured patients with an at-scene GCS<9 and a recorded systolic blood pressure after 10 minutes at the scene, 26.7 per cent had a systolic BP<100 mmHg. Hypotension is recognised as a significant cause of secondary brain injury.
6. **No intubation with GCS<9.** Of the 221 patients with a pre-hospital GCS<9 and known intubation status, 48.4 per cent did not have an endotracheal tube inserted at the scene. The majority of these patients were injured in car crashes.

7 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 PCRs, the registry data collectors were not always able to extract this information from the hospital medical records.

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 MTS

Table 3 describes the origin of the patients admitted to each of the MTS. 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 admitted directly from the scene of injury. This latter observation was as expected given triage guidelines for paediatric trauma.

The increasing percentage of patients arriving at MTS directly from the scene reflects the formal introduction of triage guidelines. For adult trauma patients, it is expected that 30-35 per cent of patients will be more than 30 minutes from a MTS and thus require transfer to a non MTS hospital first. A large increase in the number of patients who arrive at the Royal Children's Hospital reflects the compliance with triage guidelines.

Table 5: Numbers of direct admissions and transfers to each MTS

Hospital	Year	n	Direct from scene %	Transfer in from referral hospital (or from LMO) %	Other %	Total %
The Alfred	1	708	61.7	34.2	4.1	100.0
	2	732	64.6	32.8	2.6	100.0
Royal Melbourne Hospital	1	291	55.3	41.6	3.1	100.0
	2	292	62.3	36.3	1.4	100.0
Royal Children's Hospital	1	112	27.7	68.8	3.6	100.0
	2	114	39.5	57.9	2.6	100.0
Total	1	1111	56.6	39.6	3.8	100.0
	2	1138	61.5	36.2	2.3	100.0

Mode of transport

Overall, the most common mode of transport for direct admissions to a MTS was via a road ambulance provided by the MAS. The most common mode for referral admissions was via road transportation. As expected, the mode of transport to a Regional Trauma Service (ReTS) or a Regional Urgent Care Service (RUCS) was via road ambulance provided by the RAV.

Transfers across the system

Overall, 460 major trauma patients were transferred but complete information about all transfers and episodes of care was available for only 293 of these[8]. The majority of transferred patients (87.2 per cent) received their definitive treatment at MTS. The highest number of transferred patients was first treated at a ReTS followed by a Metropolitan Trauma Service (MeTS). This data may be biased in that ethics approval (and hence data collection) had been granted at all ReTS, but not all of the MeTS, during July 2002–June 2003. The patterns of transfer across the system indicate that patients are being transferred to a trauma service level with a higher designation, unless there is a need for specialist care (for example, for spinal cord injury (n=10)).

KEY INDICATOR 7 – Transfers across the system

(n=460 patients)	Definitive hospital of care No. of transferred patients			
First hospital of care	**MTS**	**MeTS**	**RTS**	**RUCS**
MTS	*	12	-	-
MeTS	123	16	-	-
MPCS	24	6	-	-
ReTS	139	*	-	-
RUCS	71	6	11	-
RPCS	8	-	*	*
Other	23	*	-	-

Note, 'other' refers to patients transferred into Victoria from interstate and overseas, and from a Victorian hospital that is not designated within the trauma system.

Specialist transfers

A total of 62 patients under the age of 16 years were transferred through to another trauma service level. The majority of these patients (76.8 per cent) had an ISS>15 and were transferred to a MTS (93.5 per cent), all of which were to the Royal Children's Hospital.

Table 4 summarises the specialist transfers. On a proportional basis, more children were transferred with head injury* than adults. Full data on all episodes of care were only available for 137 head injured patients and 23 spinal cord injury patients. The majority of transferred patients with a head injury (n=231) received their definitive treatment at a MTS (91.3 per cent). In comparison, a much lower proportion (61.3 per cent) of spinal cord injury patients were transferred to a MTS, as the majority were transferred through to a metropolitan trauma service. This reflects the trauma triage guidelines whereby patients with an isolated spinal injury should be transferred to the Austin and Repatriation Medical Centre.

8 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 is reduced compared to year 1 (36.3 per cent compared to 46.9 per cent for year 1). The reasons for no specific information from the referring hospital for year 2 were: ethics approval had not yet been received from the referring hospital before 30 June 2003 (n=48); data collectors were not yet recruited (n=38); information about episodes of care can not be collected from patients treated either interstate (n=12) and overseas (n=1); and data was missing from some hospitals with established data collectors: Major Trauma Services (n=1); Metropolitan Trauma Services (n=27); Metropolitan Primary Care Service (n=5); Regional Trauma Service (n=20); Regional Urgent Care Service (n=21), and Regional Primary Care Service (n=4).

Table 6: Numbers of specialist transfers

	Children		Adults	
Type of trauma	**No. of patients**	**% transferred**	**No. of patients**	**% transferred**
Head Injury*	78	38.5	543	37.0
Spinal cord injury	1	100.0	66	45.5
Both head and spinal cord injury	0	-	13	38.5

Note* a head injury was defined as a patient who received an injury to their head with an AIS>2.

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 MTS** The trauma team was activated for 71.3 per cent of all patients arriving at a MTS emergency department. This varied across the MTS hospitals: 79.4 per cent The Alfred Hospital; 64.3 per cent Royal Melbourne Hospital; 46.1 per cent Royal Children's Hospital[9]. 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 (eg. intoxication and assault with major head injury)
2. **No intubation in patients with GCS<9.** Across all trauma service levels, 99 non-intubated patients presented to an emergency department with a GCS<9. Three per cent were not intubated during their emergency department stay. All patients with a GCS<9 and known intubation status were intubated at the MTS.
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 head injured patients was >2 hours in 79 (23.7 per cent) patients who had a head CT and accurate times recorded. This time to scan was longest at the MeTS and lowest at the RUCS. The small number of patients with accurate CT scan times documented is an ongoing issue.
4. **Penetrating torso trauma >1 hour to theatre.** There were 789 patients with an injury to their torso region. The trauma was penetrating in 96 patients. Seventy-five of these penetrating torso trauma patients had full time to theatre data available, of which, 37 (48.5 per cent) were >1 hour. It is a part of the treatment protocol, that a number of these patients will be observed to determine whether operation is necessary. This will lead to "delayed" operation in less severe cases.

9 The significantly lower percentage of major trauma patients initiating a trauma team activation at the Royal Children's Hospital compared to the other major trauma services is affected by the fact that paging criteria, injury patterns and transfer patterns differ in children compared to adult trauma patients.

Outcomes of major trauma

This section describes the outcomes associated with the major trauma patients. Outcome measures include hospital length of stay, discharge status and injury severity measures at discharge. Unless otherwise stated, the data presented in this section relates to the hospital that provided definitive treatment.

Length of stay

The median length of stay in a trauma service before transfer to a MTS was four hours (range: 29 minutes – 30 days) in severely injured patients (ISS>15) and five hours (range: 45 minutes – 22 hours) in those with an ISS<15. At all levels of the trauma system, the median length of stay before transfer to a MTS was higher for ISS<15 patients. This reflects the priority transfer of the most severely injured patients.

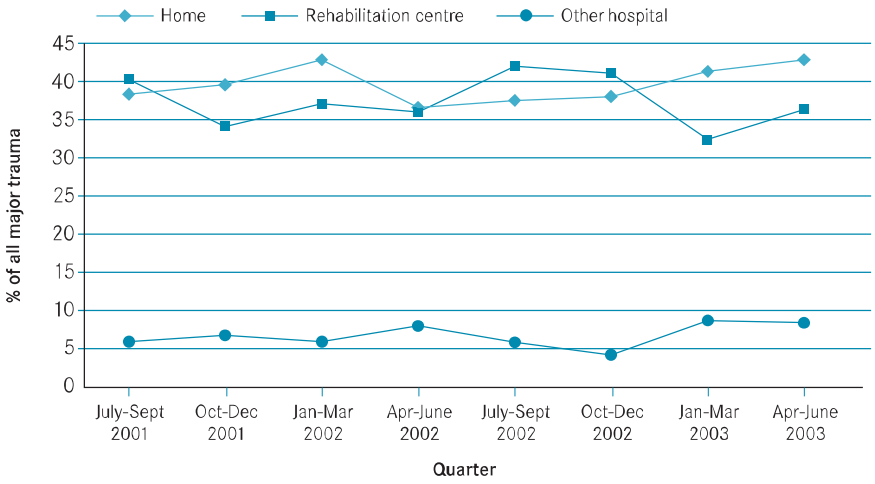
Discharge status

The majority of patients with a known outcome at their definitive hospital of care were discharged to home or rehabilitation. MTS patients were most commonly discharged to a rehabilitation centre. All others were most commonly discharged home. This reflects the fact that the more severely injured patients receive their definitive care at a MTS, and these patients are likely to require ongoing trauma care. The percentage of patients discharged to rehabilitation has been stabile.

KEY INDICATOR 8 – Discharge status

	% of all major trauma patients	
Discharge status from definitive hospital of care	**Year 1**	**Year 2**
Home	39.5	39.8
Rehabilitation centre	36.7	37.3
Dead	14.8	12.7
Other hospital	6.4	6.8
Other	1.9	2.0
Nursing home	0.6	0.6
Missing/unknown	0.0	0.5
Special accommodation	0.1	0.3

Figure 10: Seasonal trends for discharge status



Unexpected deaths

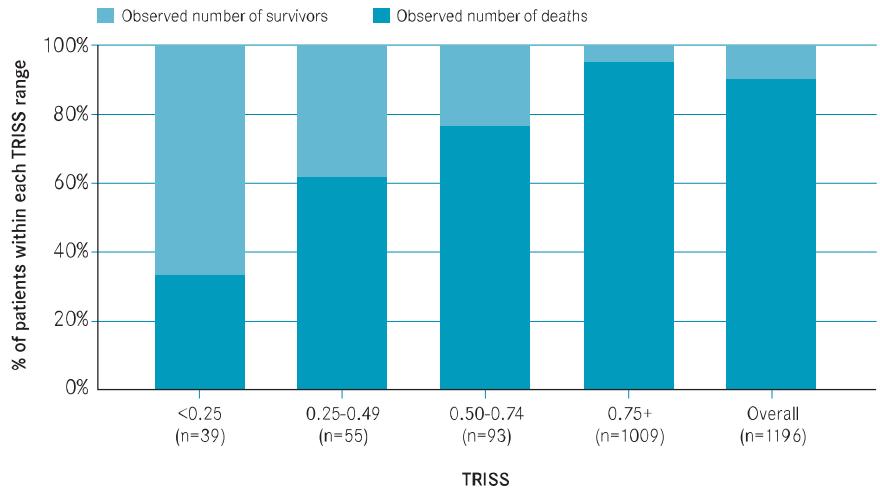
The standard international method of combining age, mechanism of injury, the Revised Trauma Score and Injury Severity Score (TRISS) can be used to estimate the rate of unexpected deaths (Boyd, Tolson & Copes, 1987). The TRISS is an estimate of the probability of survival for individual patients. The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

The TRISS could be calculated in 92.9 per cent of surviving patients with blunt or penetrating injuries, and in only 77.2 per cent of the deaths with blunt or penetrating injuries out of a total of 1,315 patients[10]. This is lower in the deaths because of the lack of information on some of the physiological parameters in these patients. This may be due to situations such as prehospital intubation or poor/loss of documentation. There are also some patients without adequate coronial data to estimate the injury severity score. VSTORM is currently developing better ways to allocate survival probabilities when necessary information is missing.

The distribution of TRISS scores is shown below. As expected, the death rate (as a proportion of patients) in each TRISS band decreased with increasing TRISS.

10 A TRISS score was estimated for the remaining patients; however as this did not significantly change any TRISS patterns the estimated TRISS scores are not included elsewhere in the report.

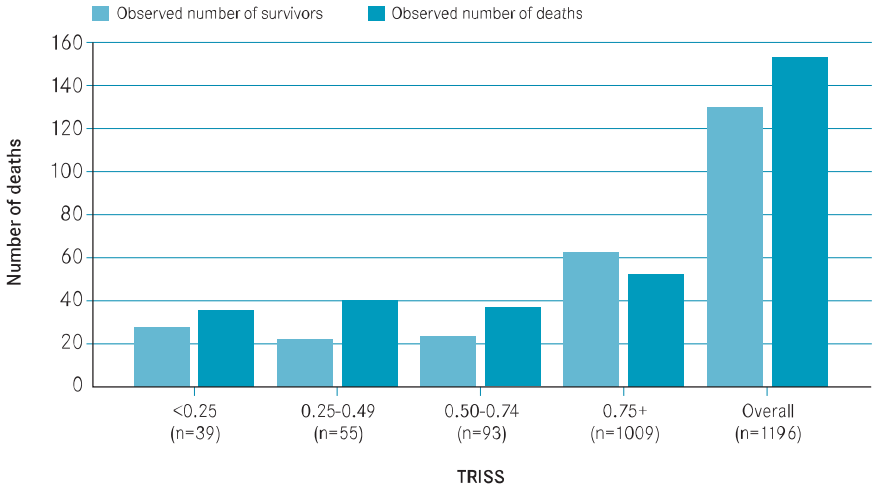
Figure 11: Mortality status of major trauma patients according to TRISS probabilities of survival, 1 July 2002 to 30 June 2003



A comparison of the observed and expected numbers of deaths, according to TRISS methodology, is shown below. Similar to year one figures, the overall observed number of deaths was significantly less than the expected number of deaths in year two. In every TRISS band, except 0.75+, the observed number of deaths was less than the expected number of deaths and the difference between observed and predicted TRISS numbers were statistically significant ($p<0.05$). Although the number of deaths was higher than expected in the 0.75+ TRISS band (59 versus 49), this was not a statistically significant difference. 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) numbers of deaths



Using the Consultative Committee on Road Traffic Fatalities (CCRTF) in Victoria methodology, the proportion of potentially preventable deaths (TRISS>0.50) as a percentage of all deaths with a TRISS value (n=129), is 63.6%, and the preventable deaths (TRISS>0.75) are 46.8%. The trend of potentially and actual preventable deaths is shown in Figures 13 and 14 for each quarter since the Registry's operation. While the proportion of potentially and actual preventable deaths have gone up, the absolute number of deaths in these groups has remained the same.

Figure 13: Trends in the number of potentially and actual preventable deaths

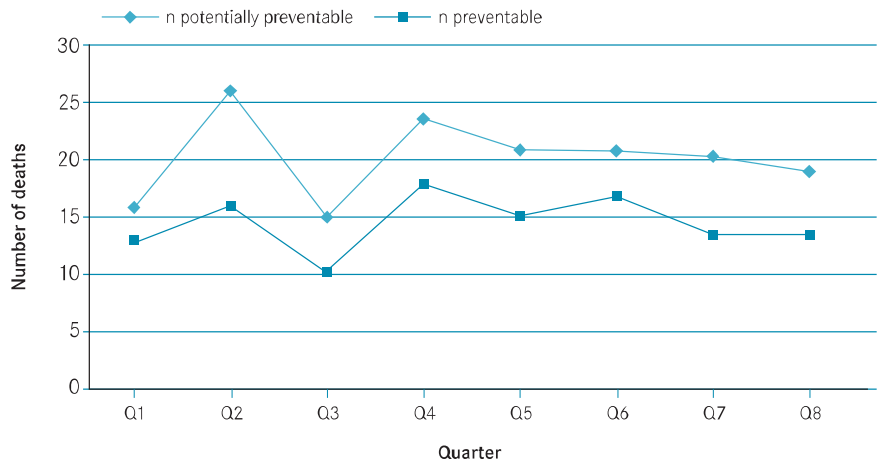
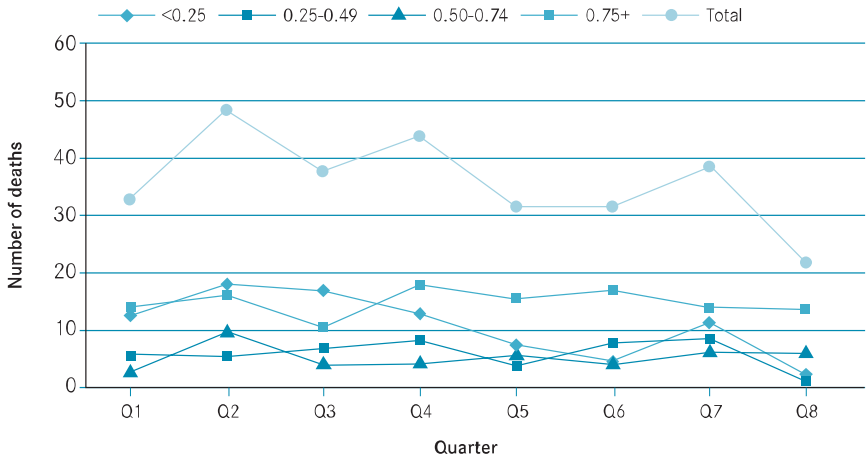


Figure 14: Trends in the distribution of deaths between the different TRISS groups



These figures indicate that the absolute number of deaths has dropped overall, with the largest drop occurring among patients with a lower probability of surviving (TRISS<0.50). This change can largely be explained by the decrease in motor vehicle trauma with ISS>40 (severe trauma). The reason for the decrease in motor vehicle related severe trauma is not clear but may be associated with road injury prevention strategies such as speed reduction.

Comparison of death rates across the MTS

The death rate was 14.8 in year one compared to 12.7 in year two. This may reflect a decreased number of injuries in the more severe group (ISS>40) and/or improved management.

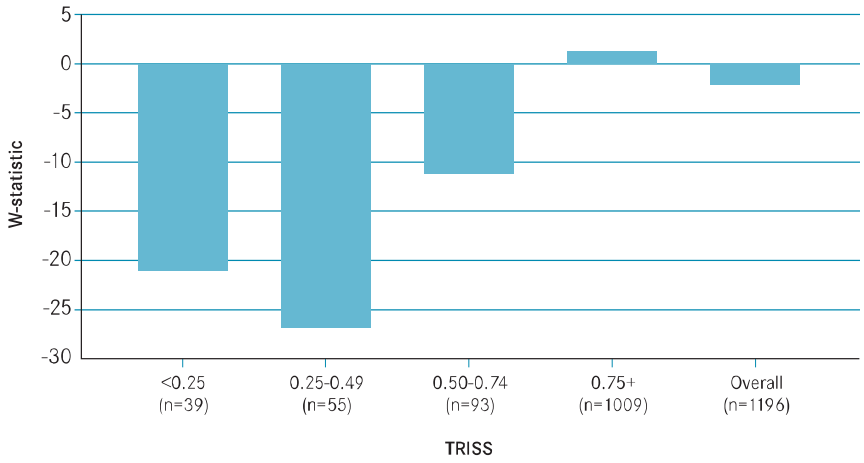
Comparison of death rates with international standard

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 (MTOS, (Boyd et al., 1987)). It can only be calculated for patients with a known TRISS probability of survival. The z-score for all major trauma patients with a TRISS probability of survival was 2.51. This indicates that the Victorian (in-hospital) major trauma death rate is statistically significantly different to that of the international standard. The positive value indicates more survivors than expected. However, the registry data relates to a sample of more severely injury patients than the MTOS sample (M-statistic=0.75).

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 to the MTOS 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 lives lost. The figure below shows the w-score in patients with different TRISS values. Overall, and on all TRISS bands, except the 0.75+ range, the Victorian trauma system saved more lives than expected compared to the MTOS norms.

Although the w-score was positive for patients in the TRISS>0.75 band, this was not statistically significant, indicating that the performance was the same as the international norm for these patients.

Figure 15: The w-score according to bands of TRISS



Death amongst patients not transferred

There were 49 patients not transferred to a MTS who subsequently died. They had a median age of 67 years, a median ISS of 20, and median length of hospital stay of 7.1 days (range: 11 minutes – 80 days; interquartile range: 4.5 hours – 7.1 days). Of these 49 patients not transferred to a MTS, nine died within an hour of arrival at hospital. The time to death following hospital arrival was not known for six patients.

Limitations and data caveats

The information presented in this report provides baseline data from which future monitoring of the Victorian trauma system can be performed. However, it is limited by its coverage of the trauma system. The coverage rate is estimated at greater than 90 per cent of all major trauma patients. However, until there is full coverage of all patients from every facility, the registry will not be able to provide definitive figures for monitoring of the system.

Hospital Capture

This incomplete coverage also has implications for monitoring all episodes of patient care. There are gaps in the data records when a patient's first or definitive hospital of care is one without ethics approval. Complete information about all transfers and episodes of care was available for only 293 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. This was often because ethics approval had not yet been received from either the referring hospital or receiving hospital. This problem will be eliminated when all hospitals contribute to the registry.

Hospital Records

The number of patients for which information on all episodes of care was available in the VSTORM database limits the dataset. A major factor is that patient care records (PCR) are not always available in the hospital medical records. When this situation occurred, an attempt was made to obtain the PCR directly from the ambulance service. Introduction of an electronic prehospital record would greatly help prehospital data collection.

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 trauma system is limited by the number of patients for which 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.

Data Limitations Shortfalls

A key component of a monitoring system, such as that undertaken by the registry, is the monitoring of outcomes. This report describes deaths and discharge status from the hospital of definitive care as two important outcome measures. In its second year, the registry has been less successful in collecting information on GCS and functional status at discharge. This is being addressed for the third year of data collection. In addition, post-discharge outcome data will be sought from all major trauma patients at up to 12 months post-injury via a telephone survey.

Generally, data are reported as either 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 is 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 overall goal of the registry is to collect information on all patients from every hospital and health care facility managing trauma patients across Victoria. Data is presented on 1,379 major trauma patients treated at 129 hospitals over the 12-month period July 2002–June 2003. 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 28.0 patients per 100,000 population and the death rate (both in-hospital and at-scene) is 23.3 deaths per 100,000 population. Approximately eighty per cent of all major trauma patients according to ROTES definition, had an ISS>15, 5.2 per cent had an ISS>40 and 25.6 per cent had a GCS<9. The overall death rate from major trauma is falling. The sustainability of this trend and the reasons for it will become clearer over time.

The data presented in this report provides evidence that the new triage guidelines have been implemented successfully. Eighty-two per cent of all major trauma patients received their definitive care at MTS. 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 that patients are being transferred to a trauma service with a higher designation, unless there is a need for specialist care (for example, for spinal cord injury).

Almost equal numbers of patients were discharged to home or a rehabilitation centre from their hospital of definitive care. MTS patients were most commonly discharged to a rehabilitation centre. All others were most commonly discharged to home. This may reflect that a higher proportion of very severely injured patients receiving their care at a MTS.

Overall, 12.7 per cent of all major trauma patients died compared with 14.8 last year. This death rate is similar to international reports. Adjusting for injury severity, the system is functioning at a high level.

The data presented in this report provides a 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 aid future improvement of the trauma system.

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Gabbe B, Cameron P, Finch C. Is the Revised Trauma Score still useful? Australian and New Zealand Journal of Surgery. 2003; 73: 944-948.

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Dowrick A, Gabbe B, Williamson O, VSTORM Group. Does upper extremity injury affect outcomes in major trauma patients?. Submitted to the Journal of Trauma.

Gabbe B, Cameron P, Wolfe R, Simpson P, Smith K, McNeil J. Prehospital prediction of Intensive Care Unit stay and mortality in blunt trauma patients. Submitted to the Journal of Trauma.

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Cameron P, Gabbe B, McNeil J, Finch C, Smith K Wolfe R. Prehospital predictors of major injury. Proceedings of the 13th World Association for Disaster and Emergency Medicine Congress, Melbourne, March 2003.

Collins L, Smith K, Cameron P, Finch C, Faulkner C, McNeil J. Monitoring and Evaluation of the Victorian State Trauma System – The Victorian State Trauma Registry. Australasian Epidemiology Association 10th Annual Scientific Meeting. Sydney, NSW. 27th-28th September 2001. (Australasian Epidemiologist; 2001; 8(3): 32).

Glossary

Abbreviated Injury Scale (AIS)	A numerical method for ranking and comparing injuries by severity, and to standardise 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.
Charleson Index	The Charleson Index assigns weights (0-6) to co-morbid conditions and has been used to predict mortality and morbidity in cohorts of hospitalisations. The Charleson index have been modified to be based on ICD-9 codes[11] and ICD-10 codes.
Coronial cases	Each coronial case are assigned a case number the coronial database. As long as a case is under investigation it is marked as “open”, which means that no identifying information is available. When an investigation is finished the case is marked as closed and identifying information becomes available.
Functional Measure	The Functional Measure (FM) 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 Scale (GCS)	The GCS is a measure of the level of the severity consciousness of a patient and is an indicator of of a head injury. The scale ranges from 3 (unconscious) to 15 (normal functioning), with a score <9 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.

11 J. Librero, S. Peiro and R. Ordinana, Chronic comorbidity and outcomes of hospital care: length of stay, mortality, and readmission at 30 and 365 days. J Clin Epidemiol 52 (1999), pp. 171–179.

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.
Injury Severity Score (ISS)	Used to define injury severity for comparative purposes and is a useful tool for the evaluation of trauma outcomes. It incorporates both anatomical and severity indices and is derived from the AIS 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>15 is taken to be indicative of major trauma as mortality in this group has been shown to be >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 MTOS database (international standard). Values range from 0–1. If the M-statistic is >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, as they relate to patients with similar injury severities.
Major Trauma Outcome Study (MTOS)	The MTOS is 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 GCS, systolic blood pressure and respiratory rate. Reliance on the respiratory rate and 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 0–12, 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 <2 are associated with a 70 per cent or more predicted probability of death (Senkowski & McKenney, 1999).
TAC-compensable patient	Patients where there is a strong likelihood that compensation would be received from the Transport Accident Commission (TAC) for treatment costs and/or loss of income. This is as recorded at the last hospital of care.
Trauma service level	The Victorian trauma service has a tiered 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 Hospital, Royal Melbourne Hospital and Royal Children's Hospital. A hospital at the highest tier of the state trauma service. 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. Regional Urgent Care Service: hospitals at this level are at the second tier of the state trauma service in rural and regional Victoria. Regional Primary Care Service: hospitals at this level are at the third, and lowest tier of the trauma service in rural and regional Victoria.

TRISS	An estimate of the probability of survival of individual patients. It is derived from the age, RTS, mechanism of injury and ISS. 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 (VAED)	This is maintained by Department of Human Services and 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.
W-score	The W-score is 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	The Z-score is used to compare a dataset with the international MTOS 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 > 2 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 than expected survivors.

Appendix 1–The VSTORM Group

The VSTORM group, based at the Department of Epidemiology and Preventive Medicine at Monash University, coordinates the Victorian State Trauma 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 2002–2003 VSTORM Steering Committee, all of whom have expertise in epidemiology, trauma management or related areas, included:

- Mr Chris Atkin (Senior Trauma Surgeon, The Alfred Hospital)
- Mr Bill Barger (Manager, Metropolitan Ambulance Service Victoria)
- Associate Professor Peter Danne (Director of Trauma, Royal Melbourne Hospital)
- Dr Belinda Gabbe (NH&MRC Fellow, Department of Epidemiology and Preventive Medicine, Monash University)
- Dr Robert Henning (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)

Note, other Steering Committee members joining after July 2003 included:

- Associate Professor Rodney Judson (Director of Trauma, Royal Melbourne Hospital)

The Victorian State Trauma Registry staff during the second year of its operations included:

- Associate Professor Caroline Finch (Head of VSTORM until August 2003)
- Dr Lisa Collins (Research Fellow)
- Mr Sean Conley (Project Coordinator)
- Ms Christine Faulkner (Project Coordinator)
- Ms Sue McLellan (Project Coordinator)
- Ms Doris Toh (Personal Assistant to Head)
- Mr Steven White (Database Manager)
- Various casual data entry clerks

Report prepared by:

- Ms Kirstine Magtengaard (Project Coordinator)

Appendix 2–Hospitals and health services with ethics committee approval for the period July 2002–June 2003

Collection of patient-level data from each of the hospitals and health services is conducted under strict NHMRC guidelines and national and Victorian privacy legislation. Accordingly, full ethics committee approval is required from each hospital/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 from the NCIS (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/rural areas. By 30 June 2003, registry data collection was approved at 129 hospitals/health services. These 129 hospitals/health services are listed in the following table.

Trauma Service Level	Hospital
Major Trauma Service	The Alfred Hospital
	Royal Children's Hospital
	Royal Melbourne Hospital
Metropolitan Trauma Service	Austin and Repatriation Medical Centre
	Dandenong Hospital
	Monash Medical Centre (Clayton)
	Mornington Peninsula Hospital (Frankston)
	The Northern
	*St. Vincent's Hospital
	Western Hospital
Metropolitan Primary Care Service	*Epworth Hospital
	*Mayne Health (Knox Private Hospital)
	Monash Medical Centre (Moorabbin)
	Mornington Peninsula Hospital (Rosebud)
	Sandringham and District Memorial Hospital
	*Sunshine Hospital
	*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)
Regional 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 & Community Services
	Portland and District Hospital
	South West Health Care (Camperdown)
	Terang & Mortlake Health Service (Terang)
	Timboon and District Healthcare Service
	Western District Health Service (Hamilton) (changed to a Regional Trauma Service, December 2003)
Regional Primary Care Service	Balmoral Bush Nursing Centre
	Cobden District Health Services
	Colac Community Health Services (Birregurra)
	Dartmoor & 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
Regional Urgent Care Service	Cohuna District Hospital
	Echuca Regional Health
	Kerang & District Hospital
	Kyabram & District Memorial Community Hospital
	Kyneton District Health Service
	Maryborough District Health Service
	Swan Hill District Hospital
Regional Primary Care Service	Boort District Hospital
	Dingee Bush Nursing Centre Inc.
	Inglewood and District Health Service
	Lockington & District Bush Nursing Centre
	Mallee Track Health & Community Service
	Managatang and District Hospital
	McIvor Health & Community Services
	Mt Alexander Hospital
	Robinvale District Health Services
	Rochester and Elmore District Health Service
	Sea Lake & District Health Service Inc.

Gippsland Region	
Regional Trauma Service	New Latrobe Regional Hospital
Regional Urgent Care Service	Bairnsdale Regional Health Service
	Central Gippsland Health Service (Sale)
	Gippsland Southern Health Service (Leongatha, Korumburra)
	Kooweerup Regional Health Service
	Orbost Regional Health
	South Gippsland Hospital
	Warley Hospital
	West Gippsland Health Care Group (Warragul)
	Yarram & District Health Service
Regional 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 Service
	Wimmera Health Care Group (Horsham)
Regional Urgent Care Service	East Grampians (Ararat)
	East Wimmera Health Service (St Arnaud)
	Edenhope & District Memorial Hospital
	Hepburn Health Service (Daylesford)
	Stawell Regional Health
	St. John of God Health Care Ballarat
	West Wimmera Health Service (Nhill)
Regional Primary Care Service	Ballan and District Soldiers' Memorial Bush Nursing Hospital
	Beaufort & Skipton Health Service (Beaufort, Skipton)
	Djerriwarrh Health Services
	Dunmunkle Health Services
	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
	Rural Northwest Health (Hopetoun, Warracknabeal)
	Wimmera Health Care Group (Dimboola)

Hume Region	
Regional Trauma Service	Goulburn Valley Health (Shepparton)
	Wangaratta District Base Hospital
Regional Urgent Care Service	Alpine Health (Bright, Mt. Beauty, Myrtleford)
	Benalla and District Memorial Hospital
	Cobram District Hospital
	Kilmore & 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
Regional 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
	Yackandandah Bush Nursing Hospital

* These hospitals have not been included in the results of this report as data was incomplete due to lack of a data collector.