Incidence and outcomes of major trauma assaults: a population-based study in Victoria

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ABSTRACT

Objective: To describe the incidence and outcomes of assault resulting in serious injury in Victoria.

Design and setting: Analysis of population-based data from the Victorian State Trauma Registry for assaults between 1 July 2001 and 30 June 2007.

Main outcome measures: Overall trends in the rate of assault-related major trauma, inhospital mortality, and functional outcomes 6 months after injury as measured by the Extended Glasgow Outcome Scale.

Results: The rate of assault-related major trauma rose significantly over the 6-year study period (incidence rate ratio [IRR], 1.21 [95% CI, 1.16–1.26]), particularly for blunt assault (IRR, 1.33 [95% CI, 1.26–1.41]). There were 803 admissions for major trauma related to assault: 484 (60%) were for blunt trauma and 319 (40%) for penetrating trauma. Most patients were young men. Compared with penetrating trauma, blunt trauma was associated with more severe injury; 396 patients (82%) with blunt trauma had serious head injuries, and 102 (24%) of these required inpatient rehabilitation. A higher percentage of patients with penetrating trauma died in hospital compared with those with blunt trauma (35 [11%] v 23 [5%]; $P = 0.001$). Follow-up at 6 months showed that only 19% of respondents (42 patients) had made a complete recovery; outcomes at 6 months were worse for patients with blunt trauma than for those with penetrating trauma.

Conclusions: The incidence of assault resulting in severe trauma rose significantly between 2001–02 and 2006–07, mostly due to a rise in assault resulting in blunt trauma. The increase in incidence, the young age of the victims, and the potential for high burden of injury and poor outcome, combined with the preventable nature of assault, highlight the importance of developing effective assault-prevention strategies.

MJA 2009; 190: 129–132

Emergency department presentations for injuries resulting from assault are common, and are often related to drugs or alcohol.[1-3] Some studies report that up to 20% of admissions to the emergency department are for non-accidental injury and that these patients consume a high percentage of medical resources.[1,4]

Most victims of assault are young men.[5,6] The resultant — mostly preventable — injuries vary in severity, but can result in significant long-term physical and mental health issues.[7,8] Although an Australian Bureau of Statistics survey reported a drop in the number of assaults between 2002 and 2005,[9] media reports of stabbings and shootings suggest an increasing incidence of assault and interpersonal violence.[10] Anecdotal evidence based on presentations to the emergency department also supports the idea that violence is on the rise.

Here, we examine the incidence, profile and outcomes of assaults resulting in severe injury in Victoria between 2001 and 2007 using data from the population-based Victorian State Trauma Registry (VSTR).

METHODS

Setting

Victoria has a population of 5.1 million people, with a large urban population of 3.7 million in Melbourne.[11] The state is serviced by three Melbourne-based major trauma centres (two adult and one paediatric).

Study design

We reviewed data from the VSTR collected prospectively between 1 July 2001 and 30 June 2007. Inclusion criteria for the registry include any of the following: death due to injury, Injury Severity Score (ISS) > 15, intensive care unit (ICU) stay longer than 24 hours requiring mechanical ventilation, or urgent surgery.[12]

The registry collects identifiable information to enable tracking of patients across the health system. Therefore, cases are counted only once, irrespective of the number of admissions for the same injury.

Since July 2005, all adult (age ⩾ 15 years) major trauma patients who survived to discharge have been followed up by telephone at 6 months. We measured patients' functional outcome using the Extended Glasgow Outcome Scale (GOS-E), which classifies functioning on an eight-point scale from one (death) to eight (full recovery) using a valid, reliable and standardised questionnaire.[13]

Patients

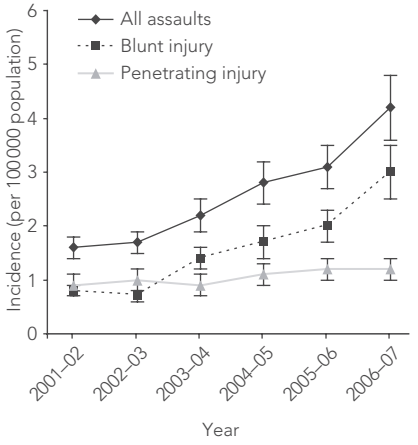
The VSTR includes an intent-of-injury data item with the options of sexual assault and other assault; International classification of diseases (ICD) codes were not used to classify assault cases. We included major trauma patients aged ⩾ 15 years for whom the intent of injury was other assault; victims of sexual assault were excluded.

We extracted demographic data, injury event details, clinical observations, management and outcomes for analysis. The type of trauma was categorised as either blunt (eg, caused by a fist or baseball bat) or penetrating (such as gun-shot or knife wounds). For patients with both blunt and penetrating injuries coders assigned a trauma category according to the mechanism that caused the most severe injury. We used the ISS as an overall measure of the severity of a patient's injuries, and the Abbreviated Injury Scale (AIS) diagnosis code (1 = minor to 6 = maximum) to quantify the severity of specific injuries.[14,15]

Statistical analysis

The outcome measures of interest were inhospital mortality, length of hospital stay, ICU stay, and the GOS-E at 6 months after injury. For between-group comparisons, we used χ^2 tests for categorical data, and continuous variables were analysed with the Mann–Whitney *U* test. Population-based incidence rates (95% CIs) were calculated for each financial year based on the total population at the end of each June for the years 2002–2007.[16] We used Poisson regression to test for increasing incidence by assuming a linear increase in the logarithm of the rate with time, using population as the exposure. For all tests, a *P* value < 0.05 was considered significant.

1 Incidence of assault resulting in major trauma in Victoria, 2001–2007*



* Bars show 95% CIs. ◆

Ethics approval

Ethics approval for the VSTR was granted by the Human Research Ethics Committees of all participating institutions and Monash University.

RESULTS

Over the 6-year period, 803 adults with assault-related major trauma were admitted to hospitals in Victoria, rising from 82 in 2001–02 to 218 in 2006–07. Of the 803 patients, 484 (60%) had blunt trauma and 319 (40%) had penetrating trauma.

The yearly rate of assault resulting in major trauma rose overall (incidence rate ratio [IRR], 1.21 [95% CI, 1.16–1.26]) and for blunt assault cases (IRR, 1.33 [95% CI, 1.26–1.41]), but the rate of penetrating major trauma assaults did not increase significantly over the study period (IRR, 1.06 [95% CI, 0.99–1.13]) (Box 1).

Profile of patients

More than 90% of patients were men and over half were younger than 35 years. Age and sex did not differ by trauma type (Box 2). There was an association between the type of trauma and ISS ($P < 0.001$), with penetrating trauma being less severe than blunt trauma. Discharge to inpatient rehabilitation was more common for blunt than penetrating trauma cases ($P = 0.002$). However, the inhospital death rate was higher for penetrating trauma than for blunt trauma (11% v 5%; $P = 0.001$). Median (interquartile range [IQR]) length of stay for blunt trauma was 5 days (3–11 days) compared with 6 days (3–9 days) for penetrating trauma ($P = 0.94$). Overall, 326 patients (41%) spent time in the ICU.

Location and time of assault

About two-thirds (67%) of assaults occurred in metropolitan Melbourne, mainly in the northwest region (38%), which includes the central business district, and the southern region (22%). Twenty per cent of recorded assaults occurred in regional Victoria, with Barwon South West accounting for 5% of cases. Blunt injuries most often occurred on a road, street or highway (38%), while penetrating trauma most commonly occurred at home (42%). The highest percentage of assaults occurred on weekends (42%), usually between 21:00 and midnight (41%) and between 01:00 and 04:00 (22%).

Injuries

Most patients (498 [62%]) sustained an injury to more than one region of the body, and 61% of all patients sustained an injury to the head. Multiple body regions were affected in 312 cases (64%) of blunt trauma and 186 instances (58%) of penetrating trauma.

There was a significant association between the type of trauma and serious injury (ie, AIS score > 2) for the head ($P < 0.001$), face ($P < 0.001$), thorax ($P < 0.001$), and abdomen ($P < 0.001$). Head injuries (82% v 9%) and serious facial injuries (12% v 2%) were more common following blunt trauma than penetrating trauma. Conversely, penetrating trauma was more common than blunt trauma as a cause of serious thoracic injury (48% v 9%) and serious abdominal injury (32% v 4%).

Serious head injury

Serious head injury (AIS score > 2) was a common outcome of assault, with 82% of patients who had sustained blunt trauma having a serious head injury. Most patients with serious head injury (64%) were discharged directly home, but 24% required inpatient rehabilitation, compared with 5% of patients without a serious head injury ($P < 0.001$) (Box 3). There was no difference between patients with and without head injury with respect to age ($P = 0.07$), length of hospital stay ($P = 0.52$) or ICU stay ($P = 0.42$).

Long-term outcomes

Of the 352 patients eligible for follow-up at 6 months (ie, those who had survived to discharge), 232 (66%) were successfully contacted. There was no difference between patients followed up and those lost to fol-

2 Patient characteristics, injury severity and discharge status by type of trauma

	Total* ($n = 803$)	Blunt ($n = 484$)	Penetrating ($n = 319$)
Male	740 (92%)	450 (93%)	290 (91%)
Age (years)			
15–34	467 (58%)	280 (58%)	187 (58%)
35–44	165 (21%)	92 (19%)	73 (23%)
45–54	108 (13%)	73 (15%)	35 (11%)
55–64	37 (5%)	22 (5%)	15 (5%)
⩾ 65	26 (3%)	17 (3%)	9 (3%)
Injury severity score			
< 16	230 (29%)	71 (15%)	159 (50%)†
16–25	409 (51%)	305 (63%)	104 (32%)†
26–40	150 (19%)	103 (21%)	47 (15%)
> 40	14 (2%)	5 (1%)	9 (3%)
Discharge status			
Home	579 (72%)	330 (68%)	249 (78%)†
Rehabilitation	121 (15%)	103 (21%)	18 (6%)
Died in hospital	58 (7%)	23 (5%)	35 (11%)
Stayed in ICU	326 (41%)	203 (42%)	123 (38%)

ICU = intensive care unit. * Percentages do not add to 100% because of rounding.
† $P < 0.001$ for penetrating versus blunt trauma. ◆

3 Basic characteristics by classification of head injury

	Serious head injury*† (*n* = 423)	No serious head injury (*n* = 376)†‡
Male	393 (93%)	343 (91%)
ISS > 15	392 (93%)	181 (48%)§
Discharge type		
Home	274 (65%)	305 (81%)§
Rehabilitation	102 (24%)	19 (5%)
Died in hospital	30 (7%)	24 (6%)
Stayed in ICU	167 (39%)	123 (33%)
Age (years)¶	31 (22–42)	33 (24–43)
LOS (days)¶	5 (3–11)	6 (3–9)

ISS = Injury Severity Scale. ICU = intensive care unit. LOS = length of stay.
* Serious head injury defined as Abbreviated Injury Scale score > 2.
† Data are number of patients (%) unless otherwise indicated.
‡ This group includes patients with minor or no head injuries.
§ $P < 0.001$ for comparison of patients with and without serious head injuries.
¶ Data are median (interquartile range). ◆

4 Functional outcomes of patients with assault-related major trauma 6 months after injury (*n* = 232)

GOS-E rating	GOS-E definition	No. (%)*
Dead (after discharge)		2 (0.9%)
Vegetative state	Unable to obey simple commands, utter any word or communicate in any way	3 (1.4%)
Severe disability		
Lower	Assistance of another person at home is essential every day for activities of daily living	15 (6.8%)
Upper	Able to look after themselves for up to 8 hours during the day but unable to shop or travel locally without assistance	16 (7.3%)
Moderate disability		
Lower	Able to shop without assistance, drive or use public transport to get around, unable to work or study if doing so prior to injury, rarely participates in social or leisure activities, and daily disruption to family and friendships	45 (20.5%)
Upper	Able to shop without assistance, drive or use public transport to get around, returned to work or study but at a reduced capacity, extensive restriction to social or leisure activities, frequent disruption to family and friendships	56 (25.6%)
Good recovery		
Lower	Returned to pre-injury work or study capacity, but participating less in social and leisure activities, occasional disruption to family and friendships, or reporting other problems relating to the injury that affect daily life	40 (18.3%)
Upper	Returned to pre-injury capacity for work or study, social and leisure activities, no disruption to family and friendships, and no problems relating to their injury that affect daily life	42 (19.2%)

GOS-E = Extended Glasgow Outcome Scale. * Data missing for 13 patients. ◆

low-up with respect to age ($P = 0.13$), sex ($P = 0.27$), ISS ($P = 0.57$) or type of injury ($P = 0.76$).

Two-hundred and thirteen patients (92%) who were followed up were living at home, although 26 of these patients required additional care within the home. Two patients had died since being discharged, nine were living in an aged-care facility, four remained in an inpatient rehabilitation centre, two were in prison, and one patient was in hospital. Of the nine patients who were living in an aged-care facility, five were younger than 65 years (range, 20–61 years) and two were in a high-care facility.

Forty-two patients (19%) had completely recovered at 6-month follow-up (GOS-E, upper good recovery) (Box 4). Three patients remained in a vegetative state at follow-up. Outcomes were worse in the 153 follow-up patients who had sustained blunt trauma, with 20% (30 patients) unable to return to independent living by 6 months compared with 9% of patients (6 of 67 patients) with penetrating trauma ($P = 0.047$).

DISCUSSION

Our investigation revealed a significant increase in assaults resulting in major trauma in Victoria between 2001–02 and 2006–07, particularly blunt trauma-related assault. There were 58 deaths in hospital over the 6-year period, a further two deaths after discharge, and only 19% of patients had recovered fully at 6-month follow-up.

Data from the Victorian Emergency Minimum Dataset (VEMD) (requested from Monash University Accident Research Centre) suggest only a small increase in assault-related presentations to emergency departments: from 7886 in 2001 to 8134 in 2006. However, VEMD data were not available for the 2006–07 data-collection year when the large rise was noted by VSTR. Police statistics[17] report an 18% rise in assaults in recent years, from 30 782 in 2002–03 to 36 358 in 2006–07, supporting the findings of our study.

The combined VEMD, VSTR and police statistics suggest that although numbers of assaults have risen overall, the greatest increase has been in assaults that result in severe injury. The size and impact of this increase in violence suggest that more effective assault prevention strategies should be implemented and that further research is needed to identify the best approach to this sociological problem.

The incidence of assault-related penetrating trauma was stable over the 6-year study period, findings that contradict those from a report[18] from a major trauma centre in Melbourne of a near doubling in the rate of abdominal stabbings between March 2005 and March 2006. This report's findings probably reflect a concentration of stabbing cases in a single hospital rather than the overall state trend.

Although the rate of inhospital mortality was higher in patients with penetrating trauma than in those with blunt trauma, the actual number of patients with penetrating trauma was smaller, and survivors experienced better functional outcomes than did blunt-trauma patients. These better outcomes are probably related to the high prevalence of single-system injuries that can be repaired with surgical intervention in cases of penetrating injury.

The smaller rise in penetrating injuries compared with blunt-trauma injuries may also be the result of regulations introduced in 2000 to restrict the number of weapons in

the community. The National Firearms Monitoring Program[19] and legislative reforms to restrict the sale and possession of knives and other weapons[20] have strengthened restrictions on firearm ownership and possession and knives carried in public places.

However, of concern is the substantial increase in serious assault-related blunt-trauma injury. Not only was blunt trauma more common than penetrating trauma, but it also resulted in higher rates of inpatient rehabilitation and poorer long-term outcomes for patients; in addition, it was associated with high rates of serious head injury. Thus, efforts to prevent blunt-trauma assault should be a high priority.

Understanding the demographics of assault is necessary to enable effective implementation of prevention programs through the identification of high-risk areas, or so-called hot spots. We found that most assaults occurred in the metropolitan area, which includes the central business district, where there is a large concentration of outlets and entertainment venues that serve alcohol, and almost two-thirds of assaults occurred between 21:00 and 04:00. Early in 2008, the Victorian Government moved to prevent admission of patrons to hotels and clubs after 02:00 in an effort to curb violence in the areas around licensed premises. The effectiveness of this initiative will be captured through the VSTR and other key datasets.

The strengths of our study relate to the population-based nature of the trauma registry, the detail of data collected and the inclusion of outcomes at 6 months for survivors. Further, there has been no change in coding practices in hospitals or within the VSTR during the study period.

Some limitations of our study include a lack of information about alcohol and drug consumption by both the victim and the attacker, which have been identified as contributing factors in assaults.[2,21-23] Another drawback of our study is that it did not include deaths at the scene because these incidents are not recorded by the VSTR. Data collected by the National Coroners Information System registry were incomplete as many cases were still open at the time of conducting this study. Thus, tracking of year-on-year trends was not possible.

Loss to follow-up at 6 months after injury was higher than that in the general trauma population;[24] nevertheless, a comparison of responders with non-responders revealed no obvious bias. Finally, as the study included only major trauma cases, the ability to generalise these findings to minor injuries is limited.

The marked increase in incidence of assaults, the young age of the patients affected, poor outcomes and high burden of injury, combined with the preventable nature of assault, highlight the importance of developing effective assault-prevention strategies.

Community-based interventions to reduce high-risk alcohol consumption and assist in harm reduction include responsible beverage service, limiting underage access to alcohol, and increasing local enforcement of drinking and driving laws.[25] Key areas for further investigation are the identification of precipitating factors in assaults, development of effective assault-prevention strategies, and improvement of long-term outcomes for assault victims.

ACKNOWLEDGEMENTS

We thank Andrew Hannaford and Sue McLellan for their assistance with data extraction, the VSTR Steering Committee and the data collectors. Belinda Gabbe was supported by a Career Development Award from the National Health and Medical Research Council (NHMRC) during preparation of this manuscript.

COMPETING INTERESTS

None identified.

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REFERENCES

1 Luna G, Adye B, Haun-Hood M, et al. Intentional injury treated in community hospitals. *Am J Surg* 2001; 181: 463-465.
2 Savola O, Niemelä O, Hillbom M, et al. Alcohol intake and the pattern of trauma in young adults and working aged people admitted after trauma. *Alcohol Alcohol* 2005; 40: 269-273.
3 Swanson SM, Sise CB, Sise MJ, et al. The scourge of methamphetamine: impact on a level I trauma center. *J Trauma* 2007; 63: 531-537.
4 Luna GK, Kendall K, Pilcher S, et al. The medical and social impact of nonaccidental injury. *Arch Surg* 1988; 123: 825-827.
5 Fothergill NJ, Hashemi K. A prospective study of assault victims attending a suburban A&E department. *Arch Emerg Med* 1990; 7: 172-177.
6 Shepherd JP, Shapland M, Pearce NX, Scully C. Pattern, severity and aetiology of injuries in victims of assault. *J R Soc Med* 1990; 83: 75-78.
7 Boström L. Injury panorama and medical consequences for 1158 persons assaulted in the central part of Stockholm, Sweden. *Arch Orthop Trauma Surg* 1997; 116: 315-320.
8 Brennan IR, Moore SC, Shepherd JP. Non-firearm weapon use and injury severity: priorities for prevention. *Inj Prev* 2006; 12: 395-399.
9 Australian Bureau of Statistics. Crime and safety, Australia. Canberra: ABS, 2005. (ABS Cat. No. 4509.0.)
10 Munro P. Just another hot, bloody night in the city. *The Age* (Melbourne) 2007; 23 Dec. http://www.theage.com.au/articles/2007/12/22/1198175413377.html (accessed Dec 2008).
11 Spatial Analysis and Research, Victorian Department of Planning and Community Development. Victorian population bulletin — special edition. Melbourne: DPCD, 2007. http://www.dse.vic.gov.au/DSE/dsenres.nsf/LinkView/0E019FE9FE43A13FCA2573DA000A2FCC9CF72632FC3C8899CA256D1900232D11 (accessed Nov 2008).
12 Cameron PA, Finch CF, Gabbe BJ, et al. Developing Australia's first statewide trauma registry: what are the lessons? *ANZ J Surg* 2004; 74: 424-428.
13 Wilson JT, Pettigrew LE, Teasdale GM. Structured interviews for the Glasgow Outcome Scale and the extended Glasgow Outcome Scale: guidelines for their use. *J Neurotrauma* 1998; 15: 573-585.
14 Baker SP, O'Neill B, Haddon W Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. *J Trauma* 1974; 14: 187-196.
15 Rating the severity of tissue damage. I. The abbreviated scale. *JAMA* 1971; 215: 277-280.
16 Australian Bureau of Statistics. Population by age and sex, Australia. Canberra: ABS, 2008. (ABS Cat. No. 3235.0.)
17 Victorian Police. Crime statistics 2006–2007. http://www.police.vic.gov.au/statistics (accessed Jul 2008).
18 Rozen WM, Ma EH, Jones IT, Judson RT. Emerging epidemic in Australia: abdominal stab wounds. Twenty-four months at a major trauma centre. *Emerg Med Australas* 2007; 19: 262-268.
19 National Firearms Monitoring Program. Canberra: Australian Institute of Criminology, 2007. http://www.aic.gov.au/research/projects/0002.html (accessed Nov 2008).
20 Minister for Police and Emergency Services. Swords to become prohibited weapons [media release]. 8 Mar 2004. http://www.legislation.vic.gov.au/domino/Web_Notes/newmedia.nsf/bc348d5912436a9cca256cfc0082d800/53facb21ce5501ecca256e51007dd9be!OpenDocument (accessed Dec 2008).
21 Stein DJ, Boshoff D, Abrahams H, et al. Patients presenting with fresh trauma after interpersonal violence. Part I. Alcohol and substance abuse. *S Afr Med J* 1997; 87: 996-998.
22 Sumner BB, Mintz ER, Brown PL. Injuries caused by personal violence. *Injury* 1987; 18: 258-260.
23 Wright J, Kariya A. Assault patients attending a Scottish accident and emergency department. *J R Soc Med* 1997; 90: 322-326.
24 Gabbe BJ, Cameron PA, Williamson OD, et al. The relationship between compensable status and long-term patient outcomes following orthopaedic trauma. *Med J Aust* 2007; 187: 14-17.
25 Holder HD, Gruenewald PJ, Ponicki WR, et al. Effect of community-based interventions on high-risk drinking and alcohol-related injuries. *JAMA* 2000; 284: 2341-2347.

(Received 14 Jul 2008, accepted 24 Sep 2008) ❑