NSW HEALTH

NSW Metropolitan Trauma System Monitoring Report

1995-2000

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Executive summary

The *NSW Metropolitan Trauma Monitoring Report* is concerned with the measurement of clinical indicators across the metropolitan trauma system. The intent of the report is to present information on the performance of the metropolitan trauma system against which individual trauma services can assess themselves. Data analyses have been undertaken for the five years from July 1995 to June 2000, with information from the first data collection period in 1994/95 presented as a comparison.

The NSW Trauma Monitoring Program has been in place since 1994/95. Analysis is conducted using data submitted from the Ambulance Service of NSW (Ambulance Service), the trauma registries maintained at each of the major trauma centres and the *Police Report of Death Registry.* The report is presented in four sections relating to the four phases in the management of the trauma patient across the trauma system:

1. Pre-hospital.
2. Emergency department.
3. Definitive care and trauma outcomes.
4. Performance is assessed using eleven performance indicators.

Pre-hospital phase

On average 39,431 trauma-related cases are transported by the Ambulance Service within the Sydney metropolitan area per annum of which 94% of cases will be triaged as minor injuries (categories 3-5). On average about 1,970 cases are triaged as potentially severely injured (categories 1 and 2), the majority of which are then transported to a major trauma centre. These cases represent between five to six cases per day across Sydney. Approximately 43% of these cases will have severe injuries as defined by an Injury Severity Score greater than or equal to 16 (ISS $\geq$ 16).

The accuracy of the pre-hospital triage tool used by the Ambulance Service is of particular relevance in relation to:

- the additional workload for both the Ambulance Service and the major trauma centres resulting from over-triage of cases necessitating bypass of the nearest hospital
- the sensitivity of the triage tool in identifying severely injured patients (ISS $\geq$ 16)
- the under-triage rate, where patients with severe injuries are triaged initially as minor (category 1-3).

Over-triage results in an additional two to three cases per major trauma centre per week. Between 57% and 83% of cases with an ISS $\geq$ 16 are correctly triaged in the pre-hospital environment. The under-triage rate is on average 19% of cases.

Recommendations

The following recommendations are made in relation to the findings of this report. It is envisaged that the Institute of Trauma and Injury Management will work with the major trauma centres and Area Health Services to progress the recommendations.

Pre-hospital phase

Recommendation 1

Major trauma centres and the Ambulance Service should review their quality improvement and performance improvement programs to ensure prospective data collection and sharing of data, for the subset of patients with an injury severity score greater than or equal to 16, in relation to the pre-hospital triage decision.

Recommendation 2

The Ambulance Service should monitor the effective use of the pre-hospital trauma triage tool, as well as the compliance of ambulance officers in accurately completing the ambulance case sheets and the timely provision of this information to the receiving hospital.

Recommendation 3

Close monitoring of the number of cases triaged as category 6 by both the Ambulance Service and the major trauma centres, with review of the circumstances surrounding each case.

Recommendation 4

Local review is undertaken of the circumstances involved for all cases that have been triaged as category 7. Feedback regarding this review is to be provided to the Ambulance Service and the NSW Trauma Services Committee.

Recommendation 5

The under-triage rate should continue to be monitored and included as a performance indicator in subsequent monitoring reports. A performance benchmark for the indicator should also be established.

Recommendation 6

The major trauma centres should advise the Ambulance Service of cases which are identified as under-triaged (both cases transported directly to the major trauma centre and cases which are transferred to the major trauma centre from urban hospitals). A review of these cases should then be undertaken.

Recommendation 7

The Ambulance Service should undertake close monitoring of performance against the established time benchmarks and provide feedback to the NSW Pre-Hospital Trauma System Committee of its findings and proposed actions to address the issues.

Recommendation 8

In future reports, data regarding entrapment and entrapment time should be included in the analysis of scene time data.

Major trauma centre – emergency department phase

Recommendation 9

Extend the minimum dataset requirements to include information on the source of transfer to the major trauma centres, including the mode of arrival at the transferring hospital and the reason for transfer.

Recommendation 10

Development and implementation of standardised trauma team activation criteria across the metropolitan trauma system. Following this, Indicator 7 should be modified to measure response, according to the pre-defined trauma team activation criteria.

Recommendation 11

All major trauma centres are to institute prospective performance improvement programs to review the under-triage rate for trauma team activation. The trauma team activation data should be reported in the *Annual Trauma Report* of each major trauma centre.

Definitive care phase

Recommendation 12

All major trauma centres are to peer review all patients falling outside the current agreed benchmarks for access to definitive care. The review should include an evaluation of the reason for delay, the clinical appropriateness of the delay and the impact of the delay on patient outcome. Local strategies should be developed and implemented in response to any identified issues. Any identified system-wide issues are to be reported to the NSW Trauma Services Committee.

Trauma outcomes

Recommendation 13

Expansion of the current performance indicators for trauma outcome to include relevant morbidity and quality of care indicators.

Recommendation 14

NSW Institute of Trauma and Injury Management coordinate a review of the relevance and appropriateness of West's Potentially Avoidable Death Index and Wesson's Salvageable Rate and determine which outcome measures should be incorporated in the ongoing Trauma Monitoring Program.

Recommendation 15

All trauma related deaths should undergo review locally by the Hospital Trauma Committee, with any potentially avoidable deaths reported to the NSW Trauma Death Review Committee.

Recommendation 16

The NSW Trauma Death Review Committee commence a program of Peer Review Death Audit of all deaths that are peer reviewed at a major or regional trauma centres as potentially avoidable. A report of provider and system errors should be provided in a patient de-identified manner to the NSW Department of Health and to the Area Health Services.

General recommendations

Recommendation 17

Institute of Trauma Injury Management (ITIM) to coordinate the implementation of a Minimum Trauma Data Set (MTDS) across all major and regional trauma services with standard definitions and development of a data dictionary.

Recommendation 18

Reporting of performance data on an annual basis is mandatory for all major trauma centres and metropolitan regional trauma centres.

Recommendation 19

Future trauma monitoring reports will report on individual, site specific trauma centre data which will be used for analysis.

Recommendation 20

All Area Health Services with a major trauma centre prepare an annual trauma report. This report should include a review of the spectrum of injury and injury outcomes in their hospital. It should include a report on performance review and programs of continued performance improvement and a report on access to definitive care complications and adverse outcomes and mortality outcomes.

Recommendation 21

A review of the trauma monitoring program should be undertaken, to include a review of the performance indicators for each phase of care and the establishment of appropriate performance benchmarks.

Introduction

This report is concerned with the measurement of clinical indicators across the metropolitan trauma system. The intent of the report is to present information on the performance of the metropolitan trauma system against which individual trauma services can assess themselves. Data analyses has been undertaken for the five years from July 1995 to June 2000, with information from the first data collection period in 1994/95 presented as a comparison.

The report is presented in four sections, with each section relating to a different phase in the management of the trauma patient:

- pre-hospital (the ambulance phase of care)
- emergency department (mode of arrival and local response at the major trauma centre)
- definitive care (surgical intervention when required)
- patient outcomes (including the number of deaths).

Eleven performance indicators are presented. These indicators remain unchanged from those introduced in 1994 (Appendix 1). In the absence of established benchmarks for each of the performance indicators, indicator results are evaluated based on performance in previous years. With the exception of the pre-hospital phase, the indicators are applied to all major trauma centres in the Sydney and Newcastle metropolitan areas. In addition to the performance indicators, other information has been incorporated, where available, with the intent of providing a more complete picture of the trauma system in the Sydney metropolitan area.

Background

A system of trauma services for NSW was first proposed in 1988.[1] The NSW State Trauma Plan[2] was released in 1991 resulting in the implementation of a three-tier trauma system in Sydney and Newcastle in 1991, with the pre-hospital component commencing in Sydney in March 1992.

The State Trauma Plan was revised in 1994[3] in response to the release of the *National Road Trauma Advisory Committee (NRTAC) Report of the Working Party on Trauma Systems* in 1993. Following this review, the system was changed to two tiers in the Sydney metropolitan area to bring it in line with the structure recommended by NRTAC. There was no change to the number and siting of the designated major trauma centres. The NSW Trauma System Advisory Committee was established in 1994 as a sub-committee of the NSW Critical Care Advisory Committee and the metropolitan trauma monitoring program was commenced. A further review of the metropolitan trauma system was undertaken in 2000 with the recommendations included in the report of the Greater Metropolitan Services Implementation Group.[4] A further review of the data collection, minimum data set and the and the monitoring program, has been undertaken during 2003 by the NSW Institute of Trauma and Injury Management (ITIM).

The objective of the Sydney metropolitan component of the State trauma system is the provision of a coordinated and systematic means for identifying patients at risk of serious injury, and the delivery of these patients, in a timely manner, to definitive care, matching the needs of the injured to the appropriate level of care. The aims of this system are prompt delivery of life saving care and reduction in inter-hospital transfers of critically injured patients.

1. Emergency Services in NSW, *Policy for Trauma Services*, NSW Department of Health (ISBN. 0 7305 3317 4).

2. *State Trauma Plan*, NSW Department of Health, 1991 (ISBN 0 7305 3531 2).

3. *NSW State Trauma System Policy Review 1994,* NSW Department of Health, June 1994 (ISBN 0 7310 0591 0).

4. *Report of the Greater Metropolitan Services Implementation Group,* NSW Department of Health, June 2001 (ISBN 0 7347 3296 1).

The metropolitan component of the State trauma system is based on a system of pre-hospital triage where ambulance officers identify patients either with, or at risk of serious injury and the delivery of the these patients in a timely manner to the closest major trauma centre. The model requires the coordination between the pre-hospital providers and the major trauma centres. The major trauma centres are expected to have the necessary expertise and equipment to offer definitive treatment to the most severely injured patients with the most complex injuries. This includes rapid on-site access to a range of tertiary referral services including neurosurgery, cardiothoracic surgery and orthopaedics, in addition to tertiary level emergency department, operating theatres and intensive care unit to manage these complex cases.

Moderately and severely injured patients, while constituting only a small number of all trauma patients, are associated with high mortality. It is these patients who will benefit most from a system of care which facilitates rapid access to a trauma centre with multidisciplinary teams experienced in the management of severe trauma and ready access to the specialist services which may be required.

During the period of this review there were ten major trauma centres in Sydney located at:

- Liverpool Hospital
- Nepean Hospital
- Prince of Wales Hospital
- Royal North Shore Hospital
- Royal Prince Alfred Hospital
- St George Hospital
- St Vincent's Hospital
- Sydney Children's Hospital
- The Children's Hospital at Westmead.
- Westmead Hospital

John Hunter Hospital is the only major trauma centre located outside the Sydney metropolitan area. A review of the NSW trauma system was undertaken in 2000, this review recommended five adult and two specialist paediatric major trauma centres are required in the Sydney metropolitan area. This recommendation was endorsed by the Greater Metropolitan Services Implementation Group and included in the recommendations contained in the report of the Greater Metropolitan Services Implementation Group (June 2001). John Hunter and John Hunter Children's Hospitals will remain the only major trauma centres located outside the Sydney metropolitan area.

Major trauma and trauma registries

The introduction of the Trauma Monitoring Program in 1994 entailed the establishment of trauma registries in each major trauma centre with the provision of seeding funds from the NSW Department of Health. In 1995 funding was provided to establish a trauma death registry located at the Royal Alexandra Hospital for Children (now the Children's Hospital at Westmead) to collect data on all injury related deaths reported to the Coroner.

Severely injured trauma patients in this report have been measured by enumerating cases with an Injury Severity Score (ISS) of sixteen or higher (ISS $\geq$ 16). The ISS is an accepted international measure of the severity of injuries sustained, with a score of sixteen or higher considered as indicative of severe injury. The use of the ISS allows comparison with the previous evaluations conducted in NSW. It should be noted that patients with an ISS score less than sixteen constitute the largest proportion of trauma presentations to NSW hospitals and some of these patients may have sustained a potentially life-threatening injury.

Since the inception of the monitoring program each major trauma centre has been required to submit data on an annual basis to the NSW Department of Health. Only data on cases with an Injury Severity Score of sixteen or higher (ISS $\geq$ 16) are submitted. The centres are required to submit aggregated data on a number of specified items (Appendix 1). This data is then further aggregated and collectively analysed according to the established performance indicators (Appendix 2).

It has become apparent during the monitoring process that there are disparities across the individual trauma registries in the data definitions used, the range of data collected, and the quality of this data. This is being addressed through the allocation of additional resources to major trauma centres by ITIM.

Pre-hospital phase
(Sydney metropolitan area only)

The pre-hospital phase of care is the period from the time of injury to arrival at hospital. This phase focuses on the period during which the patient is in the care of the Ambulance Service. The accurate identification of patients with severe injury and their timely arrival at hospital are crucial to the effectiveness of the trauma system. Five of the eleven performance indicators pertain to the pre-hospital phase.

The pre-hospital phase has been divided into three areas of relevance:

1. **Trauma caseload**
   The number of trauma cases transported by the Ambulance Service.
2. **Accuracy of pre-hospital triage**
   The effectiveness of the triage tool in identifying patients with severe injury and transporting these patients to an appropriate facility.
3. **The pre-hospital times**
   Examination of the time taken from initial notification of the Ambulance Service to the arrival of the trauma patient at hospital.

The information presented has been derived from data supplied by the Ambulance Service from their central database. The database is compiled from the individual case sheets completed by the attending ambulance officers. Pre-hospital data has been included from 1994 to June 2000. Additional data for the period July 1996 to June 2000 has been included in Appendix 4.

A performance review of the Ambulance Service was undertaken by the Audit Office in 2000/01 with the report[5] *'Readiness to Respond'* released in March 2001. This review identified a number of issues impacting on recent reported ambulance performance. The issues relevant to this monitoring report include:

- data reliability during the implementation of the Computer Aided Dispatch (CAD) System in Sydney in 1999
- changes to data definitions affecting comparability of data with that collected pre-CAD
- as well as, the impact of industrial disputes, resulting in the non-completion of case sheets ('paper bans') during 1999, on the volume and accuracy of data collected.

The Ambulance Service has indicated that following the full implementation of CAD the capture, reliability and accuracy of the time related data has improved. The Ambulance Service has also indicated that a number of additional strategies have been implemented to date, including significant changes to operating procedures to improve overall performance. While these changes have been implemented after the reporting period included in this report (1995-2000) it is anticipated that improvements in performance will be demonstrated in subsequent reports. The issues identified by the Audit Office should be considered when reviewing the data results, particularly when comparing data from 1999/2000 against previous years.

Background

Pre-hospital trauma triage is about the early recognition of patients with severe injuries, as well as those at risk of severe injury, and the transport of these patients from the scene of injury to a facility that is able to provide the specialised care needs for these patients. This entails ambulance officers initiating a triage process which identifies the most severely and potentially severely injured patients for direct transport, bypassing the closest hospital if necessary, getting the 'right patient to the right hospital in the right time'.

The hospital bypass component of the pre-hospital trauma triage protocol (Protocol 4) only applies to the Sydney metropolitan area where it has been in place since March 1992. Because of the relatively short distances between hospitals and the geographic spread of the major trauma centres in the Sydney metropolitan area it is possible to bypass smaller hospitals and deliver the patient to a major trauma centre in a timely manner. Because of distances and travelling times this is often not feasible in rural areas. The classification and recording of transport decisions is made by the attending ambulance officers according to Protocol 4 of the Ambulance Service (Appendix 3). Because hospital bypass is only applied in the Sydney metropolitan area, the information in this section pertains only to this area.

5. *Performance Audit Report,* Ambulance service of New South Wales: Readiness to Response, The Audit Office of New South Wales, 2001, ISBN 0734 72117, www.audit.nsw.gov.au

Pre-hospital trauma triage categories

The trauma transport decision is made using a number of criteria which include both physiological parameters and the accident mechanisms which carry a high risk of serious injury (Appendix 3). Once the patient has been assessed, the ambulance officer will determine the appropriate trauma transport decision, this is then recorded on the patient's case sheet:

Categories 1-3 – 'minor'

Patients found to have either a minor injury or a low risk mechanism (that is, the causative factor is unlikely to result in a serious injury) are triaged as 'minor' and given a category of 1 to 3. These patients are transported to the nearest hospital emergency department regardless of its trauma designation.

Categories 4-5 – 'serious'

Patients found to have either sustained a severe injury or who were involved in a mechanism which places them at high risk of sustaining severe injury, are triaged as 'serious' trauma requiring transport to the nearest major trauma centre. These patients are classified as either category 4 or 5 depending on the location of the nearest major trauma centre.

Category 6

Is used in situations where a patient who fulfils the criteria for transport directly to a major trauma centre, is transported to another hospital because the nearest major trauma centre has restricted access. The use of this category should be extremely rare.

Category 7 – 'dying'

Patients triaged as being severely injured, in an unstable condition and at risk of dying enroute to a major trauma centre are triaged as category 7, 'dying', and are transported to the nearest hospital for immediate resuscitation, regardless of its trauma designation.

Trauma patients can be transported from the accident scene by either road ambulance or by rescue helicopter. The Ambulance Service is responsible for coordinating and tasking the helicopter services for primary response to an accident scene when required. Data for primary helicopter responses is not included in this section. The established pre-hospital benchmarks are not relevant for helicopter responses.

Trauma caseload for metropolitan Sydney Area Health Services

The average number of cases transported by ambulance to hospital across the Sydney metropolitan area as a result of injury is 39,431 per annum. There are annual fluctuations of between 6% and 17% in the number of cases transported. However despite peaks in activity which occurred in 1995/96 and 1997/98 there was an overall decline of 14% between 1994/95 and 2000 in the number of cases transported. The Ambulance Service have reported that the decline in case numbers in 1999/00 may in part be due to an increase in non-completed case sheets resulting from paper bans introduced as part of industrial action over that period.

Table 1. Ambulance trauma triage decisions 1994 to 2000

		1994/95	1995/96	1996/97	1997/98	1998/99	1999/00	Total 1994-00
Minor 1-3	**No.**	33,164	43,214	34,413	40,064	34,395	32,395	217,645
	%	82	96	92.5	93.7	93.6	94.7	92
Major 4	**No.**	1,105	1,079	1,529	1,454	1,261	1,187	7,615
	%	2.8	2.4	4.1	3.4	3.4	3.5	3.2
Major 5	**No.**	632	637	757	709	579	604	3,918
	%	1.6	1.4	2	1.7	1.6	1.8	1.7
Major 6	**No.**	8	0	3	3	4	3	21
	%	0.02	0.01	0.01	0.01	0.01	0.01	
Dying 7	**No.**	45	41	57	46	36	39	264
	%	0.1	0.1	0.2	0.1	0.1	0.1	0.1
Missing/ invalid data	**No.**	5,272	239	426	467	489	227	7,120
	%	13.1	0.5	1.2	1.1	1.3	0.7	3.0
Total		40,226	45,210	37,185	42,743	36,764	34,228	236,583

Source: Ambulance Service of NSW 1994 - 2001

Only information from the Sydney metropolitan area is included.

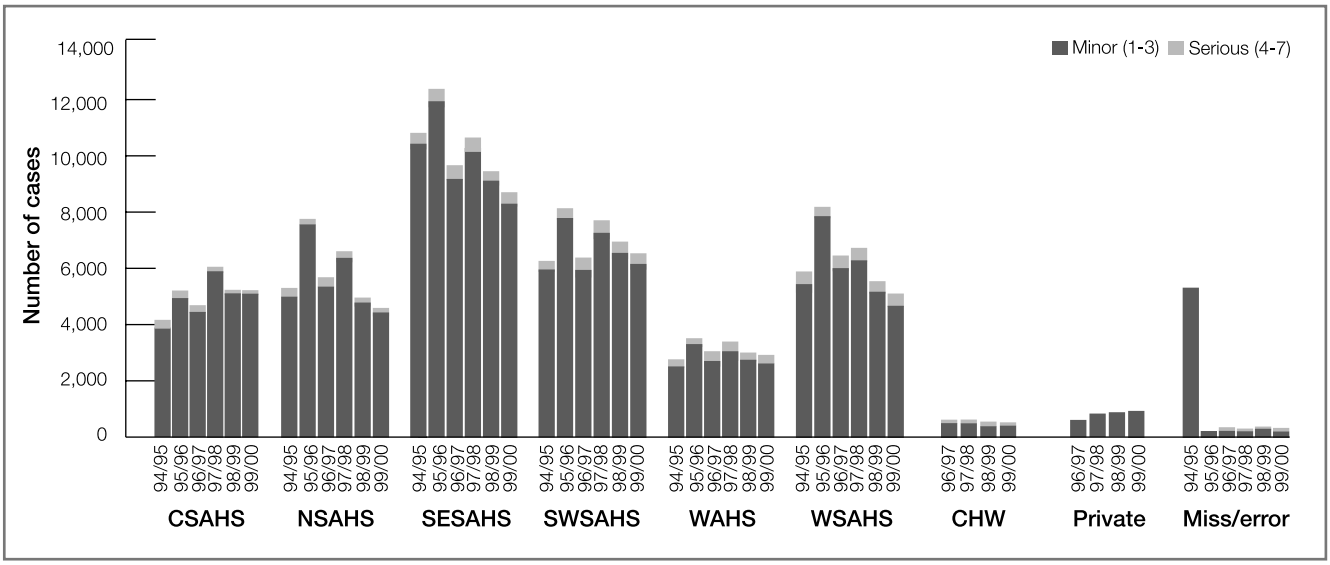
Minor 1-3 includes cases transported to emergency departments located in private hospitals.

Invalid – includes cases triaged as categories 4 and 5 which were not transported to a major trauma centre, as well as cases recorded as transported to a hospital which does not have an emergency department; Missing data refers to cases where the name of the hospital to which the case was transported is not recorded.

The percentage of the total caseload represented by each triage category has remained relatively constant since 1997/98 irrespective of fluctuations in the numbers of cases. The variation between 1994/95 and 1995/96 may be, in part, attributed to reclassification of cases with the introduction of a new case sheet by the Ambulance Service in May 1995.

Examining the trauma caseload on an area by area basis across the Sydney metropolitan area indicates that the highest number of trauma transports occur to hospitals within the South Eastern Sydney Area Health Service (Figure 1). It should be noted that due to boundary changes, the catchment populations for Central and South Eastern Sydney Area Health Services have varied over time.

Figure 1. Ambulance trauma triage decisions breakdown by Area Health Service 1994-2000



Source: Ambulance Service of NSW 1994-2000

Neither of the specialist paediatric trauma centres provided data prior to 1996/97. Private refers to cases transported to private hospital emergency departments for categories 1-3 only. Miss/error – refers to cases with incomplete or missing pre-hospital triage information.

There has been an increase in the number of trauma transport cases in South Western Sydney, Central Sydney and Wentworth Area Health Services, whereas case numbers have declined in Northern Sydney, South Eastern Sydney, and Western Sydney Area Health Services. Activity in the private hospitals has remained relatively static.

Caseload triaged as 'minor' – categories 1-3

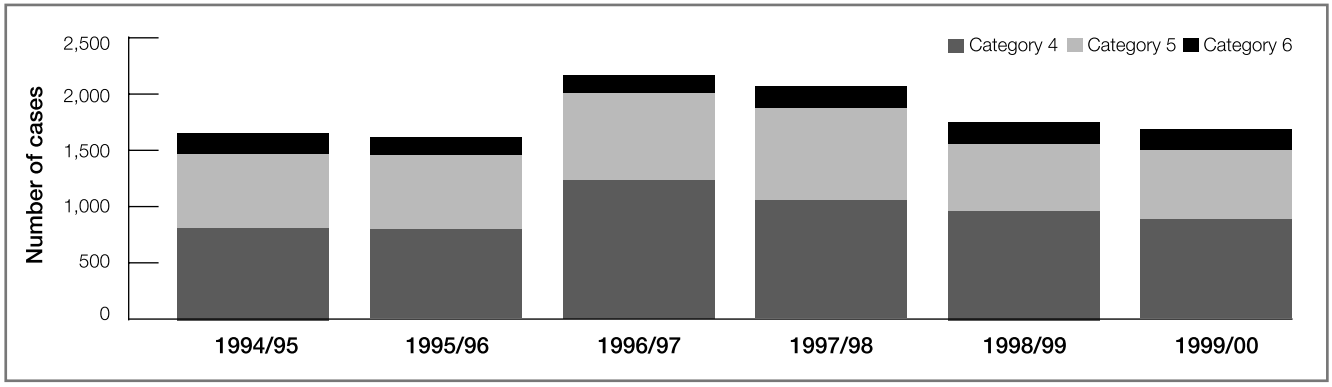
Cases triaged as minor (categories 1-3) are transported to the nearest emergency department for treatment. Since 1995/96 minor cases represent approximately 94% of all trauma cases transported by ambulance. Some of these cases may subsequently be found to have sustained more severe injury than initially indicated, requiring more complex management or access to specialist services, necessitating transfer to a major trauma centre, but the majority of cases can be managed locally.

Analysis of the number of minor cases managed at major trauma centres compared to urban trauma hospitals indicates that within each Area Health Service the trauma caseload at the major trauma centre(s) is considerably higher than the caseload managed at any of the urban trauma hospitals. In three of the Area Health Services the major trauma centre managed over double the number of trauma cases managed at the busiest urban trauma hospital in the area. This confirms that within the Sydney metropolitan area the management of trauma is concentrated in the major trauma centres.

Caseload triaged as 'serious' – categories 4, 5 and 6

Cases triaged as 'serious' categories 4 or 5 should be transported directly to a major trauma centre. In the case of category 4 this will require bypassing the nearest hospital(s) to reach the closest major trauma centre whereas for category 5 the nearest hospital is a major trauma centre.

Figure 2. Breakdown by triage category of the caseload triaged as 'serious' (categories 4, 5 and 6), 1994/95 to 1999/00



Source: Ambulance Service of NSW

Excludes cases triaged as 'serious' but not transported to a major trauma centre.

There was a sharp increase in the number of cases triaged as categories 4 and 5 (37% increase) between 1995/96 and 1996/97. The reason for this sudden increase is not known however a corresponding 27% increase in the number of cases with an ISS ≥ 16 also occurred. These increases are in contrast to a decline in the overall number of trauma cases transported by ambulance during the same period. Following the sudden increase in 1996/97 the number of cases has declined annually and in 1999/2000 was at similar levels to 1994/95.

Indicator 1. Caseload triaged as 'serious' – categories 4 and 5

The number of cases triaged as category 4 or 5 per annum and transported to a major trauma centre and the percentage of the total trauma transport caseload that these cases represent.

	Number serious cases – category 4 and 5	Percentage of total trauma transport cases
1994/95	1,737	4.2%
1995/96	1,716	3.8%
1996/97	2,286	6.2%
1997/98	2,163	5.1%
1998/99	1,840	5.0%
1999/2000	1,791	5.2%

Source: Ambulance Service of NSW

Comment:

- The percentage of cases triaged as categories 4 and 5 has increased since 1995/96 and has remained at more than 5% of the total trauma caseload in the Sydney metropolitan area. This increase corresponds to a similar increase in the over-triage rate (page 16).
- Cases triaged as 'serious' represent between five to six cases per day across Sydney.

Category 4 – 'bypass'

Across the metropolitan trauma system on average only 3.2% of all the trauma transport cases are triaged as category 4, requiring bypass of another hospital to reach the nearest major trauma centre. This equates to approximately three cases per day requiring hospital bypass across the Sydney metropolitan area.

Category 4 cases represent approximately 67% of the serious caseload (categories 4 and 5). The bypass caseload is of interest as these cases represent additional workload for the major trauma centres, having bypassed a closer hospital to be transported to the major trauma centre. Averaged across the major trauma centres in Sydney, the bypass workload represents between two and three cases per major trauma centre per week.

In contrast category 5 cases although severely injured are workload that the major trauma centre would have received irrespective of the trauma triage decision, as the receiving major trauma centre is the nearest hospital to the scene of injury.

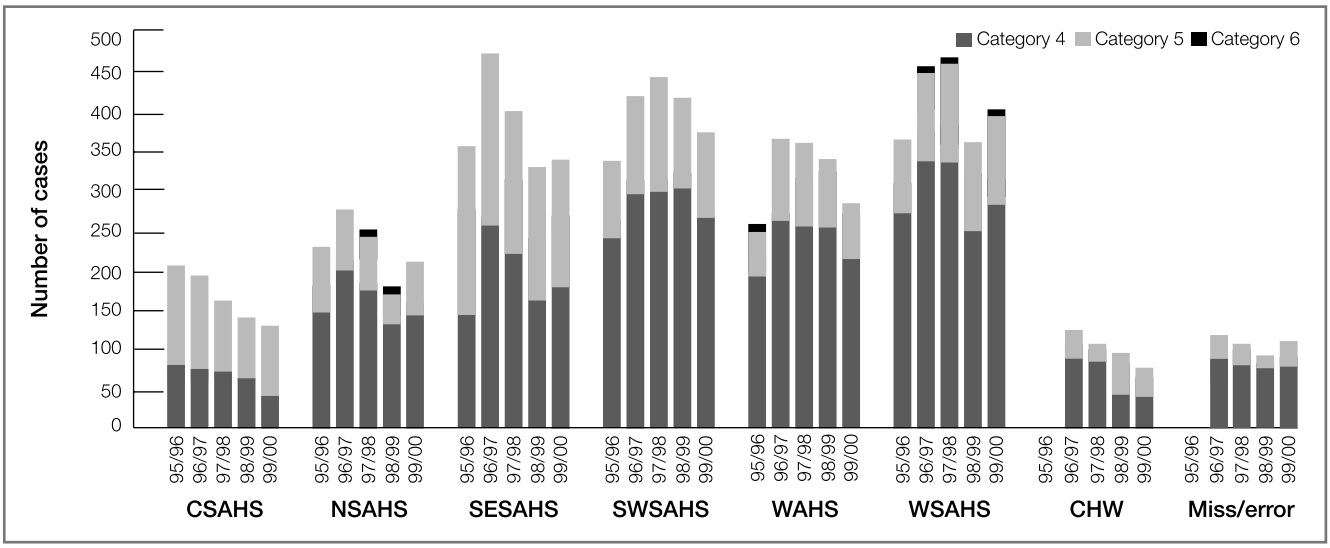
Category 6

The number of cases triaged as category 6 has remained consistently low at about three cases per annum. It is expected that the need to triage patients as category 6, necessitating their transport to either a non-major trauma centre or to a major trauma centre other than the nearest centre should not occur. It is recommended that close monitoring of the numbers of these cases with review of the circumstances surrounding each case is undertaken by both the major trauma centres and the Ambulance Service of NSW on a regular basis.

Categories 4-6 – breakdown by Area Health Service

The largest number of cases triaged as serious (categories 4-6) occurs in Western Sydney, South Western Sydney, South Eastern Sydney and Wentworth Area Health Services. The numbers of cases triaged as serious has continued to increase in each of these Areas with the exception of South Eastern Sydney Area Health Service, where the number of cases have declined.

Figure 3. Number of 'serious' cases (categories 4, 5 and 6) by metropolitan Area Health Service 1995/96 to 1999/2000



Source: Ambulance Service of NSW

Miss/invalid refers cases in which there was incomplete data on the transport hospital or which were triaged as 'serious' (categories 4 and 5) but which were not transported to a major trauma centre.

Proportionately the number of cases requiring hospital bypass (category 4) are higher in the western and northern areas of Sydney (SWSAHS, WSAHS, WAHS and NSAHS) than in the central and south-eastern areas of Sydney reflecting the close proximity of major trauma centres in the central and eastern metropolitan area.

Cases identified as category 7 – 'dying'

Category 7 is used to triage cases which the ambulance officers identify as requiring immediate medical care. This may be because:

- the patient is either in cardiac arrest
- the patient's condition is such that the ambulance officer identifies that bypassing the nearest hospital may compromise the patient
- the patient's condition has become unstable or deteriorated during transport.

Cases triaged as category 7 are transported to the nearest hospital regardless of its trauma designation. Not all these patients die from their injuries, but transport to the nearest hospital in such extreme circumstances enables prompt access to medical care for initial resuscitation and management.

There has been concern that category 7 would be applied to cases that could have been transported to a major trauma centre resulting in severely injured patients being unnecessarily transported to the nearest hospital irrespective of the facilities at the hospital to adequately manage these patients. In consideration of this concern the category 7 caseload has been included as a performance indicator, as well as a breakdown of category 7 cases transported to urban trauma hospitals and major trauma centres.

Indicator 2. Number and percentage of cases triaged as category 7

The number of trauma patients triaged as 'dying' (category 7) and transported to the nearest hospital. Category 7 cases as a percentage of the total number of trauma cases transported by ambulance within the Sydney metropolitan area.

	Number of cases per annum	Percentage of all trauma transport cases
1994/95	45	0.1%
1995/96	41	0.1%
1996/97	57	0.2%
1997/98	46	0.1%
1998/99	36	0.1%
1999/00	39	0.1%

Source: Ambulance Service of NSW

Comment

- The number of cases triaged as category 7 has remained low, representing approximately 0.1% of all trauma transport cases across Sydney.
- Cases triaged as 'dying' (category 7) represent less than one case per week.

Category 7 cases transported to urban trauma hospitals

Number and percentage of cases transported to urban hospitals and major trauma centres per annum.

	No. to an urban trauma hospital	No. to major trauma centre	Type of treating hospital not recorded	Percentage of cases transported to an urban trauma hospital
1994/95	35	10	0	78%
1995/96	n/a	n/a	n/a	n/a
1996/97	44	9	4	77%
1997/98	34	8	4	74%
1998/99	33	3	0	92%
1999/00	33	6	0	85%

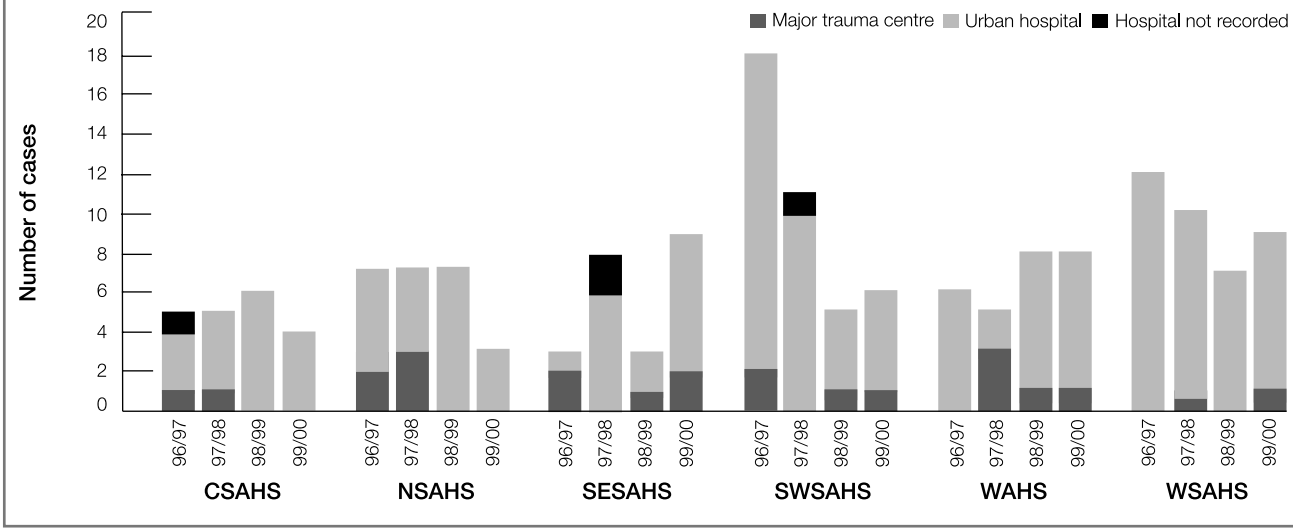
Source: Ambulance Service of NSW

Comment

- The majority of cases are transported to urban trauma hospitals, which receive between 80% and 90% of category 7 cases per annum.
- While the percentage of cases transported to urban hospitals has increased, the overall number of cases triaged as category 7 has declined.

Over 60% of category 7 cases occur in the western and southwestern areas of Sydney (includes SWSAHS, WSAHS, WAHS). This corresponds with the higher number of serious cases that are transported within this area of Sydney and may reflect the longer distances between hospitals in these Areas. Southwestern Sydney Area Health Service have had a significant reduction in the number of cases triaged as category 7 despite an overall increase in the number of cases triaged as major within this Area. It is recommended that local review is undertaken of the circumstances involved for all cases which have been triaged as category 7.

Figure 4. Number of category 7 cases per annum by Area Health Service and hospital type 1996/97-1999/00



Source: Ambulance Service of NSW

Accuracy of pre-hospital trauma triage

The following indicators are intended to evaluate the accuracy of the ambulance triage process in identifying patients with severe injury, as defined by an Injury Severity Score (ISS) greater than or equal to sixteen (ISS ≥ 16). The indicators are derived using data from the Ambulance Service and the trauma registries maintained at each of the major trauma centres.

There are three particular areas of interest related to the accuracy of the pre-hospital triage process. These are:

- additional workload related to number of cases which are over-triaged (Indicator 3a)
- sensitivity of the pre-hospital triage protocols in correctly identifying patients with serious injury (Indicator 3b)
- number of cases with serious injury that are under-triaged.

The importance of these indicators is ensuring that patients with severe injury are identified in the pre-hospital environment and transported directly to a major trauma centre, minimising the time from injury to the delivery of the patient at a facility able to provide definitive care.

It should be noted that the Injury Severity Score (ISS) is only one measure of the severity of trauma and is calculated retrospectively following definitive diagnosis of the patient's injuries. Therefore, some cases which initially require urgent specialist intervention available at the major trauma centres may subsequently be found to have an ISS ≥ 16. In addition, the parameters used for the pre-hospital triage tool are intentionally broad to ensure a degree of over-triage to reduce the number of cases with potentially severe injuries that are not recognised in the pre-hospital environment and are consequently not transported directly to a major trauma centre.

Table 2. Number of cases with an ISS ≥ 16 triage category for cases transported by ambulance directly to a major trauma centre in Sydney

	Minor 1-3	Category 4 – 'bypass'	Category 5	Category 6	Category 7 – 'dying'	Triage category not available	Total
1994/95	155	205	210	2	9	110	691
1995/96	104	232	176	1	5	170	688
1996/97	182	234	212	1	8	237	874
1997/98	158	249	242	2	4	213	868
1998/99	179	232	172	0	5	271	859
1999/00	161	283	245	1	6	242	935

Source: Major trauma centres – trauma registries

Table 3. Number of major trauma cases (categories 4-7) transported by ambulance directly to a major trauma centre in Sydney

	Category 4 – 'bypass'	Category 5	Category 6	Category 7 – 'dying'	Total
1994/95	1,058	632	2	10	1,677
1995/96	1,079	637	1	5	1,722
1996/97	1,529	757	1	9	2,296
1997/98	1,454	709	2	8	2,173
1998/99	1,261	579	0	3	1,843
1999/00	1,187	604	2	6	1,799

Source: Ambulance Service of NSW

The number of cases with an ISS ≥ 16 for which the pre-hospital triage decision is not available has increased from 110 cases in 1994/95 to 242 cases in 1999/2000, peaking at 271 cases in 1998/99. The increasing number and percentage of cases with severe injury for which the triage decision is not available is a matter of concern. In 71% of these cases the lack of data is attributed to the triage decision not being recorded on the ambulance case sheet. The remaining cases are attributed to the lack of an ambulance case sheet. It is presumed that in a number of these cases the triage decision is being recorded retrospectively by the ambulance officers when the case sheets are finalised, however this information is then not automatically passed on to the major trauma centre to be included in the data. As discussed earlier, the increase noted in 1998/99 and 1999/00 may also be due to industrial action and the non-completion of case sheets ('paper bans') during 1999.

Further analysis of the effectiveness of the pre-hospital trauma triage tool and the development of valid conclusions are precluded due to the number of cases for which the triage data is not available. The lack of available data should be addressed by individual trauma centres in consultation with the local ambulance service representatives on a case-by-case basis. Additionally, it is recommended that the Ambulance Service should monitor the effective use of the pre-hospital trauma triage, as well as the compliance of ambulance officers in accurately completing the ambulance case sheets and the provision of this information to the receiving hospital. The Ambulance Service has indicated that data accuracy and availability will be improved following the full implementation of the CAD system.

Over-triage workload

This indicator is concerned with quantifying the additional workload at the major trauma centres resulting from over-triage. Over-triage refers to those cases triaged as 'serious' (category 4 – 'bypass') in the pre-hospital environment, necessitating that they be transported directly to a major trauma centre (bypassing other hospitals) and subsequently found to have less severe injury (ISS ≤ 16). The indicator describes the additional workload in both ambulance transport and at the major trauma centres for patients with less severe injuries. Some degree of over-triage is desirable to minimise the risk of not transporting patients with potentially severe injuries to a major trauma centre, however it is relevant to quantify the additional workload produced by these cases.

Cases triaged as category 5 or category 7 – 'dying', are not included in this indicator as they do not contribute to the over-triage workload since the receiving major trauma centre is the nearest hospital and would receive these cases irrespective of the triage decision. Therefore these cases do not represent additional workload.

The over-triage workload is only a small percentage of the total ambulance trauma caseload across the Sydney metropolitan representing between a maximum of 1.9% (853/40,226) and 3.5% (1295/37,185) of cases transported annually.

Indicator 3a. Over-triage workload

The additional workload for the Ambulance Service and at the major trauma centres generated by cases that were triaged as 'serious' in the pre-hospital environment requiring transport to the nearest major trauma centre necessitating 'bypass' (category 4) of the nearest hospital.

Calculated from the difference between the number of cases triaged as 'serious' – category 4 and the number of these cases which are subsequently found to have an ISS ≥ 16. The results are:

- presented as a range to account for cases with an ISS ≥ 16 for which the pre-hospital triage decision is unknown. It is assumed that either all these cases were triaged as category 4 or that none were
- are quantified as the maximum number of additional cases per day which are required to be managed in the major trauma centres in the Sydney metropolitan area.

	No cases over-triaged (including cases where triage decision is unavailable minimum value)		No. cases over-triaged (excludes cases where triage decision is unavailable maximum value)	Maximum additional number of cases transported to MTCs across Sydney per day
1994/95	743	to	853	2
1995/96	677	to	847	2
1996/97	1,058	to	1,295	4
1997/98	992	to	1,205	3
1998/99	758	to	1,029	3
1999/00	662	to	9,04	3

Source: Ambulance Service of NSW

Comment

- The additional workload resulting from over-triage is the equivalent of about three cases per day across the Sydney metropolitan area.
- Averaged across the ten major trauma centres in Sydney this is the equivalent of an additional two to three cases per major trauma centre per week. Therefore these additional cases should not excessively increase the workload at the individual major trauma centres.

Sensitivity of triage guidelines

The sensitivity is used to evaluate the accuracy of the pre-hospital triage tool in identifying patients with severe injuries. The evaluation is based on the percentage of all cases transported by ambulance directly to a major trauma centre, which were triaged as 'serious' (categories 4-7) and subsequently found to have an ISS ≥ 16.

As with the over-triage workload (Indicator 3a), the results of this indicator are presented as a range. This is to allow for the cases with an ISS ≥ 16 where the pre-hospital triage category is not available. The assumption in generating this range is that either all cases where the triage category is unknown were triaged as having serious injury (categories 4-7) or they were all triaged as minor injury (categories 1-3).

As noted previously, the ISS is only one measure of severe injury and patients with a lower score may still require urgent specialist intervention available at the major trauma centres.

Indicator 3b. Sensitivity of triage tool

The percentage of cases with an ISS ≥ 16 which were triaged as 'serious' (categories 4-7) and transported by ambulance directly to a major trauma centre in Sydney.

	Percentage of cases triaged as 'serious' with ISS ≥ 16 (excluding cases where the triage decisions is not known – assuming all these cases where triaged as categories 1-3) Minimum value		Percentage of cases triaged as 'serious' with ISS ≥ 16 (includes cases where the triage decision was known – assuming all these cases were triaged as categories 4-7 Maximum value
1994/95	61.7%	to	77.6%
1995/96	60.2%	to	84.9%
1996/97	52.1%	to	79.2%
1997/98	57.3%	to	81.8%
1998/99	47.6%	to	79.2%
1999/00	56.9%	to	82.8%

Source: Major trauma centres

Comment

- Given the large percentage of cases for which the pre-hospital triage decision is not known it is difficult to accurately interpret the results of this indicator. The range between the minimum and maximum cases has increased since 1994/95 and has remained between 25% and 32% per annum.
- Across the six years of data reviewed, it can be concluded that on average a minimum of 56% of cases with an ISS ≥ 16 transported directly to a major trauma centre have been correctly triaged as categories 4-7.
- For approximately 25% of cases the triage decision is not available, however, it can be hypothesised that a percentage of these cases would have been triaged as 'serious'.

The availability and capture of pre-hospital triage data varies across the major trauma centres, with several Centres consistently having a high level of data availability. The sites which consistently have high levels of data availability (data available for over 90% of cases) report an average of 75% (range 69% to 80%) of cases with an ISS ≥ 16 are triaged as 'serious' (categories 4-7). This would indicate that for these Area Health Services the pre-hospital triage decisions are correctly identifying severely injured patients and transporting them directly to a major trauma centre.

Under-triage caseload

Under-triage refers to cases triaged by the ambulance officers as 'minor' (Code 1-3) which are subsequently found to have an ISS ≥ 16. The level of under-triage is an important indicator of the effectiveness of the pre-hospital triage process in recognising patients with severe injuries and ensuring that these cases are transported directly to a major trauma centre.

Table 4. Under-triage caseload 1994/95 to 1999/00

	No. of cases with ISS ≥ 16 triaged as Minor (1-30) transported direct to MTC	Total No. of cases transported direct to MTC with ISS ≥ 16	Percentage of cases transported directly to the major trauma centre with ISS ≥ 16 triaged as Minor 1-3
1994/95	155	691	22.4%
1995/96	104	688	15.1%
1996/97	182	874	20.8%
1997/98	158	864	18.3%
1998/99	179	859	20.8%
1999/00	161	935	17.2%

Source: Major trauma centres

There are annual fluctuations in the number and percentage of cases under-triaged, however, the percentage of cases has continued to remain lower than the results for 1994/95.

It is recommended that the under-triage rate should continue to be monitored and should be included as an indicator in subsequent monitoring reports. A performance benchmark for the indicator should also be established.

Cases with severe injuries which are initially transported by ambulance to urban trauma hospitals are an important patient group requiring closer monitoring and analysis. Currently the data collected is not sufficiently detailed to enable review of the mode of arrival at the urban trauma hospital or the pre-hospital triage decisions for this patient group. It is assumed that a high proportion of cases with an ISS ≥ 16 which are initially transported to the urban trauma hospitals will ultimately be transferred to a major trauma centre for on-going management, however data is not currently collected from the urban trauma hospitals against which to evaluate this assumption.

It is recommended that the major trauma centres should advise the Ambulance Service of cases which are identified as under-triaged (both cases transported directly to the major trauma centre and cases transferred from the urban trauma hospitals), a review of these cases should then be undertaken.

Pre-hospital times

As stated previously the intention of the metropolitan trauma system is the delivery of the trauma patient to the appropriate hospital in the minimum possible time from injury. For severely injured patients it has been well demonstrated in the literature that there is a correlation between the time of injury to the commencement of definitive care and patient outcome.

The areas of relevance are the ambulance response time, time spent at scene, and the total pre-hospital time. In addition, the actual travelling time to hospital (transport time) is reviewed for category 4 cases, because these cases are required to bypass the nearest hospital to be transported to a major trauma centre.

Cases have been excluded from the data used for this analysis if any of the time parameters were missing, or where any of the times exceeded 720 minutes (12 hours), as these cases were considered as outliers or data errors. This has resulted in between 0.8% and 1.3% (305-447 cases) of the total trauma transports being excluded in any year.

As noted previously, due to problems with data reliability and accuracy associated with the implementation of the CAD system in 1999 direct comparison of data from 1999/00 with previous years cannot be made. The data from 1999/00 has been included with the time indicators for information only and has not been included in comparisons of performance of the individual indicators.

Pre-hospital times – all trauma transport cases

In this section, the response, scene and total pre-hospital times are reviewed for all trauma cases transported by the Ambulance Service to hospital within the Sydney metropolitan area. The benchmarks used for the time indicators have remained unchanged from those included in the monitoring program since 1994/95. These time benchmarks were derived from the ORCON standards (developed by the consultancy group Operational Research Consultants) which were established over two decades ago; while these standards have been widely used by ambulance services around the world they are not a world-wide standard.

Response time

The response time is the time taken for an ambulance to arrive at the scene of the accident following the call for assistance.

Ambulance response time is a complex issue that involves many variables including ambulance availability, dispatch (including Computer Aided Dispatch), and road access including prevailing traffic conditions.

The decline in performance for this indicator in 1999/00 can be in part attributed to a change in the definition of response time, which occurred with the introduction of the CAD system in July 1999. The definition for response time is now taken from the time the call for assistance is received at the ambulance operations centre to the time of arrival of the ambulance at the scene, as opposed to previously when the time was taken from completion of the call for assistance and dispatch of the ambulance. This change in definition will have increased the response time and will have had an impact on the performance of this indicator for 1999/00.

Indicator 4a. Response time ≤ 10 minutes

The percentage of trauma cases where the ambulance arrives at the accident scene within 10 minutes from the call for assistance.

	Number of cases with time data available	Number of cases meeting benchmark (time ≤ 10 minutes)	Percentage of cases meeting benchmark
1994/95	39,518	25,869	66%
1995/96	43,951	27,924	64%
1996/97	36,341	22,198	61%
1997/98	41,860	24,310	58%
1998/99	35,973	21,034	59%
1999/00	33,879	16,761	50%

Source: Ambulance Service of NSW

Comment

- The performance of this Indicator has declined by 7% between 1994/95 and 1998/99.
- The sharp decline in performance noted in 1999/00 can be attributed to changes in the definition for response time. For this reason the data for 1999/00 should not be compared with that for previous years.

Review of the average response time per annum for minor and serious cases indicates that on average the response time is between two to three minutes longer than the established benchmark, and that the response time for 'serious' cases is marginally less than for minor cases.

Table 5. Average response times per case for 'minor' and 'serious' cases 1996/97-1999/00

	Average time per cases for 'minor' cases (category 1-3) (minutes)	Average time per cases for 'serious' cases (category 4-7) (minutes)
1996/97	12.4	12.3
1997/98	13.1	13.0
1998/99	12.9	12.1
1999/00	14.0	13.4

The reason for the decline in performance up to 1998/99 against the response time benchmark is not apparent. However the Ambulance Service is aware of the decline and has advised that it is in the process of addressing this issue.

The Ambulance Service has advised that the implementation of an emergency call triaging tool known as ProQA has commenced. ProQA will enable prioritisation of all emergency calls received by the Ambulance Service to identify time critical cases that will receive priority for dispatch of ambulances.

Scene time

Scene time is defined as the length of time the patient remains at the accident scene from arrival of the ambulance officers until departure from the scene for transport to hospital. The scene time will be prolonged in cases where there is entrapment. Identification of these cases including the entrapment time is not possible from the data available during the reporting period. In future reports these cases will be identified.

Indicator 4b. Scene time ≤ 20 minutes

The percentage of trauma cases remaining at the accident scene for 20 minutes or less following the arrival of an ambulance.

	Number of cases with time data available	Number of cases meeting benchmark (time ≤ 20 minutes)	Percentage of cases meeting benchmark
1994/95	39,641	33,591	85%
1995/96	44,855	37,238	83%
1996/97	36,341	29,510	81%
1997/98	41,860	33,431	80%
1998/99	35,973	28,098	78%
1999/00	33,786	26,255	78%

Source: Ambulance Service of NSW

Comment

- Across the five years of data between 78% to 85% of cases spent 20 minutes or less at the accident scene.
- There has been an annual decline in performance of this indicator. The reason for this decline is not readily apparent and it is recommended that the Ambulance Service undertake further review.

Total pre-hospital time

The pre-hospital time is the total time per case from call for assistance until arrival at hospital. It is the sum of the response time, scene time and transport time to hospital.

Indicator 4c. Pre-hospital time ≤ 60 minutes

The percentage of trauma cases with a total pre-hospital time of 60 minutes or less.

	Number of cases with time data available	meeting benchmark (time ≤ 60 minutes)	Number of cases Percentage of cases meeting benchmark
1994/95	39,669	37,859	95%
1995/96	44,762	41,570	93%
1996/97	36,341	33,328	92%
1997/98	41,860	37,984	91%
1998/99	35,973	32,431	90%
1999/00	33,786	29,949	89%

Source: Ambulance Service of NSW

Comment

- On average 92% of all trauma cases within the Sydney metropolitan area arrived at a hospital within 60 minutes of a call for assistance being received by the Ambulance Service.
- There has been an annual decline of between 1-2% in the performance indicator over the six years of data reviewed.

The observed decline in the performance of the total pre-hospital time Indicator of 5% (to 1998/99) is consistent with the percentage decline observed for the response time and scene time. The results of the performance of this Indicator, in light of the results for the response time and scene time indicates that for the majority of cases within the Sydney metropolitan area the time taken to reach a hospital from the accident scene is less than thirty minutes.

Table 6. Average total pre-hospital time for 'minor' and 'serious' cases 1996/97-1999/00

	Average time per cases for 'minor' cases (category 1-3) (minutes)	Average time per cases for 'serious' cases (category 4-7) (minutes)
1996/97	38.2	47.9
1997/98	39.2	51.8
1998/99	39.9	51.3
1999/00	41.5	52.2

While the average total pre-hospital time for cases triaged as 'serious' has increased by approximately three minutes between 1996/97 and 1998/99, the average time for both 'minor' (categories 1-3) and 'serious' (categories 4-7) remains lower than the benchmark.

Pre-hospital times – category 4 transports 'bypass' cases

The pre-hospital times for category 4 – 'bypass' cases are of interest because these patients are identified by the ambulance officers as potentially severely injured requiring transport direct to a major trauma centre necessitating bypass of the nearest hospital. The scene time, transport time and the total pre-hospital times are reviewed. Of particular relevance is the transport time and the impact of the additional transport distance on the total pre-hospital time.

Data on category 5 cases has been provided as a comparison between the performance of category 4 when contrasted against the times for all trauma transport cases, and whether any variations in performance can be attributed to bypass or are applicable to all cases triaged as 'serious' (categories 4 and 5).

Scene time

The benchmark for this indicator is scene time of twenty minutes or less.

Indicator 5a. Scene time ≤ 20 minutes – category 4 – 'bypass' cases)

The percentage of category 4 -bypass cases with a scene time of 20 minutes or less.

	No. of category 4 with time data available	No. of cases with scene time ≤ 20 minutes	% cases meeting benchmark
1994/95	1,090	656	60%
1995/96	1,074	612	57%
1996/97	1,520	880	58%
1997/98	1,443	743	52%
1998/99	1,257	614	49%
1999/00	1,174	622	53%

Source: Ambulance Service of NSW

Comments

- There has been a marked decline in the percentage of category 4 cases with a scene time less than 20 minutes over the six years of data reviewed.
- The results for this indicator are lower than those for all trauma cases (indicator 4b) this may be due to cases with entrapment requiring extrication. The influence of cases with entrapment on the results of this indicator cannot be ascertained from the available data.

It can be postulated that the majority of cases that are entrapped as a result of the accident are more likely to be triaged in the pre-hospital environment as 'serious' and transported directly to a major trauma centre.

Table 7. Comparison of the average scene times (in minutes) by triage category 1996/97-1999/00

	Minor 1-3	'Serious' – category 4 – 'bypass'	'Serious – category 5	'Serious' – category 7 – 'dying'
1996/97	15	21	20	18
1997/98	15	23	22	24
1998/99	15	23	23	17
1999/00	16	22	22	17

Source: Ambulance Service of NSW

The average scene time for categories 4 and 5 are higher than the benchmark. The average scene time triaged as 'minor' is seven minutes less than for categories 4 and 5. This may reflect additional time required to stabilise and extricate the more severely injured trauma patients at the scene. Conversely patients triaged as category 7 – 'dying', have a scene time on average five minutes shorter than those for categories 4 and vie, this most likely reflects the unstable and urgent nature of the condition of these patients.

Transport time

This indicator measures the percentage of cases requiring hospital bypass arriving at a major trauma service within 30 minutes of departing the scene. This indicator reflects the impact of hospital bypass on the transport times for patients triaged as category 4. Category 5 data is presented as a comparison, given that these cases are also triaged as 'serious' but the major trauma centre is the nearest hospital.

Indicator 5b. Transport time ≤ 30 minutes – category 4 – 'bypass' cases

The percentage of bypass cases arriving at the major trauma centre within 30 minutes of leaving the accident scene.

	Category 4 cases		Category 5 cases	
	No. category 4 cases with time data available	No. cases with transport time ≤ 30 minutes	% cases meeting benchmark	% cases meeting benchmark
1994/95	1,099	1,001	91%	n/a
1995/96	1,073	963	90%	n/a
1996/97	1,520	1,380	91%	99%
1997/98	1,443	1,271	88%	99%
1998/99	1,257	1,120	89%	98%
1999/00	1,174	1,041	89%	99%

Source: Ambulance Service of NSW

Comment

- The results of this Indicator have remained consistent over the past five years with about 90% of cases having a transport time 30 minutes or less.
- As expected almost 100% of category 5 (major trauma centre is nearest hospital) cases have a transport time of less than 30 minutes.

Review of the average transport time by triage category demonstrates that the average transport time for cases requiring hospital bypass to reach a major trauma centre is consistently lower than the benchmark. The additional transport time that can be attributed to bypassing the nearest hospital is on average ten minutes longer than for category 5 cases where the major trauma centre is the nearest hospital.

Table 8. Average transport time (in minutes) by triage category 1996/97-1999/00

	Categories 1-3 – 'minor'	Category 4 – 'bypass'	Category 5	Category 7
1996/97	11	18	9	6
1997/98	11	19	9	8
1998/99	11	19	9	7
1999/00	11	19	9	7

It can be concluded that the use of hospital bypass to transport the patient direct to a major trauma centre has not resulted in excessively long transport times for these 'seriously' injured cases.

Total pre-hospital time

The pre-hospital time will be influenced by extended response time, scene time and transport time.

Indicator 5c. Total pre-hospital time ≤ 60 minutes – category 4 – 'bypass' cases

The percentage of cases requiring hospital bypass arriving at a major trauma centre within 60 minutes of the call to the Ambulance Service for assistance.

	Category 4 cases		Category 5 cases	
	No. category 4 cases with time data available	No. cases with transport time ≤ 60 minutes	% cases meeting benchmark	% cases meeting benchmark
1994/95	1,096	843	77%	n/a
1995/96	1,072	831	78%	n/a
1996/97	1,520	1,149	76%	90%
1997/98	1,443	974	68%	87%
1998/99	1,257	886	71%	86%
1999/00	1,174	779	66%	85%

Source: Ambulance Service of NSW

Comment

- There has been a 6% decline in the percentage of cases meeting the benchmark for this indicator for category 4 cases up until 1998/99. On average 74% of patients arrive at a major trauma centre within 60 minutes.
- The difference in the result between the total trauma cases (Indicator 4c) and the category 4 cases reflect the increased scene time and transport time for the category 4 group.
- The difference in result between category 4 and category 5 cases can probably be attributed to the extended transport time required for category 4 cases.

On comparison of the average total pre-hospital time between the different triage categories, category 4 cases (bypass) consistently have the longest total pre-hospital time. The total pre-hospital time has increased for each of the triage categories between 1996/97 and 1998/99 by between two to three minutes, however the average time for each of the triage categories is less than the benchmark time of sixty minutes.

Table 9. Average total pre-hospital time (in minutes) by triage category 1996/97-1999/00

	Categories 1-3 – 'minor'	Category 4 – 'bypass'	Category 5	Category 7
1996/97	38.2	52	42	34
1997/98	39.0	56	43	42
1998/99	40.0	55	44	36
1999/00	42.0	57	45	37

The increased pre-hospital time for category 4 and 5 cases compared to the 'minor' cases can be attributed to the extended scene time for these cases as well as the declining performance against the scene time benchmark for the 'serious' triage categories. The variation in total pre-hospital time between category 4 and category 5 cases is due to the variation in transport times between these two groups.

Conclusions – pre-hospital phase

The total number of trauma cases transported to hospital within Sydney has declined over the past six years. However during this period there has been increasing activity in the west and southwestern areas of Sydney, in particular the number of cases being triaged as 'serious' (categories 4 and 5). The under-triage rate has varied between 15.1% to 22.4% indicating that the pre-hospital triage tool is effective in identifying the majority of patients with severe injury.

Based on the data presented in this section of the report two main areas of concern are identified. The first of these is the decline in Ambulance Service performance against each of the time benchmarks. It has been well documented in the literature that there is a correlation between the time taken from injury to the commencement of definitive care and patient outcome. Therefore, timely response and performance in the pre-hospital environment is critical. Also of concern is the increasing number of cases with an ISS $\geq$ 16 for which the triage information is not available. This lack of data has implications for the accuracy of the evaluation of the triage tool. It is noted that there are variations in the availability of data across the major trauma centres suggesting that some of the centres have developed a system for following up these cases and obtaining the information. This aspect will need to be addressed by both the major trauma centres and the Ambulance Service to ensure that this data is available.

The benchmark for NSW total pre-hospital time needs to be validated against trauma outcomes for both blunt and penetrating trauma. Scene times, as currently captured, do not differentiate times for entrapment. The NSW Trauma System Advisory Committee recommends scene times of 15 minutes or less after dis-entrapment is adopted as a pre-hospital trauma indicator. To provide the data for this subset this report recommends a review of quality data collection by Ambulance Services (Recommendation 2) so that a more complete data set is available for analysis. The Ambulance Service of NSW may need to review the pre-hospital data set to obtain scene times after dis-entrapment.

Recommendations

Recommendation 1

Major trauma centres and the Ambulance Service should to review their quality improvement and performance improvement programs to ensure prospective data collection and sharing of data for the subset of patients with an Injury Severity Score (ISS) greater than or equal to 16 or greater, in relation to the pre-hospital triage decision.

Recommendation 2

The Ambulance Service should monitor the effective use of the pre-hospital trauma triage tool, as well as the compliance of ambulance officers in accurately completing the ambulance case sheets and the timely provision of this information to the receiving hospital.

Recommendation 3

Close monitoring of the number of cases triaged as category 6 by both the Ambulance Service and the major trauma centres, with review of the circumstances surrounding each case.

Recommendation 4

Local review is undertaken of the circumstances involved for all cases that have been triaged as category 7. Feedback regarding this review is to be provided to the Ambulance Service and the NSW Trauma Services Committee.

Recommendation 5

The under-triage rate should continue to be monitored and included as a performance indicator in subsequent monitoring reports. A performance benchmark for the indicator should also be established.

Recommendation 6

The major trauma centres should advise the Ambulance Service of cases which are identified as under-triaged (both cases transported directly to the major trauma centre and cases which are transferred to the major trauma centre from urban hospitals). A review of these cases should then be undertaken.

Recommendation 7

The Ambulance Service should undertake close monitoring of performance against the established time benchmarks and provide feedback to the NSW Pre-Hospital Trauma System Committee of its findings and proposed action to address the issues.

Recommendation 8

In future reports, data regarding entrapment and entrapment time should be included in the analysis of scene time data.

Major trauma centre – emergency department phase

The emergency department phase is concerned with the mode of arrival at the major trauma centre of severely injured patients as well as the local response at the major trauma centre to the arrival of these patients.

The data used has been submitted from the trauma registries maintained at each of the major trauma centres in Sydney and Newcastle. The data has been aggregated so that individual major trauma centres cannot be identified. The decision to aggregate data from the trauma centres was made at the inception of the monitoring program in 1994. The premise was, that the monitoring program was to evaluate the effectiveness of the trauma system rather than the performance of individual service providers; it was also initially to encourage centres to submit data for inclusion in the monitoring program. The expectation is that individual centres will compare their performance against the collective performance.

The impact of aggregating the data is that, variations in individual centre performance can have the impact of skewing the data and the overall results. The NSW Trauma System Advisory Committee had agreed that in future monitoring reports individual centre data would be identified. The *NSW ITIM 2002 Annual Report*[6] included site-specific activity data.

The information in this section pertains only to cases which are found to have an Injury Severity Score (ISS) greater than or equal to sixteen (ISS ≥ 16), these are patients with severe, potentially life threatening injuries. These cases represent only a small percentage of the total number of trauma cases managed at each of the major trauma centres per annum, accounting for approximately 3% of the total trauma cases transported by the Ambulance Service within the Sydney metropolitan area per annum. However, this group of patients is associated with higher mortality rates and has demonstrated the greatest benefit from better organised and coordinated treatment.

Number of cases with an ISS ≥ 16

The number of severely injured patients (ISS ≥ 16) managed at the major trauma centres has increased by 24% since 1996/97 with about 17% of this increase occurring between 1998/99 and 1999/00. The increase in the number of cases with ISS ≥ 16 is in contrast to a decline in the number of trauma cases reported as transported by ambulance in the Sydney metropolitan area, however during the same period there was also an increase in the number of trauma related deaths in the Sydney metropolitan area. The lower case numbers reported in 1994/95 and 1995/96 may, in part, be attributed to identified problems with data collection resulting from changes in collection procedures and staffing at some sites.

Table 10. Activity per annum at the major trauma centres 1994/95-1999/2000

No. sites	1994/95 11 sites	1995/96 9 sites*	1996/97 11 sites	1997/98 11 sites	1998/99 11 sites	1999/00 11 sites
No. cases with an ISS ≥ 16 per annum (excluding transfers from another MTS)	1,074	1,150	1,408	1,497	1,486	1,740
No. cases per week with an ISS ≥ 16	21	22	27	29	29	34
Range in the no. cases with ISS ≥ 16 per site per annum	20-190	39-187	13-267	11-276	15-328	23-301

Source: Major trauma centres trauma registries

(Includes patients arriving by direct transport and transfers from metropolitan and non-metropolitan hospitals. Excludes transfers between major trauma centres to prevent double counting of cases).

* 1995/96 data was not submitted by the two paediatric sites.

6. *NSW Trauma Minimum Data Set, 2002 Annual Report* – NSW Institute of Trauma and Injury Management 2003.

Averaged across the six years of data, the major trauma centres in Sydney and Newcastle treated 27 cases with an ISS ≥ 16 per week, or on average 2.6 cases per site per week.

On review of data from each major trauma centre, there is a wide variation in the number of cases managed at individual sites, with the busiest sites receiving up to six cases with an ISS ≥ 16 per week, whereas other sites are managing less than one case per fortnight. The low case numbers experienced at some sites will have implications for the skill development and maintenance among clinical staff in the management of severe trauma, as well as implications for the dedication of resources to the trauma service including data collection and research within the hospital.

Source of referral

Trauma patients arrive at a major trauma centre either directly from the accident scene or as a transfer from another hospital. Patients arriving directly to the major trauma centre may arrive by road ambulance, helicopter, or private transport. Alternatively patients may be transferred to the major trauma centre from other urban hospitals or from rural areas for more complex or specialised management. Generally these transfers are transported to the major trauma centre by either road and/or air ambulance, or alternatively by helicopter.

Table 11. Source of referral to the major trauma centres for cases with ISS ≥ 16

No. sites	1994/95 11 sites	1995/96 9 sites*	1996/97 11 sites	1997/98 11 sites	1998/99 11 sites	1999/00 11 sites
Mode of arrival						
Direct						
– Road ambulance	727	734	930	935	921	1,046
– Helicopter	59	103	101	111	101	125
Arrival by private transport	36	55	73	58	85	65
Transfers to MTC from:						
– Urban hospitals	91	92	121	114	163	174
– Non-metropolitan	156	156	179	266	196	292
Not known	5	10	4	13	19	38
Total cases per annum**	1,074	1,150	1,408	1,497	1,486	1,740
Transfers to MTC from another MTC	52	37	76	65	75	93

Source: Major trauma service trauma registries

* In 1995/96 data was not submitted by the two paediatric sites.

** Excludes transfers between MTCs to avoid double counting of cases. These cases will have been included in data submitted from the presenting MTC.

Of the total cases with an ISS ≥ 16 managed at the major trauma centres, on average about 71% are transported directly to the centre either by road ambulance or primary helicopter rescue, from the Sydney and Newcastle metropolitan areas. A further 24% of cases are transferred to the major trauma centres from other urban hospitals or from rural areas. The percentage of cases arriving by private means has remained low.

Indicator 6. Source of referral to the major trauma centres

The percentage of the cases with major injuries (ISS ≥ 16) treated at the major trauma centres by source of referral.

Cases transported directly to the major trauma centre include all cases transported by road ambulance or primary helicopter transport.

The following cases have been excluded: transfers between major trauma centres, cases arriving by private transport, and cases where the source of referral is unknown.

	% total cases transported direct to MTC	% total cases transferred from non-metropolitan hospitals	% total cases transferred from urban trauma hospitals	% cases from metropolitan areas direct to MTC
1994/95	73.2%	14.5%	8.5%	89.6%
1995/96	72.8%	13.6%	8.0%	90.1%
1996/97	73.2%	12.7%	8.6%	89.5%
1997/98	69.9%	17.8%	7.6%	90.2%
1998/99	68.8%	13.3%	11.0%	86.3%
1999/00	67.3%	16.8%	10.0%	87.1%

Comment

- Within the Sydney and Newcastle metropolitan areas between 86% and 90% of cases with an ISS ≥ 16 which were transported by ambulance, were transported directly to a major trauma centre, ie the majority of cases with severe injury occurring within the metropolitan are transported directly to the major trauma centres.
- The percentage of cases with an ISS ≥ 16 which are transferred to the major trauma centres from urban hospitals and non-metropolitan areas has increased, with over 55% of transfers coming from the non-metropolitan hospitals.

Transfers into the major trauma services

While not all cases with an ISS ≥ 16 are transported directly to a major trauma centre it is estimated that only a small number of patients with this severity of injuries will complete their course of treatment outside of the major trauma centre. The most notable exceptions are patients with severe burn injuries who are transferred from either an urban hospital or non-metropolitan hospital to the burn unit at Concord Hospital for management. Concord Hospital is not a major trauma centre so these patients are not captured as trauma data. Patients with burn injuries managed in the burn unit at Royal North Shore Hospital or Children's Hospital at Westmead should be included in the trauma registry. Data on patients managed in the burn unit at Concord Hospital should be captured and included in the state-wide data collection.

Transfers between major trauma centres are frequently to access specialist services (such as spinal injuries or burn services) or to access a bed in intensive care. While major trauma centres should be able to manage the majority of severely injured patients there will continue to be occasions where demand for critical care services will exceed supply and patients will need to be transferred to an alternative centre. While the number of cases transferred between the major trauma centres has increased over the period reviewed, the percentage of the total transfers that these cases represent has remained relatively static.

Table 12. Source of transfers to the major trauma centres – cases with an ISS ≥ 16

	1994/95		1995/96		1996/97		1997/98		1998/99		1999/00	
Source of transfer	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Urban hospitals	91	30	92	32	121	32	114	26	163	38	174	31
Non-metropolitan hospitals	156	52	156	55	179	48	266	60	197	45	292	52
Other major trauma centres	52	17	37	13	76	20	65	15	75	17	93	17
Total transfers to major trauma centres	299		285		376		445		435		559	

Source: Major trauma service trauma registries

On a State-wide basis approximately 27% of cases with an ISS ≥ 16 managed at the major trauma centres are transferred from other hospitals for management. On an annual basis, of the total cases with an ISS ≥ 16 managed at the major trauma centres the percentage of cases transferred into the centre has increased from 24% to 31% over the period reviewed. On average over 50% of these transfers are from non-tetropolitan hospitals. The data currently collected does not allow further analysis of the source Area Health Services and the reasons for transfer. This lack of detailed data should be addressed with any future review of the minimum dataset and monitoring program.

When the volume of transfers to the major trauma centres is reviewed as a percentage of all cases with ISS ≥ 16 managed at the major trauma centres, there has been a small overall increase in the percentage of cases transferred from both metropolitan and non-metropolitan hospitals.

Trauma team activation

Trauma patients presenting to the emergency department should be promptly assessed by a multidisciplinary trauma team. The decision to activate the team is made according to articulated criteria and is based on information provided by the Ambulance Service either prior to, or on arrival at the hospital, or alternatively is applied to patients who present by other means. Ideally the trauma team should be assembled prior to the patient's arrival and be ready to receive the patient on arrival.

The role of the trauma team is to undertake the initial assessment and resuscitation of the trauma patient and coordinate timely access to appropriate definitive care. All patients who are severely or potentially severely injured should have an organised trauma team response on arrival at a major trauma centre.

On average approximately 71% of cases with an ISS ≤ 16 managed at the major trauma centres are transported directly to the centre and present via the emergency department, requiring trauma team activation. Of patients transferred into the major trauma centre many will be admitted directly to the intensive care unit or the inpatient ward areas.

Assessing the level of trauma team response for seriously injured patients (ISS ≤ 16) provides a measure of the appropriateness of the triage decision in accurately identifying patients with serious injury and activating an appropriate response. It also provides an indication of the responsiveness of the major trauma centres to the reception of seriously injured trauma patients.

A number of major trauma centres have implemented a two-tier trauma team response. Each tier is activated according to specific triage criteria. The first tier usually entails a multidisciplinary emergency department response to the trauma patient. The second tier is a more comprehensive hospital wide response involving staff external to the emergency department.

The intention of the two-tier trauma team activation is that by reducing the demand on the non-emergency department members of the trauma team for routine and less severely injured cases, will improve the response of these members to cases which are identified as potentially serious. While the majority of major trauma centres have implemented this system the activation criteria is not standardised across sites.

Indicator 7 is concerned with the appropriateness of the trauma team response and measures the accuracy of the trauma triage decisions for patients with an ISS ≥ 16. The indicator is the percentage of patients with ISS ≥ 16 admitted through the emergency department who are assessed by a trauma team response.

Indicator 7. Trauma team response

The percentage of cases with an ISS ≥ 16 presenting to the emergency department, which met the criteria for trauma team activation, and which were assessed by an organised trauma team response.

	Number of cases with ISS ≥ admitted through the ED eligible for trauma team activation	Number of cases with activation	Percentage of cases with ISS ≥ 16 admitted through ED with trauma team activation	Range in percentage activation across the major trauma centres
1994/95	771	738	96%	88%-100%
1995/96	900	811	90%	65%-100%
1996/97	1,078	982	91%	66%-100%
1997/98	1,133	1,001	88%	59%-100%
1998/99	1,111	996	90%	66%-100%
1999/00	1,253	1,208	96%	63%- 00%

Source: Major trauma service trauma registries

Comments

- There has been some annual variation in the percentage of cases with an ISS ≤ 16 which were subject to a trauma team response.
- Several sites are consistently achieving low levels of activation, this is a matter for concern and follow up with the individual sites is to be undertaken. The majority of sites are consistently achieving activation rates over 90%.
- The results for this indicator have been skewed by the markedly lower results which have occurred at one or two sites.

Conclusion – emergency department phase

The number of severely injured patients (ISS ≥ 16) managed in the major trauma centres is increasing. On reviewing the data it is evident that there is variation in the workload across the sites and in the level of performance across individual sites. Some sites are performing consistently well across all the indicators whereas other sites need to address areas of practice. There is variation in the quality of the available data and the quantity of data captured and supplied. Some of these issues can be attributed to the differences in the available resources for data collection and management, however the data items required for the monitoring program have not varied since its inception and the establishment of most of the trauma registries. There is a need for standardisation of data collected and the development of a data dictionary.

Recommendations

Recommendation 9

Extend the data requirements to include information on the source of transfers to the major trauma centres, including the mode of arrival at the transferring hospital and the reason for transfer.

Recommendation 10

Development and implementation of standardised trauma team activation criteria across the metropolitan trauma system. Following this indicator 7 should be modified to measure response, according to the pre-defined trauma team activation criteria.

Recommendation 11

All major trauma centres are to institute prospective Performance Improvement programs to review the under-triage rate for trauma team activation. The trauma team activation data should be reported in the annual trauma report of each major trauma centre.

Definitive care phase

A correlation has been established between access to definitive care and mortality rates with timely commencement of appropriate definitive care associated with improved outcomes for patients with moderate to severe injuries. Definitive care is considered to be the performance of an operative procedure, conducted on patients for whom this is clinically indicated.

The definitive care phase indicators have been developed to examine the performance of the trauma system as a whole. It is not the intention of these indicators, as they stand, to assess the performance within hospitals themselves but rather the ability of the system to first, identify patients in the field and second, ensure a timely progression to definitive care at a hospital capable of delivering that care.

The time taken for the patient to receive definitive care can be influenced by a number of factors and can be an indication of the effective functioning of the trauma system as a whole. Two significant impediments to timely delivery of care are the time taken from injury to the first hospital presentation and the delays with inter-hospital transfers. Within the hospital environment delays may be a reflection of the effectiveness of the trauma team response and the coordination of the appropriate resources including access to the operating theatres.

Each of the indicators is calculated from the time of injury to definitive care. Only results from the Sydney and Newcastle metropolitan areas are included. Cases transferred from non-metropolitan areas are excluded because of delays in time taken to arrive at the major trauma centre. However, cases transferred from metropolitan hospitals are included in the data.

A criticism of these indicators has been that in the current format they do not provide an evaluation of the appropriateness of either the care delivered, or any of the delays outside the benchmark of four hours. The indicators as currently collected do not provide detail on where the delays occurred, whether the treatment delays were appropriate or potentially avoidable, or the impact of any delays on patient outcome. This deficiency in the definitive care indicators was identified by the NSW Trauma System Advisory Committee in 1995, and in response a review of craniotomy timing was undertaken. A summary of the findings of the review is included below and the review is appended to this report for information (Appendix 5).

Injury to craniotomy

Craniotomy, for the purpose of this report, is defined as an operation for the evacuation of an acute intracranial space occupying lesion. It excludes drainage of chronic subdural haematomas and operations in which the only procedure was the insertion of an intra-cranial pressure monitor.

Indicator 8a. Head injury requiring craniotomy (for patients from the Sydney and Newcastle metropolitan areas only)

The time from injury to craniotomy for patients with head injury requiring operative management. The benchmark is the percentage of cases within the metropolitan area taken to the operative suite within two hours of injury and within four hours of injury.

	Number of cases with craniotomy	Craniotomy within two hours of injury*	Craniotomy within four hours of injury*	Percentage craniotomy within two hours	Percentage craniotomy within four hours
1994/95	147	29	70	20%	48%
1995/96	142	22	53	16%	37%
1996/97	157	21	75	13%	48%
1997/98	169	30	90	18%	53%
1998/99	150	29	93	19%	62%
1999/00	190	54	103	28%	54%

Source: Major trauma centres

* Figures for four hours include cases with craniotomy within two hours.

Comment

- The number of craniotomies performed per annum has increased by 29% since 1994/95.
- The percentage of cases proceeding to craniotomy within four hours has increased since the craniotomy review was undertaken. The percentage within two hours has remained relatively stable except for sharp rise in 1999/00.
- Currently the data provided does not enable analysis of the delays in craniotomy and an evaluation of whether these were clinically appropriate and whether the patients suffered any adverse outcomes secondary to the delay.

Based on the results for this indicator reported in 1994/95, the NSW Trauma Services Advisory Committee (TSAC) initiated a review of craniotomy timing. The aim of that review was to identify the precise reasons for delayed care and determine whether specific issues needed to be addressed in regard to triage of head injuries in the field and the emergency department.

The study reviewed all cases in the major trauma centres that had undergone a craniotomy for the evacuation of a traumatically acquired mass intracranial lesion for a two year period between 1 April 1994 and 31 March 1996. The results of the study found that over two years, 19% of cases requiring craniotomy experienced an avoidable delay.

On further investigation of the 19% of cases which experienced a delay, the reasons were found to be multi-factorial, with 21% of delays found to be unavoidable, 27% intentional and the remaining 52% of delays were found to be avoidable system delays. The review did find that despite the delay to craniotomy, the majority of patients (81%) were being actively treated with close medical review.

The review identified that the main impediments to increasing the proportion of patients undergoing craniotomy within four hours are:

- initial transport to a hospital which is not able to provide a neurosurgical service
- delays associated with inter-hospital transfers
- delay in obtaining a CT scan and interpreting the findings
- delayed identification of patients with serious head injury in emergency departments, including the role of alcohol in masking the clinical picture.

The craniotomy review demonstrated that delays are multi-factorial but performance may be improved if local strategies are developed to avoid the identified deficiencies. In response to this review NSW TSAC advocates an approach that minimises the time that a patient requiring surgical drainage of an intra-cranial haematoma waits for surgery. This is to include local review of all cases where a delay has occurred, which evaluates the reason for delay, the clinical appropriateness of the delay and the impact of the delay on patient outcome. Local strategies are to be developed and implemented to address the identified reasons for delay. Additionally any locally identified system-wide issues are to be reported to the NSW Trauma Services Committee.

Injury to laparotomy

This indicator applies to cases with abdominal bleeding for which surgical intervention is undertaken and the percentage of these cases undergoing surgery within four hours of injury.

Indicator 8b. Abdominal bleeding requiring laparotomy (for patients from the Sydney and Newcastle metropolitan areas only)

The time from injury to laparotomy for patients with abdominal bleeding requiring operative management. The benchmark is the percentage of cases within the metropolitan area taken to the operative suite within four hours of injury.

	Number of cases	Number of cases	Percentage undergoing
1994/95	170	122	72%
1995/96	201	94	47%
1996/97	221	149	67%
1997/98	209	143	68%
1998/99	174	119	68%
1999/00	230	145	63%

Source: Major trauma centres

Comment

- With the exception of 1995/96 the percentage of cases undergoing laparotomy within four hours of injury has remained over 63.
- The reason for the sharp decline in 1995/96 is not known, however performance has remained steady since that time.
- Additional information is required to determine whether the delays in laparotomy are clinically appropriate or potentially avoidable.
- Additional information on the number of negative laparotomies performed would enable assessment of the outcomes of this procedure.

Examining data from the individual major trauma centres, there is a wide range in the percentage of cases meeting the benchmark and for most years the median percentage of cases is higher than the collective results of the Indicator highlighting the skewing effect of the outliers at the lower percentages.

As with cases requiring craniotomy, additional information is required to enable more detailed analysis of the data. Information is required about whether the delay was clinically appropriate, the factors influencing delay and the impact of any delays on patient outcome. As with cases requiring craniotomy, local review of individual cases should be undertaken with the development and implementation of local strategies. Any system-wide issues which are identified during this review should be brought to the attention of the NSW Trauma Services Committee.

Injury to debridement of open long gone fractures

This indicator applies to the operative debridement of open or compound fractures of any of the long bones. The data required to measure this indicator is not collected at all the major trauma centres and there is incomplete capture of data at some centres.
The variation in data capture has been attributed to inadequate staffing levels as well as the larger patient group than for the other operative procedures such as craniotomy or laparotomy which are reviewed.

Indicator 8c. Debridement of open long bone fractures (for patients from the Sydney and Newcastle metropolitan areas only)

The time from injury to operative debridement of an open long fracture. Time to operating room is within six hours of injury.

	Number of cases with open long long bond fractures	Number of cases undergoing debridement within six hours of injury	Percentage undergoing debridement within six hours of injury
1994/95	172	98	57%
1995/96	192	102	53%
1996/97	195	101	52%
1997/98	204	122	60%
1998/99	223	143	64%
1999/00	148	87	59%

Source: Major trauma centres

Comment

- There is annual variation in the performance of this Indicator. On analysis of individual site data there is wide variation in performance across sites.
- The accuracy of this Indicator is influenced by the variations in data capture across the sites.

In cases where the patient has sustained multiple severe injuries, the debridement of open fractures may be delayed while management of more severe injuries take priority or while the patients clinical condition is stabilised.

As with the other definitive care indicators, the monitoring and validity of this indicator would benefit from provision of additional data indicating the reasons for delay, clinical appropriateness of delay and any impact on patient outcomes.

Conclusions – definitive care phase

Time from injury to definitive care has been identified as an important influence on patient outcomes. The TSAC craniotomy study establishes the veracity of local level stratified definitive care access reviews. To improve the relevance of these indicators for evaluation of trauma centre performance, patients need to be stratified into avoidable and unavoidable delays, the effect of delay on outcomes need to be defined by peer review audit, and compound long bone fractures have to be graded according to severity. Reporting aggregated de-identified data on delays in access to operating theatre surgical care at State-wide level in the current format does not provide an effective measure of a functioning trauma system.

Recommendation

Recommendation 12

All major trauma centres are to peer review all patients falling outside the current agreed benchmarks for access to definitive care. The review should include an evaluation of the reason for delay, the clinical appropriateness of the delay and the impact of the delay on patient outcome. Local strategies should be developed and implemented in response to any identified issues. Any identified system-wide issues are to be reported to the NSW Trauma Services Committee.

Trauma outcomes

The aim of the trauma system is to provide trauma patients with the best possible outcomes. Patient outcomes should be measured through indicators of both morbidity and mortality, including review of complications. However, to date, data regarding morbidity and complications has not been a requirement of the NSW monitoring program. As a result, this section focuses on mortality as an outcome, examining the number of trauma related deaths and where these deaths have occurred. For deaths occurring in-hospital, of relevance is whether these deaths were avoidable and the survival rate of patients with severe but survivable injuries.

Given the maturation of the trauma system, and following a planned review of the data collection and monitoring program it is expected that the outcome indicators will be expanded to include relevant quality of care and morbidity measures.

The data reported in this section has been submitted from the NSW Police Reports of Death Registry (PROD) and the trauma registries maintained at each of the major trauma centres.

The PROD Registry was established in 1995 with funding from the NSW Department of Health as the NSW Trauma Death Registry (the Registry). The Registry is maintained by the Department of Surgical Research at the Children's Hospital at Westmead. The source of this data is the Police Report of Death to the Coroner for all injury related deaths in NSW.

Trauma related deaths in NSW

The PROD Registry is able to provide data for all of NSW, therefore, deaths occurring in the non-metropolitan areas have also been included. The majority of data presented in this section is from 1996/97 to 1999/00 as more detailed data is available for this period. Additional information on the demographics and mechanisms of the trauma related deaths has been included in Appendix 6 for information.

Data on trauma related deaths have been included for analysis irrespective of intent whether accidental, intentional (interpersonal violence or suicide) or undetermined. Deaths from the following causes have been excluded from the analysis:

- deaths due to drowning or submersion for all age groups (excluding cases aged more than four years which have fallen into the body of water)
- deaths due to suffocation
- deaths resulting as a late sequelae of injury
- deaths where the cause was not determined, is ill-defined or not specified.

Overview

The number of trauma related deaths occurring in NSW between 1996/97 and 1999/00 ranged from 1,494 to 1,669. This represents an overall increase in the number of deaths by 11.7% over the four year period, however the average increase ranged between 0.8% to 2.6% per annum with the exception of 1998/99 when the number of deaths rose by 8%. The increase in deaths occurred only in the Sydney metropolitan area, with varying levels of increase observed across each of the metropolitan Area Health Services. The number of deaths occurring in the greater metropolitan and rural areas declined over the same period. The increase in the number of deaths reflects similar observed increases in the number of cases with an ISS $\geq$ 16 managed at the major trauma centres. The increase in 1998/99 was associated with an increase in the number of deaths as a result of falls, hanging/strangulation/suffocation and jumping from objects.

Table 13. Trauma related deaths in NSW 1996-2000

		Sydney metro		Greater metro*		Rural		Not known	
	Total deaths	No.	%	No.	%	No.	%	No.	%
1996/97	1,494	660	44.2%	267	17.9%	554	37.1%	13	0.9%
1997/98	1,533	659	43.0%	304	19.8%	563	36.7%	7	0.5%
1998/99	1,655	800	48.3%	287	17.3%	532	32.1%	36	2.2%
1999/00	1,669	901	54.0%	277	16.6%	464	27.8%	27	1.6%
Total	6,351	3,020	47.6%	1,135	17.9%	2,113	33.3%	83	1.3%

Source: NSW Trauma Death Registry/Police Report of Death Registry (PROD)

* Greater metropolitan area include the Hunter, Illawarra and Central Coast Area Health Services

The highest percentage of trauma related deaths occur in the Sydney metropolitan area. The number and percentage of deaths occurring in the Sydney metropolitan area has continued to increase since 1996/97, increasing by 22.4% in 1998/99 and 12.9% in 1999/00. In contrast the number of trauma related deaths occurring in the greater metropolitan and rural areas have declined annually since 1997/98. In Sydney the rise in deaths was associated with an increase in the number of deaths resulting from falls, assault, hanging/strangulation/suffocation and jumping from object.

Within the Sydney metropolitan area the highest number of deaths have consistently occurred in the South Eastern and South Western Area Health Services. While all the area health services have experienced an increase in the number of deaths the largest overall increases have occurred in the South Eastern, Central and Western Sydney Area Health Services. Among the greater metropolitan areas the majority of deaths occurred in the Hunter Area, while across the rural areas, Greater Murray, Mid North Coast and Northern Rivers Area Health Services consistently had the highest number of deaths. (For more detail refer to Appendix 6.)

Generally across the State the most common mechanisms of injury resulting in death were as a result of motor vehicle accidents (which includes motor cycle and pedal cycle accidents) and from hanging/strangulation/suffocation. The number of deaths from motor vehicle accidents has declined across the State with the exception of the Sydney metropolitan area where there has been an increase in 1999/00. The number of deaths as a result of hanging/strangulation/suffocation has risen annually across all areas, as have the number of deaths from falls. Deaths resulting from assault have increased while the number of stabbing and firearm deaths have declined annually.

Over 50% of trauma related deaths occur in the 15-44 year age group. Males account for over 75% of trauma related deaths representing the majority of deaths across each of the age groups. Among males injury related deaths most commonly occur in the 25-34 age group, whereas for females there is annual variation with greater representation among the older age groups.

The common mechanisms of injury vary across the different age groups with the number of deaths related to falls higher among the over 75 years age group, while hanging/strangulation was the most common mechanism for males in the 25-44 age group.

Site of trauma death

Trauma deaths can occur either at the scene of the accident, en-route to hospital (dead on arrival) or during the in-hospital period. Factors that will influence the occurrence of death at the accident scene include the intent (such as suicide), the mechanism of injury, and the severity of the injuries sustained. The location of the accident will also be a factor, with accidents occurring in isolated areas there may be delays in discovery of the accident scene as well as protracted response and transport time.

Over 70% of trauma related deaths occur at the scene of the accident, with the percentage of deaths occurring at scene in both the greater metropolitan and rural areas higher than in the Sydney metropolitan area, reflecting the impact of geography, distances and isolation. While there has been a decline in the number of trauma related deaths occurring in the greater metropolitan and rural areas, the percentage of these deaths occurring at the scene has increased. In comparison, in the Sydney metropolitan area while the number of deaths occurring at scene has increased the percentage of trauma deaths that these cases represent has remained relatively stable.

Table 14. Comparison of deaths occurring at scene of accident by areas

	1996/97		1997/98		1998/99		1999/00	
	No.	% of cases	No.	% of cases	No.	% of cases	No.	% of cases
Sydney metropolitan area	414	62.7%	457	69.3%	539	67.4%	613	68.0%
Greater metropolitan areas (Hunter, Illawarra, Central Coast)	183	68.5%	235	77.3%	208	72.5%	232	83.8%
Rural areas	430	77.6%	466	82.8%	425	79.9%	413	89.0%
Area not known	12		6	0.9%	21	2.6%	27	3.0%
Total NSW	1,039	69.5%	1,164	75.9%	1,193	72.1%	1,285	77.0%

Source: PROD

Reviewing the individual mechanisms of injury with the highest number of deaths occurring at the accident scene, there are variations across each of the mechanisms in the percentage of the total deaths per mechanism that these cases represent. For example, motor vehicle accidents which represent the mechanism of injury with the highest number of deaths occurring at scene, yet these cases represent between 63% and 76% of the total deaths resulting from motor vehicle accidents. In comparison the deaths at scene from hanging/strangulation/suffocation account for between 88% and 96% of deaths for this mechanism and for deaths from firearm/shooting between 81% and 93% of deaths occur at scene. It can be speculated that the higher percentage of deaths at scene for the latter two mechanisms may in part be attributable to the intent of the individuals involved. It should also be noted for each of these mechanisms of injury the percentage of deaths occurring at scene in the rural areas is higher than the figures for both the NSW and Sydney metropolitan area.

The most common mechanisms of injury for in-hospital trauma related deaths are motor vehicle accidents (includes motor cycle, bus and truck accidents), pedestrians and as a result of falls (which includes low level falls). As discussed previously the percentage of trauma cases dying following arrival at hospital is higher in the Sydney metropolitan area than the rural Areas. This can be attributed to the reduced response times to the accident scene as well as shorter travelling time required for the patients to arrive at hospital in the urban areas compared to rural areas.

For in-hospital trauma related deaths occurring within the Sydney metropolitan area of relevance is the percentage of these cases where the patient was managed at a major trauma centre at some point during their inpatient stay.

Indicator 9. Site of trauma death – Sydney metropolitan area

The percentage of in-hospital trauma related deaths resulting from accidents within the Sydney metropolitan area where the patient has been managed at a major trauma centre during the in-hospital stay.

Cases managed at hospital in the Sydney metropolitan area are excluded where the accident occurred outside the Sydney metropolitan area and the patient was subsequently transferred to a hospital in Sydney.

	Number of in-hospital deaths deaths	Number of cases managed at the major trauma centres	Number of cases managed in urban hospitals	Number of cases managed at other* facilities or site not known	% cases managed at the major trauma centres
1994/95	282	243	39	0	86%
1995/96	210	176	34	0	84%
1996/97	240	204	36	0	85%
1997/98	180	131	42	7	73%
1998/99	223	174	42	7	78%
1999/00	284	226	54	4	80%

Source: PROD

* Includes private hospitals, hospices, or other non-acute hospitals.

Comment

- The majority of trauma related deaths across the Sydney metropolitan area were managed at the major trauma centres, however this percentage has declined since 1997/98.
- The decline in the percentage of deaths which were managed at the major trauma centres corresponds with a decline in the number of these cases transferred from the urban trauma hospitals to the major trauma centres.

While it is expected that the majority of these cases will be managed at a major trauma centre at some point, it can be assumed that a number of these cases will have been severely injured and in an unstable condition at the accident scene necessitating transport to the nearest hospital (category 7). Following resuscitation some of these cases will then have been transferred to a major trauma centre, other cases will die prior to transfer.

Potentially avoidable death index

The potentially avoidable death index used as part of the NSW Trauma Monitoring Program is based on the criteria developed by West et al.[7] The index is calculated from the number of in-hospital deaths occurring within six hours of arrival at hospital where the cause of death was not from head injury (non-CNS deaths) but resulted from an exsanguinating injury in either the abdomen or thorax (excluding deaths secondary to injury of the heart or great vessels). The pre-requisites for determining these cases are that the patient arrived at hospital with vital signs and did not have either a thoracotomy or laparotomy initiated within six hours from arrival at hospital (West's criteria).

7. West JG, An Autopsy Method for Evaluating Trauma Care, *Journal of Trauma*, 1981;21:32-34.

Indicator 10. West's potentially avoidable death index (PADI)

The index is calculated dividing the number of deaths meeting West's criteria by total the number of deaths not due to head injury (non-CNS deaths).

	Number of non-cns deaths	Number of deaths meeting west's criteria	Potentially avoidable death index
1994/95	74	2	0.027
1995/96	103	3	0.029
1996/97	91	1	0.011
1997/98	75	1	0.013
1998/99	69	3	0.044
1999/00	88	1	0.011

Source: Major trauma service, trauma registries

Comment

- The number of non-CNS deaths occurring at the major trauma centres has remained low. Non-CNS deaths account for about 36% (annual variation 31%-41%) of all trauma related deaths occurring at the major trauma centres.
- The number of deaths meeting West's criteria has remained low and the PADI compares favourably with the pre-regionalisation value of 0.125.
- The three deaths meeting West's criteria in 1998/99 occurred across three different sites. On examination of the data for each of the major trauma centres there are no sites consistently with deaths that meet West's criteria.

Of the deaths occurring in the major trauma centres over 60% (annual variation 59.2%-68.6%) are as a result of injury to the head and/or central nervous system (CNS deaths), the remaining deaths are due to other causes (non-CNS deaths).

The number of West's potentially avoidable deaths reported in this series is small, 11 deaths without operation over six years. The number of non-CNS deaths has remained low in Sydney and the Hunter with only 500 non-CNS deaths at major trauma centres reported over the same six years. If all patients, including those with a potentially lethal injury have access to an early thoracotomy or laparotomy then the small number who are salvageable will have an improved chance of survival.

The inclusion of West's index as the measure of potentially avoidable death for the NSW trauma monitoring program has been a point of contention among TSAC members with diverging views regarding its usefulness as an outcome indicator for in-hospital mortality. It should be noted that there are limitations in the usefulness and applicability of West's methodology mainly because the majority of trauma deaths are due to CNS causes and are therefore not accounted for in the index. Additionally the method does not attempt detailed review of each case. However, one of the advantages of this methodology is that unlike the peer review process for assessing trauma cases, it is consistent in what it measures and is not dependent on opinion regarding case management.

The importance of identifying cases which fit West's index should not be disregarded, however to achieve a comprehensive view of the effectiveness of the trauma management in reducing avoidable mortality West's methodology should not be used as the only indicator but should form one of several indicators used to identify potentially avoidable trauma deaths and be considered in the context of other measures of mortality. In addition to the use of mortality indicators all trauma related deaths should undergo a death review, locally, by the Hospital Trauma Committee.

Wesson's salvageable rate

Wesson's[8] severe but salvageable rate is a measure of the effectiveness of the in-hospital care delivered to severely injured patients, focusing on the proportion of patients with severe injuries who survive to discharge. Rather than concentrate on the proportion of deaths that are determined to be avoidable or preventable, Wesson has proposed a measure of trauma system effectiveness by measuring the proportion of patients with severe injury that survive. Wesson's salvageable rate was developed in the 1980s based on data from a paediatric trauma population, however the applicability of the criteria to an entire trauma population has not been established. Therefore, while the use of this rate provides information on the effectiveness of the trauma system reliance on this data as the sole indicator of hospital effectiveness should not occur.

The inclusion criteria are that the patient must have at least one injury with an Abbreviated Injury Score (AIS) of 4 or more (therefore an ISS ≥ 16). Patients are excluded if the ISS is above 59. Also excluded are any patients with an AIS of 5 in the head and neck region with the exception of a solitary extradural haematoma. The group selected in this way has an ISS between 16 and 58 without major head injury. The 'salvageable rate' is the proportion of such cases that survive to discharge.

Indicator 11. Wesson's salvageable rate

The percentage of patients of patients with severe but salvageable injuries (using Wesson's criteria) who survive to discharge.

	Number of severe salvageable cases	Number of survivors	Number of deaths	Salvageable rate
1994/95	571	518	53	90.7%
1995/96	415	357	58	86.0%
1996/97	683	601	82	88.0%
1997/98	620	557	63	89.8%
1998/99	575	530	45	92.2%
1999/00	779	716	63	91.9%
Total	3,643	3,279	364	90.0%

Source: Major trauma service, trauma registries

Comments

- Following a sharp decline in the salvageable rate in 1995/96 the rate has continued to rise annually.

According to Wesson, in a paediatric trauma population, the value should be at least 90%. Although comparable values have not been established for an entire trauma population the six years of results presented enable comparison of the trauma system performance against previous years performance. The results presented can also serve as a baseline against which individual sites can compare themselves.

8. Wesson DE, Williams JI, Salmi LR, Spence LJ, Armstrong PF, Filler RM, Evaluating a Paediatric Trauma Program: Effectiveness versus Preventable Death Rate, *Journal of Trauma*, 1988, Aug; 28(8): 1226-31.

Conclusions – trauma outcomes

While the number of trauma related deaths have increased over the six years of data reviewed, the performance of the trauma system against each of the performance indicators has remained stable at a high level. Over 70% of trauma related deaths occur at the accident scene. Of the in-hospital deaths approximately 80% have received treatment at a major trauma centre during their inpatient episode. More detailed evaluation of the metropolitan cases which are not managed at major trauma centre should be undertaken to evaluate the circumstances surrounding these cases. As part of the review of outcomes and the need to institute change at a State-wide level, TSAC recommends State level peer review of all potentially avoidable trauma deaths.

The current outcome indicators only review mortality outcomes, the outcome indicators should be expanded to include morbidity indicators. The continued use of both West's Index and Wesson's Salvageable Rate as the sole in-hospital mortality measures requires review and will be considered as part of a planned review of the monitoring program.

Recommendations

Recommendation 13

Expansion of the current performance indicators for trauma outcome to include relevant morbidity and quality of care indicators.

Recommendation 14

NSW Institute of Trauma and Injury Management coordinate a review of the relevance and appropriateness of West's Potentially Avoidable Death Index and Wesson's Salvageable Rate and determine which outcome measures should be incorporated in the ongoing Trauma Monitoring Program.

Recommendation 15

All trauma related deaths should undergo review locally by the Hospital Trauma Committee, with any potentially avoidable deaths reported to the NSW Trauma Death Review Committee.

Recommendation 16

The NSW Trauma Death Review Committee commence a program of Peer Review Death Audit of all deaths that are peer reviewed at a Major or Regional Trauma Centres as potentially avoidable. A report of provider and system errors should be provided in a patient de-identified manner to the NSW Department of Health and to the Area Health Services.

Conclusions

This report provides a review of the performance of the NSW Metropolitan Trauma System over a five year period (1995-2000) measuring performance against eleven established performance indicators. The results of this indicate that while the overall performance of the Metropolitan Trauma System is good there are areas for improvement in particular the pre-hospital times. However as noted in the report the performance issues related to the pre-hospital times may be transient and related to industrial issues and data capture associated with the change to a Computer Aided Dispatch System. The review of the data and the preparation of this report highlighted the variations in the quality of data and the quantity of data captured and supplied across the individual sites. It has highlighted the need for standardisation of the data collected and the development of a data dictionary.

The current performance indicators while providing some information on the performance of the trauma system require updating to reflect the maturation of the NSW Metropolitan Trauma System and to enable adequate evaluation of the different aspects of the System. Given the maturation of the system, the establishment of the NSW Institute of Trauma and Injury Management in 2002 and the allocation of additional funds to the metropolitan trauma services, it is timely to review the Trauma Monitoring Program. In particular the reporting responsibilities and requirements of the trauma services, the review of the performance indicators and the establishment of appropriate and relevant indicators including the setting of performance benchmarks.

General recommendations

Recommendation 17

NSW ITIM to coordinate the implementation of a Minimum Trauma Data Set (MTDS) across all major and regional trauma services with standard definitions and development of a data dictionary.

Recommendation 18

Reporting of performance data on an annual basis is mandatory for all major trauma centres and metropolitan regional trauma centres.

Recommendation 19

Future trauma monitoring reports will report on individual site specific trauma centre data which will be used for analysis.

Recommendation 20

All Area Health Services with a major trauma centre prepare an annual trauma report. This report should include a review of the spectrum of injury and injury outcomes in their hospital. It should include a report on performance review and programs of continued performance improvement and a report on access to definitive care complications and adverse outcomes and mortality outcomes.

Recommendation 21

A review of the Trauma Monitoring Program should be undertaken, to include a review of the performance indicators for each phase of care and the establishment of appropriate performance benchmarks.

Glossary

AIS	Abbreviated Injury Score
CAD	Computer Aided Dispatch
CCAHS	Central Coast Area Health Service
CSAHS	Central Sydney Area Health Service
FWAHS	Far West Area Health Service
GMAHS	Greater Murray Area Health Service
HAHS	Hunter Area Health Service
IAHS	Illawarra Area Health Service
ISS	Injury Severity Score
ISS ≥ 16	Injury Severity Score greater than or equal to 16
ITIM	NSW Institute of Trauma and Injury Management
MAHS	Macquarie Area Health Service
MNCAHS	Mid North Coast Area Health Service
MWAHS	Mid West Area Health Service
MTC	major trauma centre
NEAHS	New England Area Health Service
NRAHS	Northern Rivers Area Health Service
NSAHS	Northern Sydney Area Health Service
SAHS	Southern Area Health Service
SESAHS	South Eastern Sydney Area Health Service
SWSAHS	South Western Sydney Area Health Service
TSAC	Trauma System Advisory Committee
WAHS	Wentworth Area Health Service
WSAHS	Western Sydney Area Health Service
Greater metropolitan areas	Also includes Hunter, Illawarra and Central Coast Area Health Services
Urban hospital	All metropolitan hospitals with an emergency department not designated as a major trauma centre

Appendix 1 – NSW metropolitan trauma indicators (implemented in 1994)

1. Pre-hospital phase – the pre-hospital phase indicators are only applicable to the Sydney metropolitan area

Phase of care	Data items	Data sources	Trauma indicators
1.1 How many trauma patients are triaged to attend a major trauma service hospital?	Ambulance triage category	Ambulance Service	**Bypass caseload** Number and percentage of trauma cases triaged `serious-bypass', and `serious-major trauma service nearest hospital'.
1.2 How many trauma patients are triaged as `dying' and transported to the nearest hospital?	Ambulance triage category	Ambulance Service	**Dying caseload** Number of trauma cases triaged 'dying' transported to urban trauma service hospitals and major trauma service hospitals.
1.3 How accurate are ambulance officers' triage decisions?	Ambulance triage category Injury Severity Score (ISS)	Ambulance Service Trauma Registry ISS mapping of Inpatient Statistics Collection (ISC)	**Over-triage rate** Percentage of patients triaged `serious' or ` dying' whose ISS ≥ 16. **Sensitivity of guidelines** percentage of patients with ISS ≥ 16 who were triaged `serious' or `dying'.
1.4 Do all ambulance transports for trauma reach hospital promptly?	Pre-hospital treatment and transport times	Ambulance Service	**Response time** Percentage of ambulances arriving at scene of accident within 10 minutes of the call for assistance. **Scene time** Percentage of patients spending less than 20 minutes at scene of accident. **Pre-hospital treatment time** Percentage of patients arriving at hospital within 60 minutes.
1.5 Do trauma patients selected to bypass urban trauma service hospitals reach hospital promptly?	Pre-hospital treatment and transport times	Ambulance Service	**Scene time – bypass cases** Percentage of patients spending less that 20 minutes at scene of accident. **Transport time – bypass cases** Percentage of bypass patients arriving at hospital within 30 minutes of leaving the scene of accident. **Pre-hospital treatment time – bypass cases** percentage of bypass patients arriving at hospital within 60 minutes.

2. Major trauma centre – emergency department phase

Phase of care	Data items	Data sources	Trauma indicators
2.1 What is the source of referral for major trauma victims?	Source of referral ISS	Trauma Registry	**Major trauma caseload** Number of trauma patients ISS ≥ 16 treated at major trauma service hospitals by source of referral.
2.2 How accurate are triage decisions that initiate a trauma response?	Nurse triage decision ISS	Trauma Registry	**Appropriateness of trauma response** Percentage of trauma patients with ISS ≥ 16 assessed by organised trauma response.

3. Major trauma centre – definitive care

Phase of care	Data items	Data sources	Trauma indicators
3.1 Is definitive care organised promptly for trauma patients?	Clinical diagnosis Time of injury Time taken to operative suite	Trauma Registry	**Time to definitive care for patients with:** **Head injury requiring craniotomy** Percentage taken to operative suite within two hours of injury. **Abdominal bleeding requiring surgical correction** Percentage taken to operative suite within four hours of injury. **Open fractures requiring debridement** Percentage taken to operative suite within six hours of injury.

4. Patient outcomes

Phase of care	Data items	Data sources	Trauma indicators
3.1 Are trauma deaths concentrated in major trauma service hospitals?	Vital status Locality of death	Area network trauma death register	**Site of trauma death** Percentage of in-hospital deaths occurring in major trauma service hospitals.
3.2 What is the potentially avoidable death rate?	West's preventability criteria[1]	Statistical summary of clinical audit	**Potentially avoidable death rate** Percentage of deaths from intra-thoracic and abdominal injury operated on within six hours of arrival at hospital.
3.3 What percentage of severely injured patients who were salvageable and survived?	Vital status ISS/AIS* (Wesson's criteria)[2]	Trauma Registry ISS mapping of ISC	**Trauma salvageable rate** Percentage of patients with severe but salvageable injuries who survive.

1. West JG, An Autopsy Method for Evaluating Trauma Care, *J Trauma,* 1981;21:32-34.

2. Wesson DE, Williams JI, Salmi LR, Spence LJ, Armstrong PF, Filler RM, Evaluating a pediatric trauma program: effectiveness versus preventable death rate, *J Trauma,* 1988 Aug; 28(8): 1226-31.

Appendix 2 – Trauma monitoring data collection form

Hospital: **Period:** **/ / to / /**

For trauma cases with ISS ≥ 16 (Sections 1.3, 2.1 and 2.2 refer to admissions)

Section 1.3 Cases delivered by primary road ambulance from within urban area

(This is the area of direct transport for trauma triage and corresponds to all Sydney Area Health Services and metropolitan Newcastle)

Trauma triage category (Sydney)	Number of cases with ISS ≥ 16
Minor – codes 1 to 3	
Serious – code 4 (bypass)	
Serious – code 5 (MTS nearest)	
Serious – code 6	
Serious – code 7	
Not known – form not available	
Not known – not recorded on form	
Total	

Section 2.1 Mode of transport for cases with ISS ≥ 16

Mode of arrival	Number of cases with ISS ≥ 16
Primary road ambulance	
Direct helicopter (primary cases not transfers)	
Transfer from urban hospital (not MTS)	
Arrival at initial hospital by ambulance	
Arrival at initial hospital by private transport	
Transfer from another major trauma service	
Transfer from non metropolitan hospital	
Arrived by private transport (car etc)	
Not known	
Total	

For all trauma cases admitted (or died in emergency department)

Section 2.2 Trauma team activations

Type of case	Number
Trauma team activations (all severities) (If two tier activation system in place include all activations)	
Cases with ISS ≥ 16 admitted via ED in which Trauma Team activation occurred (A)	
Cases with ISS ≥ 16 admitted via ED who qualified for a trauma team call in which trauma team activation DID NOT occur (B)	
Total of cases with ISS ≥ 16 (=A+B Total of above two items)	
Admitted via ED who qualified for trauma call and/or had a trauma call	

Trauma monitoring data collection form

For all trauma separations for all injury severities

(Discharges, deaths or transfers)

(Note: Metro = urban area of Newcastle and all Sydney Area Health Services and applies to the location of the patient when injured)

Section 3.1 Operative Timing

Type of operative procedure	Location of injured patient	
	Metropolitan	**Non-metropolitan**
a) Craniotomies (for evacuation of haematoma not ICP alone)		
Total separations with craniotomy		
Number of craniotomies within two hours of injury		
Number of craniotomies ≥ two hours ≤ four hours of injury		
b) Laparotomies		
Number of separations with laparotomy		
Number of laparotomies within two hours of injury		
Number of laparotomies ≥ two hours ≤ four hours of injury		
c) Open fractures of long bones		
Number of separations with operation		
Number of operations within six hours of injury		

Section 4.2 Trauma deaths

Total number of deaths (A)		
Total number of # NOF deaths (B)		
Total number of CNS deaths (head and cord injuries) (C)		
Number of non CNS deaths (excl # NOFs ie =A-(B+C))		
Number of deaths from thoracic/abdominal bleeding without operation within six hours of arrival at hospital (does not include patients with CPR on arrival)		

Section 4.3 'Wesson's salvageable' cases

Number of severe salvageable cases		
Number of severe salvageable cases surviving		

Appendix 3 – Breakdown of ambulance trauma data 1996/97-1990/00

(Sydney metropolitan area only)

Number of cases by mechanism of injury per annum

'Minor' = cases with a pre-hospital triage code 1-3, 'serious' = triage code 4-7

	1996/97		1997/98		1998/99		1999/00	
Mechanism	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**
Assault	3,627	107	4,482	90	3,389	72	3,244	76
Bites/stings	172	4	312	6	219	3	186	0
Burns/scalds	359	72	517	76	420	68	348	42
Bus	107	14	91	6	69	3	78	4
Car	6,967	976	7,133	917	6,991	753	6,822	772
Drowning	23	7	43	4	22	4	19	4
Electricity	46	3	64	2	68	4	48	4
Fall	14,278	311	16,990	284	14,382	256	13,402	244
Machinery	540	79	598	73	508	70	469	54
Motor bike	554	111	702	129	606	99	561	116
Other incident	4004	181	4,941	149	4,054	146	3,727	110
Other MVA	465	56	400	38	145	18	64	2
Pedal cyclyst	n/a	n/a	n/a	n/a	234	22	269	33
Pedestrian	1,084	243	1,280	237	1,262	219	1,168	203
Poisoning	41	5	86	1	57	3	47	2
Shooting/stabbing	197	101	244	102	185	87	207	100
Sports	1,824	38	2,020	50	1,659	37	1,621	47
Truck	125	38	161	32	125	16	115	20
Grand total	34,413	2,346	40,064	2,196	34,395	1,880	32,395	1,833

Note: No further breakdown of mechanism is available for other incident or other MVA

Mechanism as a percentage of the annual caseload

	1996/97		1997/98		1998/99		1999/00	
Mechanism	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**
Assault	10.5%	4.6%	11.2%	4.1%	9.9%	3.8%	10.0%	4.1%
Bites/stings	0.5%	0.2%	0.8%	0.3%	0.6%	0.2%	0.6%	0.0%
Burns/scalds	1.0%	3.1%	1.3%	3.5%	1.2%	3.6%	1.1%	2.3%
Bus	0.3%	0.6%	0.2%	0.3%	0.2%	0.2%	0.2%	0.2%
Car	20.2%	41.6%	17.8%	41.8%	20.3%	40.1%	21.1%	42.1%
Drowning	0.1%	0.3%	0.1%	0.2%	0.1%	0.2%	0.1%	0.2%
Electricity	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.1%	0.2%
Fall	41.5%	13.3%	42.4%	12.9%	41.8%	13.6%	41.4%	13.3%
Machinery	1.6%	3.4%	1.5%	3.3%	1.5%	3.7%	1.4%	2.9%
Motor bike	1.6%	4.7%	1.8%	5.9%	1.8%	5.3%	1.7%	6.3%
Other incident	11.6%	7.7%	12.3%	6.8%	11.8%	7.8%	11.5%	6.0%
Other MVA	1.4%	2.4%	1.0%	1.7%	0.4%	1.0%	0.2%	0.1%
Pedal cyclyst	–	–			0.7%	1.2%	0.8%	1.8%
Pedestrian	3.1%	10.4%	3.2%	10.8%	3.7%	11.6%	3.6%	11.1%
Poisoning	0.1%	0.2%	0.2%	0.0%	0.2%	0.2%	0.1%	0.1%
Shooting/stabbing	0.6%	4.3%	0.6%	4.6%	0.5%	4.6%	0.6%	5.5%
Sports	5.3%	1.6%	5.0%	2.3%	4.8%	2.0%	5.0%	2.6%
Truck	0.4%	1.6%	0.4%	1.5%	0.4%	0.9%	0.4%	1.1%

Category 7 cases – mechanism of injury per annum

	1996/97		1997/98		1998/99		1999/00	
Mechanism	**No.**	**%**	**No.**	**%**	**No.**	**%**	**No.**	**%**
Assault	7	12.3%	–	–	2	5.6%	2	5.1%
Bites/stings	–	–	–	–	–	–	–	–
Burns/scalds	–	–	3	7.0%	2	5.6%	–	–
Bus	1	1.8%	–	–	–	–	–	–
Car	23	40.4%	10	23.3%	4	11.1%	12	30.8%
Drowning	–	–	–	–	–	–	1	2.6%
Electricity	–	–	–	–	–	–	–	–
Fall	4	7.0%	4	9.3%	3	8.3%	5	12.8%
Machinery	–	–	1	2.3%	–	–	–	–
Motor bike	–	–	5	11.6%	2	5.6%	3	7.7%
Other incident	7	12.3%	7	16.3%	4	11.1%	1	2.6%
Other MVA	–	–	–	–	–	–	–	–
Pedal cyclist	n/a	–	n/a	–	1	2.8%	1	2.6%
Pedestrian	8	14.0%	10	23.3%	11	30.6%	10	25.6%
Poisoning	1	1.8%	1	2.3%	1	2.8%	–	–
Shooting/stabbing	5	8.8%	2	4.7%	5	13.9%	3	7.7%
Sports	–	–	–	–	–	–	–	–
Truck	1	1.8%	–	–	1	2.8%	1	2.6%
Grand total	57		43		36		39	

Number of cases by mechanism of injury per Area Health Service per annum

Minor cases – categories 1-3

CHW = Children's Hospital at Westmead

Sydney private includes: NSW Masonic Hospital, Sydney Adventist hospital and the Hills Private Hospital and Kareena private hospital from 1997/98

1996/97

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
Assault	598	226	1,026	729	18	12	248	770	3,627
Bites/stings	13	18	34	30	7	–	21	49	172
Burns/scalds	56	39	72	71	19	5	33	64	359
Bus	12	12	40	21	2	–	14	6	107
Car	772	1,112	1,355	1,510	91	66	647	1,414	6,967
Drowning	2	4	7	1	2	–	2	5	23
Electricity	3	6	9	9	3	–	4	12	46
Fall	1,854	2,727	4,200	1,923	196	307	926	2,145	14,278
Machinery	66	66	137	132	–	6	28	105	540
Motor bike	87	93	145	80	1	1	41	106	554
Other incident	502	515	1,069	732	69	52	348	717	4,004
Other MVA	89	61	123	96	4	5	36	51	465
Pedestrian	213	166	384	123	18	7	53	120	1,084
Poisoning	6	2	1	7	–	–	7	18	41
Shooting/stabbing	35	9	37	47	–	1	12	56	197
Sports	123	281	436	346	55	51	233	299	1,824
Truck	19	16	17	33	1	–	17	22	125
Grand total	4,450	5,353	9,092	5,890	486	513	2,670	5,959	34,413

1997/98

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
Assault	719	332	1,220	945	11	19	310	926	4,482
Bites/stings	25	35	66	63	8	8	34	73	312
Burns/scalds	75	52	117	123	22	4	38	86	517
Bus	13	23	21	4	2	–	10	18	91
Car	971	1,007	1,422	1,598	78	93	673	1,291	7,133
Drowning	1	7	10	10	4	1	4	6	43
Electricity	6	9	15	13	2	1	4	14	64
Fall	2,603	3,364	4,617	2,457	197	443	1,055	2,254	16,990
Machinery	84	69	153	145	2	7	37	101	598
Motor bike	101	120	172	116	6	70	117	702	1,404
Other incident	666	671	1277	994	79	70	419	765	4,941
Other MVA	61	67	130	57	5	1	33	46	400
Pedestrian	265	166	466	185	28	8	45	117	1,280
Poisoning	10	8	16	22	6	–	4	20	86
Shooting/stabbing	47	17	61	55	–	–	20	44	244
Sports	172	345	391	414	61	72	260	305	2,020
Truck	24	20	24	49	–	2	10	32	161
Grand total	5,843	6,312	10,178	7,250	505	735	3,026	6,215	40,064

1998/99

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
Assault	563	236	10,59	644	8	15	138	626	3,389
Bites/stings	16	26	30	57	2	6	24	58	219
Burns/scalds	56	43	87	102	17	4	40	71	420
Bus	10	3	19	14	4	–	5	14	69
Car	926	884	1,288	1,735	83	94	711	1,270	6,991
Drowning	–	5	7	4	1	–	2	3	22
Electricity	7	6	13	22	–	1	8	11	68
Fall	2,255	2,379	4,188	2,227	136	494	907	1,796	14,382
Machinery	73	54	127	115	3	12	38	86	508
Motor bike	97	106	128	101	1	8	75	90	606
Other incident	599	450	1,182	754	51	87	322	609	4,054
Other MVA	26	16	35	43	–	2	13	10	145
Pedal cyclist	25	46	68	45	4	2	26	18	234
Pedestrian	251	193	407	179	34	8	54	136	1,262
Poisoning	7	6	11	14	1	7	11	57	114
Shooting/stabbing	31	17	49	36	–	1	17	34	185
Sports	146	233	350	365	46	55	210	254	1,659
Truck	16	15	25	29	–	1	14	25	125
Grand total	5,104	4,718	9,073	6,486	391	790	2,711	5,122	34,395

1999/00

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
Assault	650	200	988	624	11	14	209	548	3,244
Bites/stings	19	21	31	46	6	6	21	36	186
Burns/scalds	51	36	84	75	14	4	32	52	348
Bus	12	14	19	4	11	–	3	15	78
Car	966	848	1,169	1,703	86	121	640	1,289	6,822
Drowning	–	3	4	7	1	–	3	1	19
Electricity	4	5	15	12	2	1	1	8	48
Fall	2,168	2,186	3,817	2,081	146	536	935	1,533	13,402
Machinery	52	55	103	115	1	21	42	80	469
Motor bike	85	98	139	87	–	7	46	99	561
Other incident	523	430	1,015	695	53	94	357	560	3,727
Other MVA	7	14	15	12	–	2	4	10	64
Pedal cyclist	54	36	79	42	2	7	28	21	269
Pedestrian	266	139	401	155	21	15	50	121	1,168
Poisoning	1	6	6	17	–	1	5	11	47
Shooting/stabbing	32	17	52	56	–	1	23	26	207
Sports	162	224	321	363	53	74	196	228	1,621
Truck	12	20	11	42	–	3	11	16	115
Grand total	5,064	4,352	8,269	6,136	407	907	2,606	4,654	32,395

Serious cases – categories 4-7

1996/97

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Not recorded	Total
Assault	17	6	16	25	3	–	19	21	–	107
Bites/stings	–	2	-	–	–	–	2	–	–	4
Burns/scalds	1	4	10	8	21	–	8	20	–	72
Bus	2	1	4	1	1	–	5	–	–	14
Car	58	119	177	177	26	1	180	236	2	976
Drowning	1	–	3	–	2	–	1	–	–	7
Electricity	1	1	1	–	–	–	–	–	–	3
Fall	27	54	75	43	27	–	46	39	–	311
Machinery	5	8	16	25	1	–	10	14	–	79
Motor bike	17	7	18	22	1	–	17	29	–	111
Other incident	11	21	39	44	11	–	21	34	–	181
Other MVA	2	6	16	11	5	–	8	8	–	56
Pedestrian	34	36	68	32	22	–	25	25	1	243
Poisoning	–	–	1	2	–	–	–	2	–	5
Shooting/stabbing	14	4	20	35	–	–	15	13	–	101
Sports	1	13	2	5	2	–	5	10	–	38
Truck	6	3	7	6	1	–	6	9	–	38
Grand total	197	283	475	436	123	1	368	460	3	2,346

1997/98

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	WAHS	WSAHS	Total
Assault	10	5	13	22	–	15	25	90
Bites/stings	1	–	2	2	–	1	–	6
Burns/scalds	4	10	8	14	17	12	11	76
Bus	–	–	1	–	2	3	–	6
Car	55	90	136	199	22	176	239	917
Drowning	–	–	1	–	2	1	–	4
Electricity	–	–	–	1	–	1	–	2
Fall	23	51	80	36	20	39	36	284
Machinery	5	7	6	23	2	8	22	73
Motor bike	15	21	20	15	3	25	30	129
Other incident	6	16	16	41	12	20	38	149
Other MVA	1	3	13	11	2	6	2	38
Pedestrian	26	32	64	41	17	24	33	237
Poisoning	–	–	1	–	–	–	–	1
Shooting /stabbing	14	2	26	29	–	16	15	102
Sports	1	10	8	10	7	8	6	50
Truck	1	1	7	5	–	8	10	32
Grand total	162	248	332	451	104	363	467	2,196

1998/99

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	WAHS	WSAHS	Total
Assault	5	2	10	18	–	21	16	72
Bites/stings	–	–	–	1	2`	–	–	3
Burns/scalds	4	5	13	12	13	10	11	68
Bus	1	–	–	1	–	–	1	3
Car	49	66	90	173	27	169	179	753
Drowning	–	–	–	3	1	–	–	4
Electricity	–	–	2	1	–	1	–	4
Fall	27	45	62	37	19	37	29	256
Machinery	7	2	7	26	1	6	21	70
Motor bike	5	9	20	23	–	20	22	99
Other incident	8	11	21	32	14	29	31	146
Other MVA	3	2	7	3	1	1	1	18
Pedal cyclist	2	1	6	3	1	6	3	22
Pedestrian	27	29	64	41	12	21	25	219
Poisoning	–	–	–	1	–	–	2	3
Shooting/stabbing	7	3	26	26	–	11	14	87
Sports	1	5	4	9	4	8	6	37
Truck	–	–	2	5	–	4	5	16
Grand total	146	180	334	415	95	344	366	1,880

1999/00

Mechanism	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	WAHS	WSAHS	Total
Assault	5	4	18	18	–	15	16	76
Burns/scalds	4	7	4	6	9	5	7	42
Bus	–	–	–	–	4	–	–	4
Car	39	78	119	155	25	156	200	772
Drowning	–	–	2	–	1	1	–	4
Electricity	1	–	1	1	–	–	1	4
Fall	19	47	63	39	12	26	38	244
Machinery	3	5	8	19	–	9	10	54
Motor bike	7	12	17	24	–	25	31	116
Other incident	8	11	25	25	5	18	18	110
Other MVA	–	1	–	–	–	–	1	2
Pedal cyclist	1	2	8	6	3	4	9	33
Pedestrian	25	27	52	37	14	18	30	203
Poisoning	–	–	–	1	–	1	–	2
Shooting/stabbing	15	7	23	30	6	19	–	100
Sports	2	8	4	10	1	6	16	47
Truck	1	1	3	5	–	2	8	20
Grand total	130	210	347	376	74	292	404	1,833

Age groups per annum by triage category

	1996/97		1997/98		19998/9		1999/00	
Age group	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**
< 2	425	34	501	41	433	30	364	18
2-14	3,620	294	3,816	234	3,301	221	3,065	177
15-24	6,531	663	7,341	633	6,085	466	5,874	483
25-34	5,414	472	6,222	487	5,204	411	4,908	404
35-44	3,838	319	4,426	262	3,889	238	3,712	258
45-54	2,943	223	3,434	192	2,944	171	2,861	147
55-64	2,196	129	2,457	121	2,147	98	2,002	92
65-74	2,642	86	3,097	78	2,557	75	2,297	72
75-84	3,865	85	4,526	60	3,865	58	3,614	53
85+	2,579	–	3,318	25	2,786	11	2,782	23
Unknown	360	7	926	63	1,184	101	916	106
Grand total	34,413	2,346	40,064	2,196	34,395	1,880	32,395	1,833

% cases by age group

	1996/97		1997/98		1998/9		1999/00	
Age group	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**	**Minor**	**Serious**
< 2	1.2%	1.4%	1.3%	1.9%	1.3%	1.6%	1.1%	1.0%
2-14	10.5%	12.5%	9.5%	10.7%	9.6%	11.8%	9.5%	9.7%
15-24	19.0%	28.3%	18.3%	28.8%	17.7%	24.8%	18.1%	26.4%
25-34	15.7%	20.1%	15.5%	22.2%	15.1%	21.9%	15.2%	22.0%
35-44	11.2%	13.6%	11.0%	11.9%	11.3%	12.7%	11.5%	14.1%
45-54	8.6%	9.5%	8.6%	8.7%	8.6%	9.1%	8.8%	8.0%
55-64	6.4%	5.5%	6.1%	5.5%	6.2%	5.2%	6.2%	5.0%
65-74	7.7%	3.7%	7.7%	3.6%	7.4%	4.0%	7.1%	3.9%
75-84	11.2%	3.6%	11.3%	2.7%	11.2%	3.1%	11.2%	2.9%
85+	7.5%	0.0%	8.3%	1.1%	8.1%	0.6%	8.6%	1.3%
Unknown	1.0%	0.3%	2.3%	2.9%	3.4%	5.4%	2.8%	5.8%

Mechanism of injury by age group per annum

Minor categories
1996/97

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	9	104	1,048	1,107	703	348	146	69	38	11	44	3,627
Bites/stings	8	43	20	24	27	14	11	13	7	2	3	172
Burns/scalds	62	43	70	68	51	30	11	9	7	6	2	359
Bus	–	14	11	11	10	15	19	11	9	6	1	107
Car	58	562	1,934	1,425	995	770	489	344	228	45	117	6,967
Drowning	7	9	1	2	–	–	2	1	1	–	–	23
Electricity	–	7	12	12	8	3	2	1	1	–	–	46
Fall	205	1,413	1,025	974	934	1,063	1,122	1,870	3,220	2,344	108	14,278
Machinery	3	20	108	145	96	82	54	19	6	2	5	540
Motor bike	–	13	196	205	87	25	15	4	3	1	5	554
Other incident	59	565	881	788	555	359	193	187	248	132	37	4,004
Other MVA	2	64	125	95	70	42	34	11	16	3	3	465
Pedestrian	5	181	218	192	130	100	66	86	72	24	10	1,084
Poisoning	5	5	8	10	6	3	1	1	2	–	–	41
Shooting/stabbing	–	7	56	66	32	23	8	3	2	–	–	197
Sports	1	564	802	263	107	43	11	7	4	2	20	1,824
Truck	1	6	16	27	27	23	12	6	1	1	5	125
Grand total	425	3,620	6,531	5,414	3,838	2,943	2,196	2,642	3,865	2,579	360	34,413

1997/98

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	3	104	1,285	1,322	831	419	198	101	65	24	130	4,482
Bites/stings	4	76	53	62	28	33	15	22	7	2	10	312
Burns/scalds	78	91	92	98	56	46	22	14	9	5	6	517
Bus	1	9	12	12	13	12	11	9	8	2	2	91
Car	74	493	1,915	1,437	1,069	828	498	358	214	42	205	7,132
Drowning	10	22	3	4	–	2	–	2	–	–	–	43
Electricity	–	4	27	15	9	5	3	1	–	–	–	64
Fall	215	1,510	1,124	1,085	1,108	1,241	1,246	2,201	3,853	3,063	344	16,990
Machinery	1	24	127	153	110	92	48	16	6	4	17	598
Motor bike	–	8	244	237	122	50	6	7	3	1	24	702
Other incident	82	597	10,48	1,039	678	470	251	248	263	152	113	4,941
Other MVA	–	65	129	85	50	30	12	8	9	–	12	400
Pedestrian	6	192	273	206	148	129	97	94	82	22	31	1,280
Poisoning	8	12	23	18	9	9	6	–	–	–	1	86
Shooting/stabbing	–	1	79	83	45	15	9	5	2	–	5	244
Sports	1	598	885	316	119	33	18	6	4	–	40	2,020
Truck	1	10	22	50	31	20	17	5	1	1	3	161
Grand total	484	3,816	7,341	6,222	4,426	3,434	2,457	3,097	4,526	3,318	943	40,064

1998/99

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	7	91	973	987	622	328	130	76	41	16	118	3,389
Bites/stings	4	47	32	41	29	21	13	9	10	1	12	219
Burns/scalds	59	71	65	80	48	35	15	10	11	7	19	420
Bus	–	12	9	4	3	16	7	8	4	–	6	69
Car	65	467	1,840	1,440	1,016	799	484	316	212	37	315	6,991
Drowning	6	9	2	3	1	–	–	1	–	–	–	22
Electricity	–	9	14	21	9	6	3	3	–	–	3	68
Fall	203	1,255	869	929	1,001	1,030	1,113	1,801	3,240	2,560	381	14,382
Machinery	–	19	101	112	100	94	40	17	7	–	18	508
Motor bike	1	9	201	191	108	41	14	5	1	–	35	606
Other incident	74	546	859	771	575	349	184	189	249	133	125	4,054
Other MVA	2	14	34	31	29	16	5	6	–	1	7	145
Pedal cyclist	–	44	64	52	38	15	2	5	1	1	12	234
Pedestrian	5	208	215	200	142	112	99	103	87	27	64	1,262
Poisoning	4	5	14	9	10	11	3	–	–	1	–	57
Shooting/stabbing	–	9	57	56	25	14	8	2	1	1	12	185
Sports	2	482	720	238	106	34	17	5	1	1	53	1,659
Truck	1	4	16	39	27	23	10	1	–	–	4	125
Grand total	433	3,301	6,085	5,204	3,889	2,944	2,147	2,557	3,865	2,786	1,184	34,395

1999/00

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	9	91	906	940	625	323	133	65	38	11	103	3,244
Bites/stings	3	44	27	29	21	23	12	15	8	2	2	186
Burns/scalds	48	53	65	60	44	28	13	9	6	8	14	348
Bus	1	21	5	8	8	14	8	3	6	2	2	78
Car	64	456	1,855	1,360	1,063	764	466	302	192	45	255	6,822
Drowning	3	10	3	1	1	1	–	–	–	–	–	19
Electricity	–	5	14	9	8	6	–	1	3	–	2	48
Fall	153	1,149	839	813	886	1,029	1,005	1,611	3,072	2,561	284	13,402
Machinery	–	15	86	117	91	82	40	15	8	1	14	469
Motor bike	–	5	195	207	77	44	10	–	2	–	21	561
Other incident	70	490	778	732	522	339	192	173	203	128	100	3,727
Other MVA	–	5	11	13	12	10	5	4	2	–	2	64
Pedal cyclist	–	44	74	67	46	13	10	5	2	1	7	269
Pedestrian	5	162	232	218	137	118	73	85	65	22	51	1,168
Poisoning	6	2	8	9	9	3	3	2	3	–	2	47
Shooting/stabbing	–	4	61	62	42	15	13	2	2	–	6	207
Sports	2	504	696	227	96	33	9	1	2	1	50	1,621
Truck	–	5	19	36	24	16	10	4	–	–	1	115
Grand total	364	3,065	5,874	4,908	3,712	2,861	2,002	2,297	3,614	2,782	916	32,395

Serious categories
1996/97

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	3	4	32	30	21	9	3	1	1	–	3	107
Bites/stings	–	2	–	1	–	–	–	–	–	–	1	4
Burns/scalds	–	16	10	8	10	7	–	–3	3	–	15	72
Bus	–	2	2	2	–	2	2	2	2	–	–	14
Car	15	83	338	192	140	78	58	36	29	–	7	976
Drowning	–	3	1	–	–	–	1	1	–	–	1	7
Electricity	–	1	1	–	1	–	–	–	–	–	–	3
Fall	7	63	57	48	31	41	22	19	21	–	2	311
Machinery	1	1	13	19	20	16	2	6	1	–	–	79
Motor bike	1	–	59	29	14	7	1	–	–	–	–	111
Other incident	2	30	40	40	25	19	10	3	7	–	5	181
Other MVA	2	12	13	12	3	5	7	2	–	–	–	56
Pedestrian	4	62	51	39	21	22	15	10	19	–	–	243
Poisoning	–	1	–	1	1	–	–	1	1	–	–	5
Shooting/stabbing	4	1	24	38	23	8	3	–	–	–	–	101
Sports	–	12	17	2	3	4	–	–	–	–	–	38
Truck	2	1	5	11	6	5	5	2	1	–	–	38
Grand total	41	294	663	472	319	223	129	86	85	–	34	2,346

1997/98

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	–	2	27	30	15	8	2	1	3	1	1	90
Bites/stings	–	5	1	–	–	–	–	–	–	–	–	6
Burns/scalds	16	18	7	10	5	9	5	1	2	1	2	76
Bus	–	1	2	2	1	–	–	–	–	–	–	6
Car	9	43	331	210	103	83	52	34	18	7	27	917
Drowning	1	2	–	1	–	–	–	–	–	–	–	4
Electricity	–	–	2	–	–	–	–	–	–	–	–	2
Fall	10	41	54	45	38	30	18	15	15	9	9	284
Machinery	–	3	15	18	14	14	5	1	2	–	1	73
Motor bike	–	5	55	46	14	6	–	–	–	–	3	129
Other incident	2	20	35	34	20	8	14	4	3	–	9	149
Other MVA	–	13	4	7	6	3	3	1	–	1	–	38
Pedestrian	2	66	40	29	20	19	15	17	17	5	7	237
Poisoning	–	–	–	–	–	–	–	1	–	–	–	1
Shooting/stabbing	1	–	37	39	10	5	4	2	–	1	3	102
Sports	–	16	20	8	4	1	–	–	–	–	1	50
Truck	–	–	4	8	11	5	3	1	–	–	–	32
Grand total	41	234	633	487	262	192	121	78	60	25	63	2,196

1998/99

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	–	–	24	27	4	5	2	3	3	–	4	72
Bites/stings	–	2	–	–	1	–	–	–	–	–	–	3
Burns/scalds	15	15	7	9	7	7	2	–	–	–	6	68
Bus	–	–	–	–	–	2	–	–	1	–	–	3
Car	5	51	251	160	92	65	40	27	22	4	36	753
Drowning	–	1	1	–	–	–	–	–	–	–	2	4
Electricity	–	–	–	–	–	2	1	–	–	–	1	4
Fall	3	50	26	43	31	32	18	15	18	5	15	256
Machinery	–	2	4	19	16	12	9	3	1	–	4	70
Motor bike	–	–	37	33	15	6	2	–	1	–	5	99
Other incident	5	32	30	40	14	10	5	4	1	–	5	146
Other MVA	–	3	6	4	–	3	–	1	–	–	1	18
Pedal cyclist	–	5	3	9	1	2	–	1	–	–	1	22
Pedestrian	2	50	35	33	28	15	13	18	11	2	12	219
Poisoning	–	–	–	–	–	1	1	1	–	–	–	3
Shooting/stabbing	–	–	32	25	14	6	4	–	–	–	6	87
Sports	–	9	9	5	8	2	–	1	–	–	3	37
Truck	–	1	1	4	7	1	1	1	–	–	–	16
Grand total	30	221	466	411	238	171	98	75	58	11	101	1,880

1999/00

Mechanism	< 2	2-14	15-24	25-34	35-44	45-54	55-64	65-74	75-84	85-99	Unknown	Total
Assault	1	1	26	19	17	5	2	–	1	–	4	76
Bites/stings	8	7	5	8	4	1	3	2	2	1	1	42
Burns/scalds	–	3	1	–	–	–	–	–	–	–	–	4
Bus	1	50	264	179	92	56	28	30	20	8	44	772
Car	1	3	–	–	–	–	–	–	–	–	–	4
Drowning	–	–	1	1	2	–	–	–	–	–	–	4
Electricity	3	36	49	37	34	23	19	15	12	9	7	244
Fall	–	1	7	10	16	8	8	–	–	–	4	54
Machinery	–	2	40	40	15	6	2	1	–	–	10	116
Motor bike	3	19	16	21	17	12	9	2	1	1	9	110
Other incident	–	–	–	–	1	1	–	–	–	–	–	2
Other MVA	–	9	7	8	5	3	1	–	–	–	–	33
Pedestrian	1	38	24	37	24	15	16	20	14	4	10	203
Poisoning	–	–	1	–	1	–	–	–	–	–	–	2
Shooting/stabbing	–	1	22	33	19	8	–	2	3	–	12	100
Sports	–	6	18	8	9	2	–	–	–	–	4	47
Truck	–	1	2	3	2	7	4	–	–	–	1	20
Grand total	18	177	483	404	258	147	92	72	53	23	106	1,833

Age group by Area Health Service

Minor
1996/97

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
< 2	37	41	75	106	61	2	41	62	425
2-14	315	485	671	817	396	40	405	491	3,620
15-24	740	894	1670	1276	22	61	609	1259	6,531
25-34	807	630	1484	981	1	40	393	1078	5,414
35-44	553	470	1015	724	1	40	296	739	3,838
45-54	421	414	754	527	1	64	207	555	2,943
55-64	356	320	560	415	–	40	139	366	2,196
65-74	360	443	856	343	–	47	172	421	2,642
75-84	504	877	1201	418	–	104	240	521	3,865
85+	328	757	755	227	–	73	114	235	2,579
Unknown	29	22	51	56	4	2	54	142	360
Grand total	4,450	5,353	9,092	5,890	486	513	2,670	5,959	34,413

1997/98

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
< 2	51	65	138	125	67	5	66	77	501
2-14	383	552	684	879	400	97	511	509	3,816
15-24	998	985	1,820	1,546	30	109	715	1,362	7,341
25-34	1,015	789	1,791	1,228	5	107	541	1,101	6,222
35-44	742	555	1,156	941	–	90	364	804	4,426
45-54	584	517	844	678	–	99	233	630	3,434
55-64	473	373	655	488	–	83	213	387	2,457
65-74	502	459	874	465	–	36	142	386	3,097
75-84	681	977	1,266	561	–	100	171	518	4,526
85+	397	885	865	314	–	73	66	329	3,318
Unknown	59	279	143	104	3	23	81	211	926
Grand total	5,843	6,312	10,178	7,250	505	735	3,026	6,211	40,064

1998/99

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
< 2	43	49	84	100	50	5	47	54	433
2-14	327	321	619	869	313	69	380	403	3,301
15-24	778	734	1,508	1,317	18	77	643	1,010	6,085
25-34	852	561	1,515	996	2	74	380	824	5,204
35-44	663	402	1,046	788	–	60	300	630	3,889
45-54	469	317	762	595	1	57	225	518	2,944
55-64	363	275	588	372	–	63	152	334	2,147
65-74	455	350	724	437	–	87	150	354	2,557
75-84	571	719	1,186	532	–	175	201	481	3,865
85+	448	673	815	323	–	106	145	276	2,786
Unknown	135	317	226	157	–	17	88	238	1,184
Grand total	5,104	4,718	9,073	6,486	391	790	2,711	5,122	34,395

1999/00

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Total
< 2	32	33	73	87	50	7	40	42	364
2-14	325	302	570	724	321	79	400	344	3,065
15-24	864	674	1,464	1,212	27	102	538	993	5,874
25-34	834	497	1376	935	3	72	389	802	4,908
35-44	639	361	881	798	1	83	275	674	3,712
45-54	472	352	734	596	1	68	211	428	2,861
55-64	366	274	513	363	–	65	138	282	2,002
65-74	435	326	601	402	–	86	160	287	2,297
75-84	575	686	1,051	539	–	173	225	365	3,614
85+	446	620	851	308	–	154	150	253	2,782
Unknown	76	227	155	172	4	18	80	184	916
Grand total	5,064	4,352	8,269	6,136	407	907	2,606	4,654	32,395

Serious cases
1998/99

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	Private	WAHS	WSAHS	Unknown	Total
< 2	3	1	3	5	17	–	4	1	–	34
2-14	6	38	61	37	97	–	47	8	–	294
15-24	55	81	116	130	6	–	125	149	1	663
25-34	48	52	92	94	–	–	74	112`	–	472
35-44	31	32	79	64	1	–	47	65	–	319
45-54	28	29	42	46	–	–	30	48	–	223
55-64	12	20	31	25	–	–	14	27	–	129
65-74	4	13	25	14	–	–	7	23	–	86
75+	6	17	23	19	–	1	8	11	–	85
Unknown	4	0	3	2	2	–	12	16	2	7
Grand total	197	283	475	436	123	1	368	460	3	2,346

1997/98

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	WAHS	WSAHS	Unknown	Total
< 2	–	2	5	6	19	6	3	–	41
2-14	7	18	38	40	79	45	7	–	234
15-24	39	76	117	138	4	116	143	–	633
25-34	41	57	92	104	1	77	116	–	487
35-44	22	27	48	63	–	36	66	–	262
45-54	14	19	35	46	–	31	47	–	192
55-64	17	12	26	22	–	21	23	–	121
65-74	9	11	15	15	–	11	17	–	78
75-84	7	10	13	6	–	8	16	–	60
85+	2	10	10	1	–	1	1	–	25
Unknown	4	6	3	10	–	11	28	–	63
Grand total	162	248	402	451	104	363	467	–	2,196

1998/99

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	WAHS	WSAHS	Unknown	Total
< 2	1	1	5	4	10	8	–	–	30
2-14	10	18	33	47	78	31	4	–	221
15-24	37	34	75	132	14	104	82	–	466
25-34	38	44	80	76	28	80	92	–	411
35-44	22	20	46	54	–	31	65	–	238
45-54	13	10	35	40	–	30	43	–	171
55-64	6	17	14	23	–	16	22	–	98
65-74	5	10	14	15	–	8	23	–	75
75-84	7	9	12	9	–	13	8	–	58
85+	1	5	–	2	–	1	2	–	11
Unknown	6	12	20	13	4	22	25	–	101
Grand total	146	180	334	415	95	344	366	–	1,880

1998/99

Age group	CSAHS	NSAHS	SESAHS	SWSAHS	CHW	WAHS	WSAHS	Unknown	Total
< 2	–	5	1	5	5	2	–	–	18
2-14	5	16	27	34	64	27	4	–	177
15-24	29	64	87	105	3	83	112	–	483
25-34	34	40	85	80	–	67	98	–	404
35-44	20	31	45	62	–	34	66	–	258
45-54	15	17	30	24	–	20	41	–	147
55-64	9	9	15	19	–	15	25	–	92
65-74	8	6	23	15	–	5	15	–	72
75-84	3	9	18	12	–	2	9	–	53
85+	1	6	6	1	–	6	3	–	23
Unknown	6	7	10	19	2	31	31	–	106
Grand total	130	210	347	376	74	292	404	–	1,833

Mechanism by gender
1996/97

	Minor		Serious	
Mechanism	**Female**	**Male**	**Female**	**Male**
Assault	908	2714	11	95
Bites/stings	74	98	2	2
Burns/scalds	146	211	18	54
Bus	63	44	6	8
Car	3,772	3,192	394	580
Drowning	6	17	–	7
Electricity	15	31	–	3
Fall	8,012	6,252	69	242
Machinery	56	484	5	74
Motor bike	57	497	8	103
Other incident	1,436	2,562	41	140
Other MVA	157	307	12	44
Pedestrian	452	631	83	159
Poisoning	14	27	1	4
Shooting/stabbing	34	162	12	89
Sports	400	1,422	5	33
Truck	21	104	6	32
Grand total	15,623	18,755	673	1,669

1997/98

	Minor			Serious		
Mechanism	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
Assault	1,164	3,312	6	12	77	1
Bites/stings	133	179	–	1	5	–
Burns/scalds	200	316	1	15	60	1
Bus	57	34	–	2	4	–
Car	3,913	3,212	8	358	558	1
Drowning	13	30	–	2	2	–
Electricity	19	45	–	–	2	–
Fall	9,762	7,221	7	79	205	–
Machinery	56	542	–	2	71	–
Motor bike	76	626	–	7	122	–
Other incident	1,789	3,145	7	25	124	–
Other MVA	93	307	–	11	27	–
Pedestrian	568	711	1	73	163	1
Poisoning	36	50	–	–	1	–
Shooting/stabbing	35	209	–	15	85	2
Sports	454	1,565	1	7	43	–
Truck	31	130	–	1	31	–
Grand total	18,399	21,634	31	610	1,580	6

1998/99

	Minor			Serious		
Mechanism	**Female**	**Male**	**Unknown**	**Female**	**Male**	**Unknown**
Assault	831	2,552	6	11	61	–
Bites/stings	103	116	–	1	2	–
Burns/scalds	176	243	1	21	47	–
Bus	40	29	–	2	1	–
Car	3,817	3,173	1	321	431	–
Drowning	9	13	–	–	4	–
Electricity	21	47	–	–	4	–
Fall	8,272	6,106	4	63	193	–
Machinery	50	458	–	5	65	–
Motor bike	68	538	–	6	93	–
Other incident	1,530	2,521	3	22	124	–
Other MVA	47	97	1	5	13	–
Pedal cyclist	30	204	–	2	20	–
Pedestrian	552	709	1	72	147	–
Poisoning	17	40	–	–	3	–
Shooting/stabbing	29	156	–	12	75	–
Sports	369	1,289	1	7	30	–
Truck	15	110	–	–	16	–
Grand total	15,976	18,401	16	550	1,329	–

1999/00

Mechanism	Minor		Serious	
	Female	Male	Female	Male
Assault	799	2,442	11	65
Bites/stings	87	99	–	–
Burns/scalds	122	226	12	30
Bus	55	23	4	–
Car	3,656	3,165	297	475
Drowning	4	15	1	3
Electricity	10	38	–	4
Fall	7,718	5,680	57	187
Machinery	40	429	2	52
Motor bike	68	493	11	105
Other incident	1,343	2,384	15	95
Other MVA	27	37	1	1
Pedal cyclist	35	234	4	29
Pedestrian	532	636	79	124
Poisoning	14	33	–	2
Shooting/stabbing	40	167	13	87
Sports	351	1,270	11	36
Truck	14	101	1	19
Grand total	14,915	17,472	519	1,314

Appendix 4 – Review of the timing of craniotomy for injured patients

The following report was prepared by the John Hunter Hospital Trauma Service on behalf of the NSW Trauma System Advisory Committee.

Project officer

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Project Review Group

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Appendix 4 – Introduction

The New South Wales Trauma System Advisory Committee established a monitoring program for acute trauma services in New South Wales. In its first report published in 1996, for the period 1 April 1994 to 31 March 1995 a total of 147 separations with craniotomy were reported from the Sydney and Newcastle metropolitan areas (five reported did not have time data available) (1996, p25). The State Indicator (3.1a for Definitive care phase) – Injury to craniotomy within two hours or four hours was met in 47% of cases (p24). Based on this it was deemed necessary that a more detailed review of cases was needed to determine '...precise reasons for delayed care...' (p26),

The timing of craniotomy for drainage of acute intracranial collection has been felt to be crucial to the outcome of the patient. In a study by Seelig, Becker, Miller, Greenberg, Ward and Choi (1981) in which a review of 82 patients with traumatic acute subdural haematoma (ASDH) was undertaken, findings indicated that the delay from injury to operation was the factor of '...greatest therapeutic importance...' (p1511). Patients operated on within four hours of injury had a 30% mortality while those with a time of greater than four hours had a mortality rate of 90% (P=0.0001) (Seelig et. al., 1981, p1511).

This does not mean though that all ASDH's require evacuation. Minimally symptomatic ASDH's do not always require drainage (Dent, Croce, Menke, et al, 1995, p36). In this study the authors reviewed 211 patients with ASDH and Glasgow Coma Scale (GCS) scores of 3-15. Of the sample 61% were managed non-operatively. It was found that those who required craniotomy had a more severe head injury and larger haematomas (p41), and an early operation only improved outcomes in comatose patients (p36). Other factors have been shown to affect the outcomes included direct admission to a trauma service, presence of subarachnoid blood, age, maximal intracranial pressure (ICP) and GCS (p39).

Therefore, it is quite a reasonable expectation that not every patient with a mass intracranial lesion will require emergency drainage within four hours of injury, and a clinical decision to observe a patient who is maintaining a high GCS is reasonable.

Based on available information the NSW Trauma System Advisory Committee felt it necessary to undertake a more detailed review of patients undergoing craniotomy for drainage of mass intracranial lesions due to trauma. The key aims of the review were identified by the Committee as being:

- to determine the timing of craniotomies for patients injured in Sydney and Metropolitan Newcastle reported in the trauma monitoring program
- to identify best practice in the management of patients requiring craniotomy for head injury
- to develop a strategy in collaboration with NSW Health and the NSW Trauma System Advisory Committee to promote best practice amongst Major Trauma Services (MTS) and their networks.

Appendix 4 – Methodology

The craniotomy project was established to review patients who had received a craniotomy for the evacuation of a traumatically acquired mass intracranial lesion. The review was conducted over a two-year period from 1 April 1994 to 31 March 1996.
The following inclusion criteria for patients were devised by the sub-committee of the State Trauma System Advisory Committee overseeing the project:

- Craniotomy performed between 1 April 1994 and 31 March 1996.
- Injury occurred in the metropolitan/urban area of Sydney/Newcastle.
- Underwent craniotomy within 24 hours of arrival at the definitive care centre, and within 48 hours of injury.
- Craniotomy was for drainage of a mass intracranial lesion (not elevation of fractures, or insertion of ICP monitor only) and includes burr hole drainage of mass lesion.

Hospitals participating in the project included:

- John Hunter Hospital
- Liverpool Hospital
- Nepean Hospital
- Prince of Wales Hospital
- Royal Alexandra Hospital for Children
- Royal Prince Alfred Hospital
- Royal North Shore Hospital
- St George Hospital
- St Vincent's Hospital
- Westmead Hospital

The project encompassed all areas of pre-hospital and hospital care, up to and including the definitive care phase. Data were collected with a data collection tool devised in collaboration with the sub-committee (see Appendix 1) and circulated to all trauma coordinators (trauma registry managers). A meeting was held with the Trauma Research Network Committee to review the criteria and data collection. Trauma Coordinators were requested to identify the patients that met the above criteria through three methods:

1. Review of trauma registries.
2. Search of theatre logs/databases.
3. Review of the International Classification of Disease Index 9th Revision, (ICD-9) for the codes 852 and 853 via the Clinical Information Department.

A retrospective case review was undertaken, with the main data source being the medical record of patients. In a small amount of cases this was not possible due to the absence of records from clinical information departments, ie under subpoena for legal matters or misplaced and unable to be found. In these cases the trauma registry data collection sheet was utilised. The Royal Alexandra Hospital for Children (RAHC) was unable to supply injury severity scores (ISS) or abbreviated injury scale (AIS) scores, and no information was available from the Sydney Children's Hospital as there was no trauma monitoring program active at the time of the study. Ambulance case sheets also formed part of the review as a data source.

Six hospitals undertook all three search strategies. The results included:

- one hospital utilised only the trauma registry for cases
- two hospitals used their trauma registry and the ICD-9 searches
- one hospital was only able to perform the ICD-9 search due to recent site relocation.

Appendix 4 – Results

A total of 351 cases were reviewed for possible inclusion. Of this number 173 (49.3%) cases met the inclusion criteria. Table 1 shows the patient numbers reviewed.

Table 1. Number of patients who met study criteria

Included	Excluded	Total cases reviewed
173	178	351

Of the 173 patients included, specific injury time was available for 170 cases and in the remaining three cases the time to operation could be determined to be either within or in excess of four hours. Therefore 79 (46%) patients underwent craniotomy within four hours of injury. Table 2 summarises these data. Of those patients admitted directly to a hospital providing definitive care, 57% (75/132) under went craniotomy within four hours of injury compared with only 10% (4/41) for those cases transferred for operation. This difference was highly significant, ($\chi^2_{(1df)} = 27.92$, $P<0.0001$) with an estimated odds ratio of 12.17 (95% confidence intervals [exact method] 3.99 to 49.06).

A total of four cases were transferred from one major trauma service to another for operation; in all of these the time to operation exceeded four hours. It was noted that in one of these cases, the patient received definitive care only after two inter-hospital transfers. These transfers are discussed later.

Table 2. Number of patients undergoing craniotomy by timing of operation and transfer status

	Admission status		
Timing of operation	**Direct admission**	**Transferred for operation**	**Totals**
Within four hours of injury	75	4	79
Greater than four hours of injury	57	37	94
	132	41	173

The mode of arrival at the first hospital and time of operation data are summarised in Table 3 below. A greater proportion of patients transported initially by the ambulance service (50%) commenced the operation within four hours compared with only 11% of those arriving by private means. This difference was highly significant, ($\chi^2_{(1df)} = 9.67$, $P=0.002$) with an estimated odds ratio of 9.67 (95% confidence intervals (exact method) 1.75 to 72.43).

Table 3. Number of patients undergoing craniotomy by timing of operation and mode of transport to the first hospital

	Mode of arrival to first hospital		
Timing of operation	**Ambulance Service**	**Private transport**	**Totals**
Within four hours of injury	77	2	79
Greater than four hours of injury	78	16	94
	155	18	173

There were 143 patients transported within the Sydney metropolitan area in which a formalised triage system was employed. In Newcastle the triage system, whilst delivering major trauma cases directly to the John Hunter Hospital, was not formalised during the period of this review and therefore triage decisions were not recorded in the same manner. Patients transported by private means (ie in a relative's car) are outside of the triage system and therefore not included in Table 4 below.

Table 4. Triage decisions for patients transported from scene of injury within Sydney

Trauma triage category/decision		Direct admissions	Patients transferred for operation		
Code	**Description**	**Craniotomy**	**Craniotomy**	**Craniotomy**	**Craniotomy**
	Decision not recorded or found	13	10	1	12
1 to 3	Minor injury	16	18	0	8
4 to 7	Major injury	32	12	3	3
	Triage Tool not employed	4	8	0	3
	Totals	65	48	4	26

Table 5. Triage groups for patients transported in Sydney by the Ambulance Service and the timing of the craniotomy

	Triage decision		
Timing of operation	**Major injury**	**Minor injury or no decision available**	**Totals**
Within four hours of injury	35	34	69
Greater than four hours of injury	15	59	74
Total	50	93	143

For patients in which there was a clear record that the patient had sustained a major injury (ie the triage decision was known and indicated serious injury), a greater proportion (70%) commenced the craniotomy within 4 hours compared with those triaged as minor injury or in whom the decision was absent or not used (37%). This difference was highly significant, ($\chi^2_{(1df)}$ = 14.56, P<0.001) with an estimated odds ratio of 4.05 (95% confidence intervals 1.82 to 9.08). These data are shown in Table 5 above. Unfortunately the absence of triage decisions precludes further exploration of the presenting GCS and mechanism of injury with the triage category. This would be necessary to determine what proportion of patients might have been transported directly to a definitive care centre.

The severity of the injuries for 170 patients were known and recorded by the Injury Severity Score (ISS). The distribution of the ISS for the two groups operated on within four hours and after four hours showed that those patients operated on earlier had a greater injury severity on average than those operated on later. This difference was highly significant, Kruskal-Wallis H = 11.003 $_{(1df)}$, P < 0.001. The data are summarised in Figure 1 and Table 6 on page 86 and suggests that those with greatest injury are operated on quickly.

Figure 1. Injury Severity Scores of craniotomy patients by timing of operation

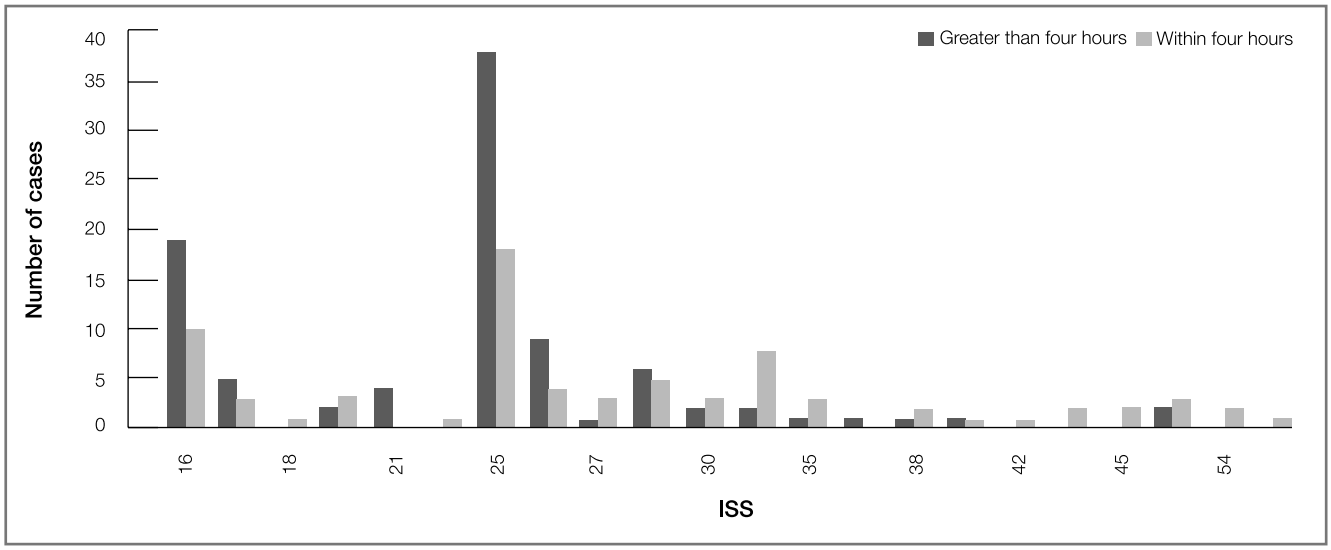


Table 6. Distribution of Injury Severity Scores for patients operated on within four hours and after four hours

Group	Number	Mean ISS	Median ISS	Lower quartile	Upper quartile
Operation after four hours	94	24.2	25	17	26
Operation within four hours	76	29.2	26	25	34

Three patients omitted due to absent ISS

The NSW Trauma System is based on a process of pre-hospital trauma triage to identify patients at risk of major injury and a limited number of hospitals designated to receive these patients. Patients on arrival at hospital are then assessed and prioritised on the basis of the initial assessment and progress in the emergency department. Whilst a patient arriving by private transport will not be under the influence of the pre-hospital trauma triage system arrival at a major trauma service will still allow the second process to be applied.

In seeking to find possible reasons for delay in direct admissions cases have been broadly grouped according the apparent main reason for delay. In some cases the circumstances of the accident prevented quick extrication or the patient presented late in the first instance. In other cases the initial presentation did not indicate life threatening injuries and may have delayed investigation. The groups are shown in Table 7 on page 87 and summarised in the flow chart – Figure 2.

For the 62 patients admitted directly to a major trauma service who took more than four hours to commence the craniotomy, 56 arrived by ambulance and six by private means (Table 7).

Some delays are such that the trauma system cannot necessarily modify the circumstances (ie entrapment) or are appropriate since they reflect continuing management and assessment of patients in whom the injury is recognised but does not require immediate intervention.

However in 11 cases the delays might have been improved if:

- delays in assessment had not occurred (six patients)
- transfer for surgery had been avoided (two patients)
- transfer from another hospital as an inpatient had not delayed treatment (two patients)
- the initial CT scan had not been read as clear (one patient).

In another 22 cases the reason for delay are less clear but reflect:

- a delay in obtaining a CT scan (11 patients)
- other non-specific delays in hospital before treatment (11 patients).

Together these 33 patients represent potentially avoidable system delays that might be modified in some cases locally. Therefore of all patients undergoing craniotomy 19 % (Figure 2 and Table 7) experienced delays that were potentially avoidable.

Table 7. Apparent major reasons for delay in craniotomy greater than four hours for patients admitted directly to major trauma services and outcome

Delay description	Mode of arrival	
	Ambulance	Private
Intentional delay		
Assessed, with early CT diagnosis and observed with GCS > 11	10	0
Clinical decision to delay GCS < 11	5	0
Unavoidable system delay		
Delay at scene	3	0
Late presentation	6	2
No mass lesion on first CT	3	0
Potentially avoidable system delay		
Delayed initial assessment despite arrival at a MTS	5	1
Unspecified system delay	11	0
Late CT diagnosis GCS > 11	9	2
Transferred to another MTS for surgery	2	0
Initial CT read as clear	0	1
Patient injured as inpatient of a hospital	2	0
Total	56	6

Appendix 4 – Discussion

From the results obtained it is possible to say there are potentially avoidable delays in the system relating mainly to cases where there is a delay in diagnosis. These delays appear to relate to the identification of seriously injured patients presenting at emergency departments, the late presentation by patients to hospital (including non-major trauma service hospitals) and delayed assessment of patients.

Delay at the scene or presentation to non-major trauma service hospitals may be amenable to improvement if such patients can be progressed expeditiously once the need for neurosurgery has been recognised. It should also be acknowledged that delayed diagnosis at any stage may simply be due to the absence of overt signs of serious head injury.

In itself however, where a patient is reported as being trapped or delayed presentation has occurred, notice could be taken by the receiving hospital team that a considerable period has already elapsed if a therapeutic intervention such as craniotomy is required so that avoidable delays do not occur.

From the review it is apparent that the majority of patients (81 %) were being actively treated with close medical review. It is not within the scope of this study nor the intended purpose to criticise or review the clinical decisions made, but further to review the systems in place that work to deliver a patient to the operating theatre.

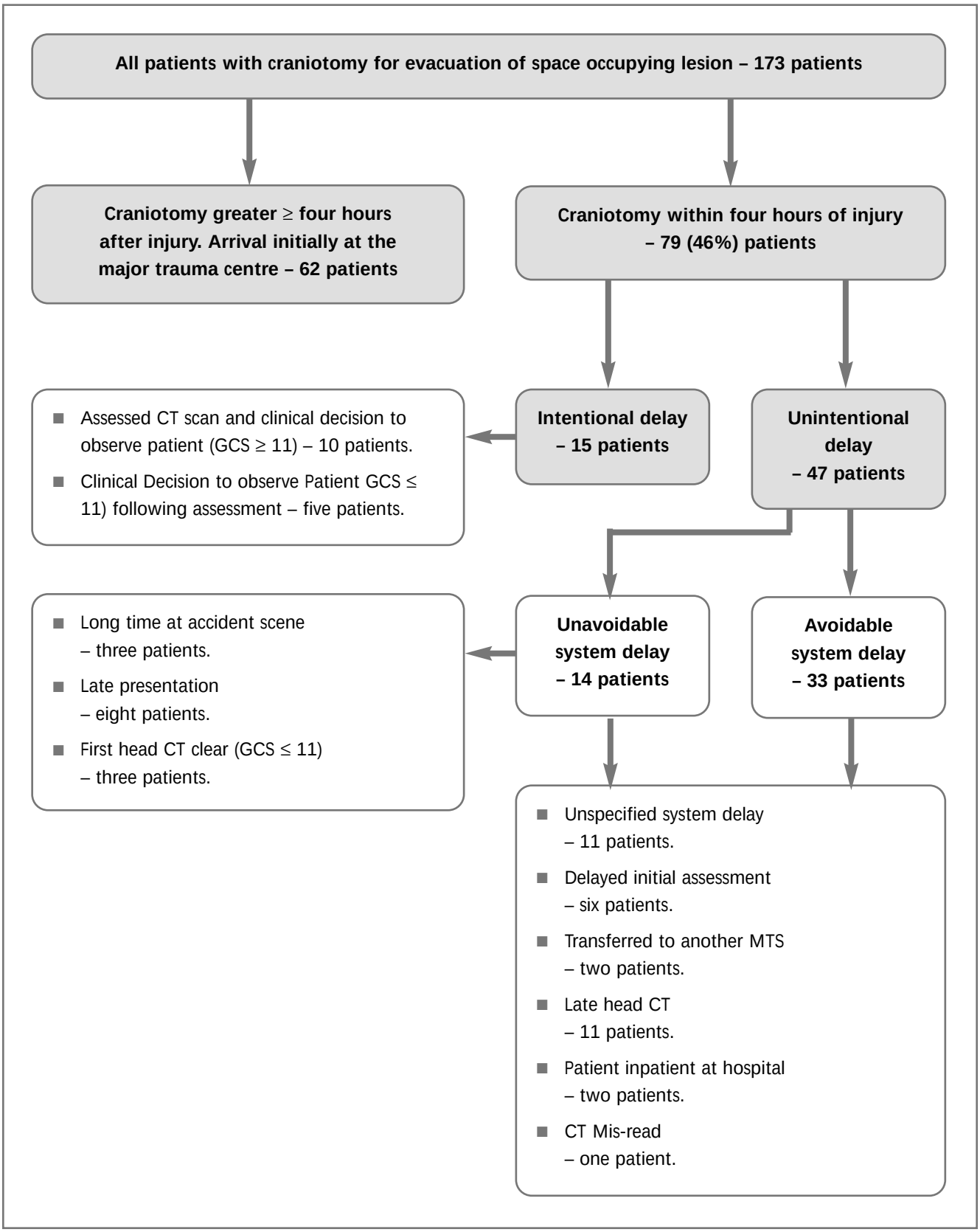
The absence of information on pre-hospital triage decisions may influence the manner in which patients are received at hospitals. It is possible that where a patient is not already labelled as having 'major injury' by the Ambulance Service an assumption is made regarding the overall severity of the patient's head injury. Whilst several cases were initially managed following 'a fit' it appears the history of injury only became apparent later. The need to maintain a healthy scepticism in assessing such patients may alert staff to the possibility of an underlying head injury as the cause. The same applies to alcohol in which patients may be identified as intoxicated and it is then supposed that the reduced conscious level is due to this and not a head injury. This is not a criticism as such but a re-iteration of well-known traps for the unwary.

It was further noted that the overall injury severity was less in those patients under going a later craniotomy. This might be expected if this group was composed of individuals without life threatening injuries at presentation and in whom the sequence of investigation was tailored to the clinical picture.

Difficulties were experienced in carrying out the review, mainly in relation to the reliability and validity of data from trauma registries. This is in part due to a lack of standardisation between hospitals, each having different definitions and very different databases and with different systems for data collection and capture. It is further compounded by absent data on a number of significant cases involving transfer in which the pre-hospital record has not been obtained.

Figure 2. Flow chart of craniotomy patients

Percentage of avoidable system delays (33) of all patients requiring craniotomy for evacuation of space occupying lesion (173).



Appendix 4 – Conclusions

The majority of patients are being managed medically and monitored which is an important factor in the prompt diagnosis and treatment of head injured patients.

For most cases with the exception of 3% with delayed initial assessment, the system of care provided appropriate medical review. The need for 30 interhospital transfers may represent a problem of under triage within Protocol 4, but this would need further review, though two cases were transferred from a MTS to a MTS for definitive care and this is viewed as less than ideal.

Cases that were classified as unspecified system delay are problematic in that it was difficult to pinpoint the exact reason/s for delay/s. The system delays ranged from lengthy scene times for unknown reason, delay from medical assessment to CT scan for unknown reason, and delay from CT scan to operation for unknown reason.

There were difficulties related to the study in obtaining consistent reliable data from the trauma registries. There was a large discrepancy between the cases identified in this study compared to those actually reported in the NSW trauma monitoring program. Table 1 shows that over half the patients reviewed were excluded from the study though the study criteria was fairly narrow in its definition purposely to exclude cases with chronic subdurals, rural injuries, late presentations and late operations.

Of this group of patients over two years, 19% of patients requiring craniotomy experienced a potentially avoidable delay. The main impediments to increasing the proportion of patients under going craniotomy within four hours identified from the review are:

- transport to a hospital not able to provide a neurosurgical service
- inter-hospital transfers
- delay in obtaining a CT scan and interpreting the findings
- delayed identification of patients with serious head injury in emergency departments, including the role of alcohol in masking the clinical picture.

The Trauma System Advisory Committee advocates an approach that minimises the time that a patient requiring surgical drainage of an intra-cranial haematoma waits for surgery. The review of the two years' experience in Major Trauma Services shows that delays are multi-factorial but performance may be improved if local strategies are developed to avoid the identified deficiencies.

Appendix 4 – Recommendations

- Standard state-wide definitions are required for reporting purposes. Trauma data systems and data capture methods need to be standardised and some process of data validation for each registry should occur at least annually.
- A review of the emergency department triage category as a method to identify delays to initial medical assessment is required and should be part of the cases review process at major trauma services.
- Patients should not be transferred from a major trauma service (MTS) to a MTS for craniotomy if unconscious, transfer if required should preferably occur post-operatively.
- A further review of the adherence to Protocol 4 (in those patients who required inter-hospital transfer prior to craniotomy) may reveal some under triage of seriously injured patients.

Appendix 4 – References

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