AUSTRALASIAN JOURNAL OF PARAMEDICINE

PARAMEDICS AUSTRALASIA

Research

Major trauma patients are not who you might think they are: a linked data study

Elizabeth Brown BSc(Hons), MSc is a PhD candidate[1] and paramedic[2]; Hideo Tohira PhD, MD, MEng, MPH, FJAAM is a Research Fellow[1,3]; Paul Bailey MBBS, FACEM, PhD is Clinical Services Director[2] and Director of Emergency Medicine[1,3]; Daniel Fatovich MBBS, FACEM, PhD is a Professor of Emergency Medicine[1,5,6]; Judith Finn PhD, MEdSt, GradDipPH, BSc, DipAppSc, RN, RM, ICCert, FACN, FAHA is Director of PRECRU[1,2,3,7]

Affiliations:

[1]Prehospital Resuscitation and Emergency Care Research Unit, School of Nursing, Midwifery and Paramedicine, Curtin University, Perth, Western Australia

[2]St John Western Australia, Perth Western Australia

[3]Division of Emergency Medicine, The University of Western Australia, Perth, Western Australia

[4]Emergency Department, St John of God Murdoch Hospital, Perth, Western Australia

[5]Emergency Medicine, Royal Perth Hospital, University of Western Australia, Perth, Western Australia

[6]Centre for Clinical Research in Emergency Medicine, Harry Perkins Institute of Medical Research, Perth, Western Australia

[7]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria

https://doi.org/10.33151/ajp.16.704

Abstract

Introduction

Major trauma patients are often perceived as being young males injured by high energy transfer mechanisms. The aim of this study was to describe the demographics of major trauma patients who were transported to hospital by ambulance.

Methods

This is a retrospective cohort study of adult major trauma (injury severity score >15) patients transported to hospital by St John Western Australia emergency ambulance in metropolitan Perth, between 1 January 2013 and 31 December 2016. To describe the cohort, median and interquartile range (IQR) were used for continuous variables and counts and percentages for categorical variables. Differences between mechanism of injury groups were assessed using the Kruskal-Wallis test. Trauma deaths were defined as early (declared deceased within 24 hours) or late (declared deceased within 30 days).

Results

A total of 1625 patients were included. The median age was 51 years (IQR 30-75) and 1158 (71%) were male. Falls from standing were the most common mechanism of injury (n=460, 28%) followed by motor vehicle crashes (n=259, 16%). Falls from standing were responsible for the majority of early (n=45/175, 26%) and late deaths (n=69/158, 44%). A large number of early deaths also resulted from motorbike crashes (n=32/175, 18%) with a median age of 34 years (IQR 21-46, p<0.001).

Conclusion

Major trauma is not only a disease of the young. More than half of the cohort was more than 51 years of age and the most common cause was a fall from standing. Pre-hospital care must evolve to address the needs of a changing trauma patient demographic.

Keywords:

major trauma; emergency medical service; patient outcomes; falls; older adults

Corresponding Author: Elizabeth Brown, elizabeth.e.brown@postgrad.curtin.edu.au

Introduction

Injury is known to be a significant cause of preventable mortality and morbidity worldwide (1). Traditionally, major trauma has been viewed as a disease of the young (2), more specifically, a disease of young males caused by high energy transfer mechanisms of injury such as motor vehicle crashes and interpersonal violence (2). In keeping with this, emergency medical service (EMS) training and resources are often focussed on the management of this group. Similarly, community awareness of mortality from major trauma tends to also focus on this group (3).

Over recent years there has been an increase in the mean age of trauma patients together with major trauma as a result of falls from a low level (2). A better understanding of the true demographics of major trauma may help to inform clinical practice, enable better tailoring of paramedic education and improve patient outcomes.

Objective

The aim of this study was to describe the demographics, injury characteristics and outcomes of major trauma patients who were transported by ambulance to hospital in a metropolitan area.

Methods

Study design

We conducted a retrospective cohort study of adult (≥16 years of age) patients who were transported by St John Western Australia (SJ-WA) emergency ambulance in metropolitan Perth (Western Australia) with an injury severity score (ISS) greater than 15 (resulting from a blunt, penetrating or thermal mechanism of injury) between 1 January 2013 and 31 December 2016. Consistent with previous trauma studies, we excluded trauma resulting from drowning, hanging or poisoning (4,5). We also excluded patients who were not initially transported by SJ-WA from the incident scene and those not transported by road ambulance. Patients with late effects of injury (more than 24 hours post-trauma) and those who had no initial electronic ambulance transport record were also excluded.

Study setting

The metropolitan area of Perth has a population of approximately 2 million (6) and SJ-WA is the sole provider of emergency ambulances. Each emergency ambulance is staffed with at least one paramedic (with the second crew member being another paramedic or ambulance officer) and all crews have the capacity to provide advanced life support (excluding rapid sequence intubation) (7). SJ-WA is contracted to provide critical care paramedics to the helicopter emergency medical service, owned by the Department of Fire and Emergency Services. However, this service does not routinely operate in the metropolitan area of Perth.

During the study period, patients were transported to one of nine hospital emergency departments. Of these, three were tertiary and six were secondary hospitals. One of the tertiary hospitals is a Level 1 trauma centre (8,9). The five secondary hospitals and one private hospital provide definitive care for non-major trauma (8). It has been recommended by the Western Australia Department of Health that major trauma patients (defined as those with an injury that has the potential to cause prolonged disability or death) should be transported directly to the Level 1 trauma centre unless there is an imminent threat to life (7,10).

Data sources

There are four hospitals that contribute data to the Western Australian State Trauma Registry (WASTR): the three tertiary hospitals and one of the secondary hospitals. The registry also includes records for patients who are transferred after initial treatment at another hospital which did not provide data to the registry (11).

Patients were identified in the WASTR if they had an ISS greater than 15, their mode of arrival was recorded as 'ambulance' and the location of injury occurrence was described as 'metropolitan'. Demographic details, injury mechanism, injury characteristics, length of hospital stay, date and location of death were then extracted from the registry. Patient data was then linked with the electronic patient care record (ePCR) from the SJ-WA database using either deterministic or probabilistic matching (FRIL ver.2.1.5, Emory University and Centers for Disease Control and Prevention, Atlanta, Georgia, US). Date of birth, first and last names and residential address were used as key identifiers to link between the databases. The SJ-WA database contains data from the ePCR, completed for each case by EMS providers, together with data from the computer-aided dispatch system.

The WASTR includes 39 different mechanisms of injury codes. For the purpose of this study certain mechanisms of injury were excluded (as detailed above) and the remaining re-coded into eight specific codes: motor vehicle crash, motorbike crash, pedestrian, pedal cyclist, fall from height (height higher than standing level), fall from standing (including falls from the toilet or chair), violence and other (fire, sport related, other). The registry also provides a severity level for each injury according to the Abbreviated Injury Scale (AIS) ranging from 6 (fatal) to 1 (minor). AIS codes were used to identify whether a patient sustained a major injury in the six ISS body regions (head/neck, face, chest, abdomen, extremities and external). An AIS level of ≥3 was used to define major injury. We defined deaths as being either early (patients who were declared deceased in hospital within 24 hours of the emergency call being received) or late deaths (those who died within 30 days [excluding those declared deceased within 24 hours]). Patients who are recognised as life extinct pre-hospital are not included in the WASTR and thus not included in this study.

Statistical analysis

To describe the cohort, counts and percentages were used for categorical variables and median and inter-quartile ranges (IQR) for continuous variables. To describe trends in demographics, injury characteristics and outcomes across the calendar years 2013 to 2016 for dichotomous variables, the Cochran-Armitage test was used. For comparisons of continuous data, the Kruskal-Wallis test was used and the Pearson chi-square used for categorical variables. Patient demographics and mortality were compared between the mechanism of injury groups using counts and percentages and the Kruskal-Wallis test for continuous variables. A p-value of <0.05 was considered statistically significant. Data analysis was performed with IBM Statistical Package for Social Sciences (SPSS) Version 24.0 (IBM, Armonk, NY, US).

Ethics approval

Ethical approval was obtained from the Curtin University Human Research Ethics Committee (HR 128/2013). Ethics approval for access to the WA State Trauma Registry data was obtained from the Royal Perth Hospital Human Research Ethics Committee (PRN 464). Approval to access the SJ-WA data was obtained from the St John Research Governance Committee.

Author contributions

EB, HT and JF designed the study. HT undertook the data linkage. EB analysed and interpreted the data and drafted the manuscript. HT assisted in data analysis. HT, PB, DF and JF assisted in writing and providing a critical review of the manuscript. All authors gave the final approval for the submission.

Results

There were 1664 records in the WASTR pertaining to patients who were 16 years of age or more who had an ISS greater than 15 from a blunt, penetrating or thermal mechanism of injury and were transported from the incident scene by SJ-WA emergency ambulances during the 4-year study period. We were unable to obtain the initial emergency ambulance transport record for 34 patients, three records could not be linked and two records were duplicated in the registry (Figure 1).

Cohort characteristics

This left a study cohort of 1625 patients (Figure 1). The median age of patients was 51 years (IQR 30-75) and 1158 (71%) were male. The median ISS was 22 (IQR 17-27) and 67% (n=1081) had a major head injury. Falls from standing were the most common mechanism of injury with 460 (28%) patients injured by this mechanism. Motor vehicle crashes were the second most common cause of injury (n=259, 16%). During the study period, there was a total of 339 (21%) deaths recorded in the WASTR that met the study's inclusion criteria. Of these, 175 (52%) were early deaths, 158 (46%) were late deaths, and six occurred after 30 days (2%).

Changes during the study period

Over the study period, median age, ISS, length of stay of those who survived 30 days and the occurrence of serious complications did not change significantly (Table 1). The number of patients injured by a penetrating mechanism increased over the study period (p=0.008). However, blunt trauma was responsible for over 90% of the injuries throughout the study period.

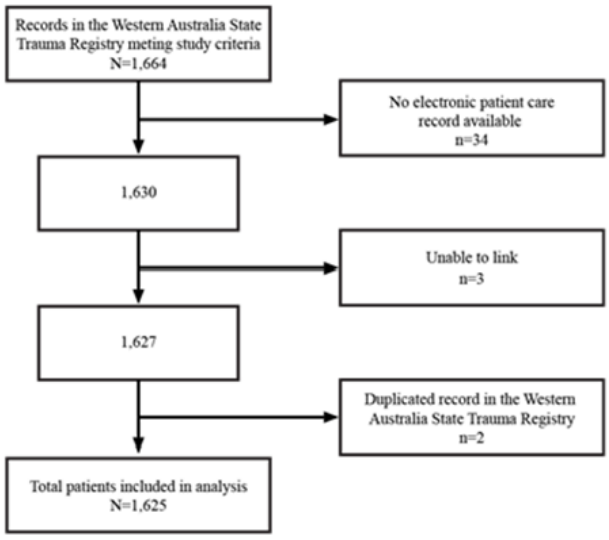

Figure 1. Included and excluded patients during the study period

Mechanism of injury characteristics

Throughout the study period, falls from standing were the most common cause of major trauma (n=460/1625, 28%) and 12% more patients were injured via this mechanism than motor vehicle crashes (n=259/1625, 16%) (Figure 2).

There was a significant difference in patient age between the mechanism of injury groups with those who fell from standing being the oldest at 80 years (IQR 66-87) and those injured in a violent mechanism the youngest at 32 years (IQR 25-44, p<0.001) (Figure 3).

Age and gender characteristics

There were more males with major trauma in all age cohorts except in the ≥85 years cohort. After the age of 45 years, there was an increasing number of females in each age cohort with females making up 54% of the ≥85 years of age cohort (Figure 4).

Table 1. Demographic and trauma characteristics of major trauma patients in the WASTR transported by SJ-WA during the study period

	2013	2014	2015	2016	p-value
Total patients	381	370	450	424	
Age median (IQR)	54 (30-77)	49 (28-74)	52 (29-74)	51 (31-75)	0.437
Male (%)	270 (71)	276 (75)	324 (72)	288 (68)	0.248†
Trauma characteristics					
Blunt injury (%)	375 (98)	358 (97)	427 (95)	404 (95)	**0.008**†
Penetrating injury (%)	6 (2)	12 (3)	23 (5)	20 (5)	
ISS median (IQR)	24 (17-27)	24 (17-29)	22 (18-27)	22 (17-27)	0.217
Injury characteristics					
Major head injury AIS ≥3 (%)	252 (66)	256 (69)	297 (66)	276 (65)	0.539†
Major chest injury (%)	144 (38)	134 (36)	177 (39)	150 (35)	0.699†
Major abdominal injury (%)	46 (12)	52 (14)	78 (17)	67 (16)	0.071†
Outcomes					
Early death (%)	45 (12)	43 (12)	46 (10)	41 (10)	0.257 †
Late death (%) ¶	42 (12)	34 (10)	42 (10)	40 (10)	0.410†
LOS in 30 day survivors median (IQR)	10 (5-18)	9 (5-17)	8 (4-15)	9 (5-18)	0.101
Serious complications (%) ††	105 (28)	87 (23)	106 (24)	109 (26)	0.583†
Mechanism of injury					
MVC (%)	57 (15)	61 (16)	69 (15)	72 (17)	
MBC (%)	46 (12)	46 (12)	63 (14)	62 (15)	
Pedestrian (%)	34 (9)	28 (8)	21 (5)	23 (5)	
Pedal cyclist (%)	15 (4)	22 (6)	17 (4)	15 (4)	0.387
Fall from height (%)	54 (14)	44 (12)	67 (15)	57 (13)	
Fall from standing (%)	113 (30)	95 (26)	133 (29)	119 (28)	
Violence (%)	26 (7)	40 (11)	49 (11)	44 (10)	
Other (%) ‡	36 (9)	34 (9)	31 (7)	32 (8)	
Transport destination					
Direct to trauma centre (%)	177 (47)	196 (53)	193 (43)	200 (47)	
Indirect to trauma centre (%)	96 (25)	99 (27)	149 (33)	115 (27)	**0.019**
No trauma centre (%)	108 (28)	75 (20)	108 (24)	109 (26)	

Notes: Data presented as count (percentage); data analysed with Cochran-Armitage test for trend, Kruskal-Wallis test, chi-square; † Cochran-Armitage test for trend; bold font indicates significance; LOS = length of stay; MVC = motor vehicle crash; MBC = motorbike crash; AIS = Abbreviated Injury Scale score; ¶ excluding deaths <24 hours; †† serious complications = acute kidney injury, acute myocardial infarction, acute respiratory distress syndrome, cardiac arrest, cardiac failure, deep vein thrombosis, pulmonary embolism, pneumonia, sepsis, stroke and unplanned return to the operating room (12); ‡ fire, sport related, other.

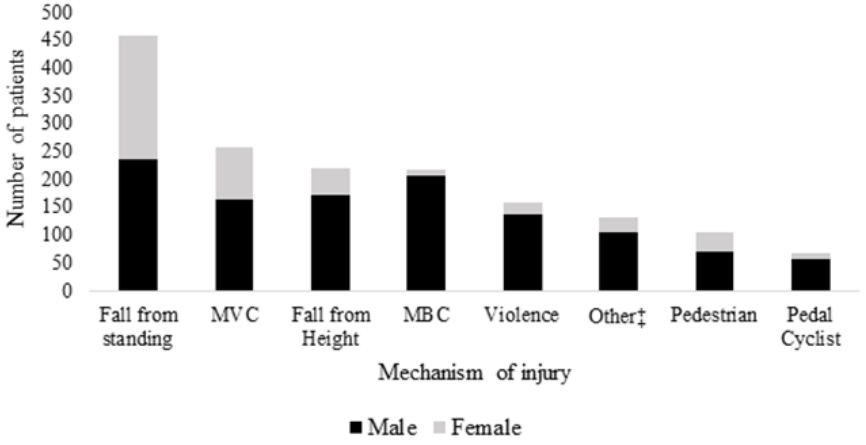

Figure 2. Number and gender of major trauma patients in the WASTR transported by SJ-WA per mechanism of injury during the study period

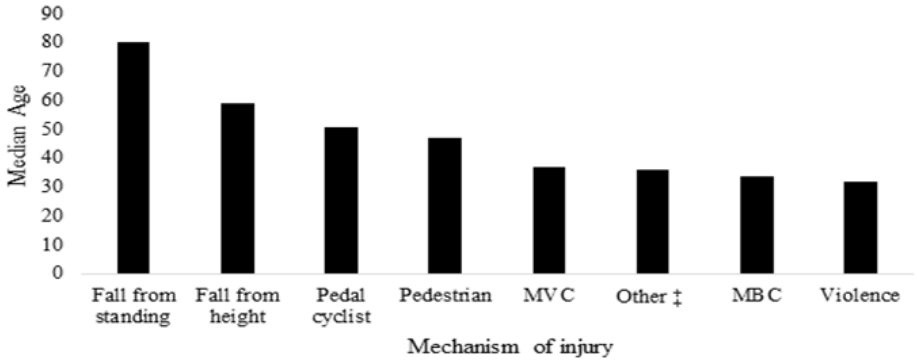

Figure 3. Median age of major trauma patients in the WASTR transported by SJ-WA during the study period

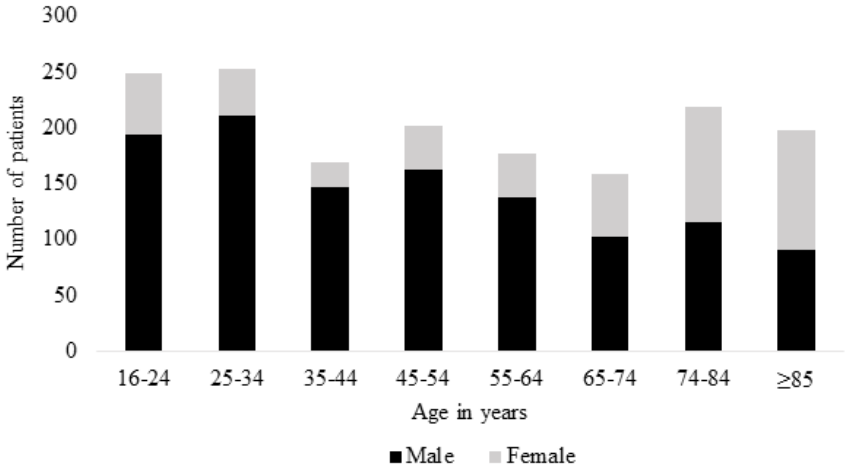

Figure 4. Number of major trauma patients in the WASTR transported by SJ-WA during the study period by age category and gender

Transport destination

Seven hundred and sixty-six patients were transported to the trauma centre directly (47%), 459 (28%) were transported indirectly and 400 (25%) were not transported to the trauma centre directly or indirectly (Figure 5). The median age was oldest in those who were not transported to the trauma centre either directly or indirectly (72 years IQR 46-84 vs. 45 years IQR 27-64, direct and 49 IQR 29-72 indirect, p=0.001). Similarly, those who did not receive trauma centre transport had the highest proportion of falls from standing (n=212/400, 53%, p<0.001), whereas the direct transport group had the highest proportion of motor vehicle crashes (n=152/766, 20%, p<0.001) (Figure 5).

Mortality characteristics

The median age of early deaths in hospital was 49 years (IQR 31-76) and the majority were male (n=127/175, 73%). The most common cause of early deaths was a fall from standing (n=45/175, 26%) and these patients were the oldest with a median age of 78 years (IQR 66-86 years). There was also a large number of early deaths resulting from motorbike crashes (n=32/175, 18%) with these patients having a median age of 34 years (IQR 21-46, p<0.001) (Table 2).

For late deaths, the median age was 77 years (IQR 51-86) and the majority were male (n=101/158, 64%). Falls from standing were responsible for almost half of the late deaths (n=69/158, 44%) and these patients were the oldest at 85 years (IQR 78-90, p<0.001) (Table 3).

Table 2. Number of early major trauma patient deaths in the WASTR transported by SJ-WA during the study period per mechanism of injury

Mechanism of injury	Number of deaths	Median age	
	(%)	(IQR)	p-value
MVC	18 (10)	33 (23-68)	
MBC	32 (18)	34 (21-46)	
Pedestrian	22 (13)	63 (42-82)	<0.001
Fall from height	20 (11)	41 (26-72)	
Fall from standing	45 (26)	78 (66-86)	
Violence	18 (10)	39 (32-48)	
Other ‡	20 (11)	47 (39-59)	

Notes: Kruskal-Wallis test for difference in median age; ‡ = fire, sport related, pedal cyclist, other; percentages are rounded to the nearest whole number

Discussion

This study described the characteristics of major trauma patients transported to hospital by emergency ambulance in the metropolitan area of Perth, Western Australia. We found that falls from standing were the most common cause of major trauma in patients transported to hospital and were the most common cause of both early and late trauma deaths. We have also shown that major trauma is not only a disease of the young, with more than half of the cohort being more than 51

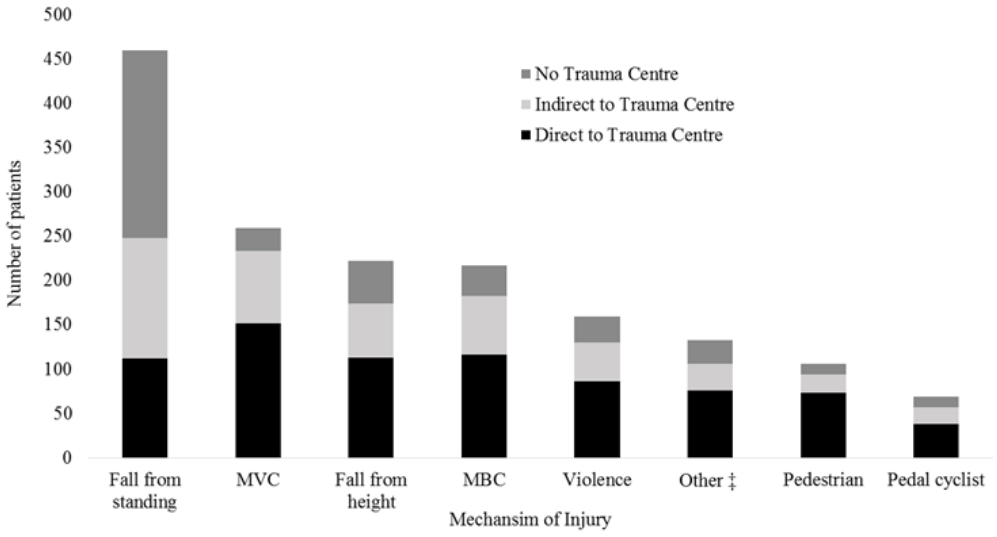

Figure 5. Number of major trauma patients in the WASTR transported by SJ-WA during the study period by transport destination and mechanism of injury

years of age. However, we have reported an alarming number of early deaths in young patients as a result of motorbike crashes.

Table 3. Number of late trauma patient deaths in the WASTR transported by SJ-WA between during the study period per mechanism of injury

Mechanism of injury	Number of deaths	Median age	
	(%)	(IQR)	p-value
MVC and MBC ††	24 (15)	50 (29-79)	
Pedestrian	13 (8)	62 (46-82)	<0.001
Fall from height	27 (17)	77 (60-84)	
Fall from standing	69 (44)	85 (78-90)	
Violence	10 (6)	31 (20-48)	
Other ‡	15 (9)	51 (27-68)	

Notes: Kruskal-Wallis test for difference in median age; †† less than five patients in one category; ‡ = fire, sport related, other; percentages are rounded to the nearest whole number

Older adults

An older median age of major trauma patient and the prominence of low falls as a cause of major trauma are not novel findings. A shift in the demographics of major trauma away from young males resulting from motor vehicle crashes and violence has also been shown in the United Kingdom with major trauma patients more than 75 years of age increasing from 8.1% in 1990 to 26.9% in 2013 (2). Similarly, in Sydney (Australia) the proportion of older major trauma patients was found to have increased from 1991-2010 (13).

The increase in older adults with major trauma creates complex issues. Age is an independent predictor of survival after major trauma (3) and compared to younger patients, older adults with major trauma are known to have higher mortality rates (14). Older adults are also predisposed to poor outcomes from co-morbidities, medication usage (eg. anticoagulation) and are susceptible to complications (3). Compounding these issues is the ability of older adults to appear deceivingly uninjured with overt physiological derangement often absent (15). It is also known that these patients have a reduced likelihood of trauma centre transport (16-19) and an increased likelihood of undertriage within hospital (20,21). Although the reduced odds of trauma centre transport are multi-faceted, treatment of older adults at non-major trauma centres is known to be associated with an increased likelihood of in-hospital mortality (16).

With a greater proportion of older adults with major trauma, trauma systems need to adapt to this shift in demographics (22). It is paramount that pre-hospital care evolves to ensure the needs of older persons following trauma are met (22). With the knowledge that the physiological response to trauma in older persons is different from younger adults, it is imperative that pre-hospital trauma triage tools reflect these differences (23) and an older adult specific trauma triage guideline may be necessary (24). However, the greatest survival gains in older adults are more likely to be achieved by injury prevention (25).

Falls

Falls are the second leading cause of accidental injury deaths worldwide after motor vehicle crashes (26). Similar to other studies, we found falls to be the most common cause of major trauma (23,27,28) and were responsible for the majority of both early and late major trauma deaths. This is contrary to community awareness on mortality from major trauma which is focused on young males involved in motor vehicle crashes (3). It is possible that EMS providers do not recognise that a fall from standing has the ability to cause major trauma. Therefore, the development of more specific major trauma triage guidelines may assist with the recognition of those with the potential to have major trauma and those who would benefit from trauma centre transport.

Motorbike crashes

After falls from standing, motorbike crashes were responsible for the highest number of early deaths and this cohort of patients had a median age of 34 years, which represents a large number of potential years of life lost. As opposed to those injured in low falls, patients fatally injured in motorbike crashes are unlikely to be under-recognised or undertriaged. Therefore, the biggest opportunity for improvement in outcomes in this cohort is likely to be from prevention.

Limitations

Patients who are recognised as life extinct pre-hospital are not captured by the WASTR and therefore were not captured by this study. It is important to note that not including pre-hospital deaths in our current study underestimates untimely deaths, however, this is a common limitation of studies using data from trauma registries (29,30).

Patients who exclusively attended a hospital that did not provide data to the WASTR were not captured by the study. It is possible that the demographics and characteristics of these patients are different from those captured in this study, meaning that our study is subject to survivor bias. However, as the Level 1 trauma centre treats approximately 80% of the state's major trauma (9), we believe that the majority of patients with major trauma would have been transported to a hospital that provided data to the registry.

It is important to consider that this study includes patients with major trauma defined as an ISS greater than 15. This retrospective diagnosis is made using information that is not available pre-hospital, for example, results from imaging. It is, therefore, important to develop ways in which major trauma can be identified pre-hospital, especially in older patients, to ensure that these patients receive appropriate care.

Conclusion

Major trauma does not only occur in the young. More than half of the major trauma patients transported by ambulance in our cohort were more than 51 years of age. In this study, falls from standing were the most common cause of major trauma. To improve patient outcomes, pre-hospital care must evolve to address the needs of a changing trauma patient demographic.

Acknowledgements

The authors are grateful for the support of Maxine Burrell, WA State Trauma Programme Manager and thank SJ-WA for their support of our study.

Conflict of interest

The authors declare they have no competing interests. Each author of this paper has completed the ICMJE conflict of interest statement.

References

1. Haagsma JA, Graetz N, Bolliger I, et al. The global burden of injury: incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease Study 2013. Inj Prev 2016;22:3-18.
2. Kehoe A, Smith JE, Edwards A, Yates D, Lecky F. The changing face of major trauma in the UK. Emerg Med J 2015;32:911-5.
3. Fatovich DM, Jacobs IG, Langford SA, Phillips M. The effect of age, severity, and mechanism of injury on risk of death from major trauma in Western Australia. J Trauma Acute Care Surg 2013;74:647-51.
4. McCoy CE, Menchine M, Sampson S, Anderson C, Kahn C. Emergency medical services out-of-hospital scene and transport times and their association with mortality in trauma patients presenting to an urban level i trauma center. Ann Emerg Med 2013;61:167-74.
5. Beck B, Bray JE, Cameron P, et al. Predicting outcomes in traumatic out-of-hospital cardiac arrest: the relevance of Utstein factors. Emerg Med J 2017;34:786-92.
6. Australian Bureau of Statistics. Australian demographic statistics. 2016 Census. Available at: www.abs.gov.au/AUSSTATS/abs@.nsf/allprimarymainfeatures/CFE97018EC49EB38CA2580F2000BEBB4 [Accessed 25 August 2018].
7. St John Ambulance Western Australia Ltd. Clinical practice guidelines for ambulance care in Western Australia - paramedic industrial paramedic ambulance officer ambulance transport officer. Version 31. 2017.
8. Towler S. Trauma system and services - report of the Trauma Working Group. Western Australia: delivering a healthy WA, 2007. [Updated 25 July]. Available at: www.health.wa.gov.au/trauma_system_and_services/home/about.cfm [Accessed 25 August 2018].
9. Government of Western Australia East Metropolitan Health Service. Royal Perth Hospital. [Updated 22 March 2018]. Available at: https://rph.health.wa.gov.au/Our-services/Trauma-Service [Accessed 16 November 2018].
10. Government of Western Australia – Department of Health. Guiding principles for major trauma inter hospital transfer. [Updated 31 July 2013]. Available at: www.health.wa.gov.au/trauma_system_and_services/home/ [Accessed 25 August 2018].
11. Western Australian Department of Health. WA State Trauma Registry. Available at: www.health.wa.gov.au/Articles/U_Z/WA-State-Trauma-Registry [Accessed 25 August 2018].
12. Hemmila MR, Cain-Nielsen AH, Wahl WL, et al. Regional collaborative quality improvement for trauma reduces complications and costs. J Trauma Acute Care Surg 2015;78:78-87.
13. Dinh MM, Roncal S, Byrne CM, Petchell J. Growing trend in older patients with severe injuries: mortality and mechanisms of injury between 1991 and 2010 at an inner city major trauma centre. ANZ J Surg 2013;83:65-9.
14. Hashmi A, Ibrahim-Zada I, Rhee P, et al. Predictors of mortality in geriatric trauma patients: a systematic review and meta-analysis. J Trauma Acute Care Surg 2014;76:894-901.
15. Fatovich DM, Burrell M, Jacobs IG. Major trauma deaths at Perth secondary hospitals. Emerg Med Australas 2011;23:754-60.
16. Brown E, Tohira H, Bailey P, et al. Older age is associated with a reduced likelihood of ambulance transport to a trauma centre after major trauma in Perth. ibid. 2019 [in press].
17. Fitzharris M, Stevenson M, Middleton P, Sinclair G. Adherence with the pre-hospital triage protocol in the transport of injured patients in an urban setting. Injury 2012;43:1368-76.
18. Doumouras AG, Haas B, Gomez D, et al. The impact of distance on triage to trauma center care in an urban trauma system. Prehosp Emerg Care 2012;16:456-62.
19. Staudenmayer KL, Hsia RY, Mann NC, Spain DA, Newgard CD. Triage of elderly trauma patients: a population-based perspective. J Am Coll Surg 2013;217:569-76.
20. Lukin W, Greenslade JH, Chu K, Lang J, Brown AF. Triaging older major trauma patients in the emergency department: an observational study. Emerg Med J 2015;32:281-6.
21. Trinder MW, Wellman SW, Nasim S, Weber DG. Evaluation of the trauma triage accuracy in a Level 1 Australian trauma centre. Emerg Med Australas 2018;30:699-704.
22. Beck B, Cameron P, Lowthian J, et al. Major trauma in older persons. BJS Open 2018;2:310-8.
23. Kehoe A, Smith JE, Bouamra O, et al. Older patients with traumatic brain injury present with a higher GCS score than younger patients for a given severity of injury. Emerg Med J 2016;33:381-5.

References (continued)

24. Cox S, Morrison C, Cameron P, Smith K. The epidemiology of elderly trauma in Victoria, Australia. Acad Emerg Med 2012;19:715.
25. Pracht EE, Langland-Orban B, Flint L. Survival advantage for elderly trauma patients treated in a designated trauma center. J Trauma Acute Care Surg 2011;71:69-77.
26. World Health Organisation. Falls 2018. Available at: room/fact-sheets/detail/falls [Accessed 14 January 2019].
27. Dinh MC, Mitchell K, Bein R, et al. Major trauma mortality in rural and metropolitan NSW, 2009-2014: a retrospective analysis of trauma registry data. Med J Aust 2016;205:403-7.
28. Curtis KM, Chong R, Balogh S, et al. Injury trends and mortality in adult patients with major trauma in New South Wales. ibid. 2012;197:233-7.
29. Fatovich DM, Jacobs IG. The relationship between remoteness and trauma deaths in Western Australia. J Trauma 2009;67:910-4.
30. Fatovich DM, Phillips M, Langford SA, Jacobs IG. A comparison of metropolitan vs rural major trauma in Western Australia. Resuscitation 2011;82:886-90.