Emergency Medicine Australasia
Check for updates

Emergency Medicine Australasia (2024) **36**, 197–205 doi: 10.1111/1742-6723.14373

REVIEW ARTICLE

Review article: Pre-hospital trauma guidelines and access to lifesaving interventions in Australia and Aotearoa/New Zealand

Tim ANDREWS ,[1,2,3] Ben MEADLEY ,[1,2,3] Belinda GABBE,[1] Ben BECK ,[1] Bridget DICKER [4,5] and Peter CAMERON [1,6]

[1]School of Public Health and Preventive Medicine, Monash University, Melbourne, Victoria, Australia, [2]Clinical Operations, Ambulance Victoria, Melbourne, Victoria, Australia, [3]Department of Paramedicine, Monash University, Melbourne, Victoria, Australia, [4]Clinical Audit and Research, Hato Hone St John New Zealand, Auckland, New Zealand, [5]Paramedicine Department, Auckland University of Technology, Auckland, New Zealand, and [6]Emergency and Trauma Centre, The Alfred Hospital, Melbourne, Victoria, Australia

Abstract

The centralisation of trauma services in western countries has led to an improvement in patient outcomes. Effective trauma systems include a pre-hospital trauma system. Delivery of high-level pre-hospital trauma care must include identification of potential major trauma patients, access and correct application of lifesaving interventions (LSIs) and timely transport to definitive care. Globally, many nations endorse nationwide pre-hospital major trauma triage guidelines, to ensure a universal approach to patient care. This paper examined clinical guidelines from all 10 EMS in Australia and Aotearoa/New Zealand. All relevant trauma guidelines were included, and key information was extracted. Authors compared major trauma triage criteria, all LSI included in guidelines, and guidelines for transport to definitive care. The identification of major trauma patients varied between all 10 EMS, with no universal criteria. The most common approach to trauma triage included a three-step assessment process: physiological criteria, identified injuries and mechanism of injury. Disparity between physiological criteria, injuries and mechanism was found when comparing guidelines. All 10 EMS had fundamental LSI included in their trauma guidelines. Fundamental LSI included haemorrhage control (arterial tourniquets, pelvic binders), non-invasive airway management (face mask ventilation, supraglottic airway devices) and pleural wall needle decompression. Variation in more advanced LSI was evident between EMS. Optimising trauma triage guidelines is an important aspect of a robust and evidence driven trauma system. The lack of consensus in trauma triage identified in the present study makes benchmarking and comparison of trauma systems difficult.

Key words: *lifesaving intervention, major trauma, pre-hospital.*

Correspondence: Mr Tim Andrews, School of Public Health and Preventive Medicine, Monash University, Level 1, 553 St Kilda Road, Melbourne, VIC 3004, Australia. Email: tim.andrews@monash.edu

Tim Andrews, MSPP, Senior Lecturer & Intensive Care Paramedic; Ben Meadley, PhD, MICA Flight Paramedic; Belinda Gabbe, PhD, Professor; Ben Beck, PhD, Associate Professor; Bridget Dicker, PhD, Adjunct Professor; Peter Cameron, MBBS, MD, Professor.

This is an open access article under the terms of the Creative Commons Attribution License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

Accepted 2 January 2024

Key findings

- There is a lack of concensus on prehospital trauma triage criteria within the region.
- A validated approach to pre-hospital trauma care is important for systems improvement.

Introduction

Access to lifesaving interventions (LSIs) is fundamental to improving survival of critically ill trauma patients.[1] Trauma systems enable optimal patient care after major trauma[2] by coordinating and integrating the care of patients from the pre-hospital setting, through to definitive care and rehabilitation.[3] In developed nations, the implementation of advanced trauma systems has led to a decrease in death and disability.[4–6] Crucial to the effectiveness of a centralised trauma system is a pre-hospital system which provides appropriate, high-level clinical care and timely transport to appropriate trauma services.[3] Provision of pre-hospital trauma care focuses on three key aspects: identification and triage of patients needing immediate care, access and delivery of LSIs, and timely transport to definitive care.

The identification of major trauma patients ensures that patients receive timely interventions and definitive care. Early identification of major trauma patients will initially occur through EMS call taking and dispatch, with the EMS using

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

systems such as Medical Priority Dispatch System to identify and dispatch appropriate resources based on urgency.[3] Subsequently, the use of infield triage tools, including the 'Field Triage Decision Scheme' (FTDS)[7] assist in identifying those patients who require specialist trauma centre management. First developed by the American College of Surgeons, the FTDS, is a four-step process, evaluating the patients vital signs, injuries, mechanism of injury and patient context,[8] and has been adopted and evaluated internationally.[9–12] Globally, many nations endorse nationwide pre-hospital major trauma triage guidelines, to ensure a universal approach to patient care.[10,13] The benefit of a validated triage tool is in the accurate and timely identification and subsequent transport to an appropriate destination for ongoing care.

Validation of trauma triage criteria includes assessing the sensitivity (under triage) and specificity (over-triage) of the guideline parameters.[11] Under triage of trauma patients can lead to delays in accessing LSIs, definitive care and an associated increased mortality rate.[9,14] Conversely, over-triage can lead to increased system costs, overwhelming volume at trauma hospitals and unnecessary transportation of patients away from their community.[12,15] Triage tools must be validated to minimise under-triage as well as over-triage and benchmark these against accepted levels.[12,16]

Lifesaving interventions need to be implemented in a timely fashion, yet the centralisation of major trauma services (i.e. increased transport times) has led to increased out-of-hospital times.[17] Median pre-hospital times exceeded 90 min in Australia and Aotearoa/New Zealand in 2021,[18] necessitating access to critical interventions in the pre-hospital phase of care. However, formally establishing how to best deliver these interventions in a standardised and evidence-based manner has not occurred, and there has been no recorded, standardised pre-hospital approach from Australia or Aotearoa/New Zealand. Fundamentally, LSI focus on haemorrhage control, and optimisation of physiology,[1] adapting the Danger Response Airway Breathing & Circulation approach of Advanced Trauma Life Support.[19] Delays in access to LSI have been associated with increased mortality.[1]

Quantifying the impact of a single LSI in the pre-hospital setting is difficult, especially in patients with multiple injuries and deranged physiology. Globally, we know that variations in pre-hospital care systems exist.[17] Additionally, we know that variation in pre-hospital clinical practice is associated with increased morbidity and mortality.[20–24] However, the extent of variation has not been previously explored in Australia and Aotearoa/New Zealand.

In this paper, we will describe and compare the trauma triage process, pre-hospital LSI and trauma destination protocols used by EMS in Australia and Aotearoa/New Zealand. By comparing guidelines across the region, we aim to identify variations in practice, and potential avenues for improvement. Identification of potential variations in practice will assist with bi-national consensus and adaptation of evidence-based guidelines.

Methods

Setting

Australia is a nation of approximately 25 million people residing in eight states or territories, spread over 7.6 million km^2.[25] In 2020/2021, approximately 9400 patients were severely injured, and transported by one of the eight state based ambulance services to one of 28 major trauma hospitals.[18]

Aotearoa/New Zealand is approximately 2000 km from the east coast of Australia and has a population of approximately 5.1 million people residing in 16 regions. Approximately 1500 patients in Aotearoa/New Zealand were severely injured in 2020/2021,[18] and transported by one of two ambulance services, to one of seven advanced trauma hospitals (level 1 trauma centre equivalent) or one of the 12 mid-level trauma hospitals. Not all major trauma patients are transported to major trauma services and a significant proportion die at scene.

St John Ambulance Western Australia was responsible for the largest geographic area (2 526 417 km^2), and Ambulance Service New South Wales covered the largest population (8 167 532)[26] (see Table 1).

All paramedics are registered in Australia by the Australian Health Practitioner Regulation Agency and in Aotearoa/New Zealand by Te Kaunihera Manapou Paramedic Council. All EMS organisations used a core of ALS paramedics, as well as specialised clinical staff, such as intensive care paramedics (ICP), critical care paramedics (CCP) and pre-hospital physicians.

A guideline evaluation process, as outlined by Graham and Harrison[27] was adapted as a framework for the present study.

Search strategy

The capture of adult clinical practice guidelines from every EMS in Australia and Aotearoa/New Zealand was sought in November 2022. Only EMS organisations responsible for responding to emergency calls (000 in Australia, 111 in Aotearoa/New Zealand) were included. All guidelines were sourced from official, freely available EMS organisation websites and applications.

Data extraction

Authors identified all guidelines relevant to the care of trauma patients, applicable to all levels of clinical practice (see Table 2). A document analysis was undertaken by two authors (TA and BM), with themes identified and tabulated for comparison. Data from key guidelines were extracted to compare triage guidelines, availability of lifesaving interventions, level of clinical practice and trauma patient destination. Lifesaving interventions were graded into fundamental or advanced (see Table 3). Interventions were defined as 'fundamental' based on the Pre-hospital Trauma Life Support guidelines,[28] while advanced interventions were more skilled and required a higher degree of clinical training.

Gaps in completeness were identified, and communication with EMS organisation representatives were

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 1. *Geography*

Region	Geography (total/capital)	Population density (persons/km^2) (total/capital)	HEMS locations	MTS location/ number	Bypass time frame
VIC: Ambulance Victoria (AV)	2 27 444 km^2; 9992 km^2	29/km^2; 503/km^2	Metropolitan: Essendon x 2; regional: Traralgon, Warrnambool, Bendigo	Metropolitan – Prahran, Royal Park, 3 MTS	60 min
NSW: Ambulance Service NSW (ASNSW)	801 150 km^2; 12 368 km^2	10/km^2; 428/km^2	Metropolitan: Bankstown, Westmead; regional: Orange, Wollongong, Belmont (Newcastle), Lismore, Tamworth (+Canberra)	Metropolitan: Westmead, Liverpool, North Shore, Sydney CBD, Kogarah; regional: Newcastle; 10 MTS	60 min metropolitan areas, 90 min regional
QLD: Queensland Ambulance Service (QAS)	1 729 742 km^2; 15 826 km^2	3/km^2; 166/km^2	Metropolitan: Brisbane, Sunshine Coast; regional: Bundaberg, Mount Isa, Roma, Toowoomba	Metropolitan: Brisbane, Gold Coast, Sunshine Coast; regional: Townsville; 6 MTS	60 min
ACT: ACT Ambulance Service (ACTAS)	2358 km^2; 814.2 km^2	197/km^2; 561/km^2	Canberra† (NSW locations)	Canberra; 1 MTS	NA
NT: St John NT	1 347 791 km^2; 3164 km^2	0.18/km^2; 47/km^2	Darwin	Darwin; 1 MTS	NA
WA: St John WA	2 527 013 km^2; 6418 km^2	1.1/km^2; 346.5/ km^2	Metropolitan: Perth; regional: Bunbury	Perth; 2 MTS	NA
SA: South Australian Ambulance Service (SAAS)	984 321 km^2; 3260 km^2	1.84/km^2; 45/km^2	Adelaide	Adelaide; 3 MTS	45 min
TAS: Tasmanian Ambulance Service (TAS)	68 401 km^2; 1357 km^2	8.3/km^2; 186/km^2	Hobart	Hobart; 1 MTS	60 min
Aotearoa/New Zealand: St John New Zealand	268 021 km^2; 607 km^2 (Auckland)	19/km^2; 2400/ km^2 (Auckland)	Metropolitan: Christchurch, Hamilton; regional: Whangarei, Ardmore, Tauranga, Taupo, New Plymouth, Palmerston North, Gisborne, Nelson, Greymouth, Dunedin, Queenstown, Te Anau	Auckland, Hamilton, Christchurch, Dunedin; 6 MTS	Staging guidelines†
Wellington: Wellington Free Ambulance	8140 km^2 (approximately)	24/km^2	Wellington	Wellington; 1 MTS	NA

†Staging guidelines refer to temporary arrival at secondary emergency departments while awaiting definitive transport to a trauma service. CBD, Central Business District; HEMS, Helicopter EMS; MTS, Major Trauma Service.

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 2. *Data extraction criteria*

	Inclusion	Exclusion
Population	Adult	Paediatric
Interventions	Chest decompression, haemorrhage and shock, airway management	Non-lifesaving interventions (analgesia, general patient care, physician only clinical interventions)
Guidelines	EMS paramedic, intensive care paramedic, critical care paramedic	Non-jurisdictional ambulance service guidelines, volunteer first responder guidelines, physician guidelines

undertaken by TA, BM and PC to ensure accuracy and completeness of all service guidelines.

Results

Trauma guidelines from 10 EMS providers in Australia and Aotearoa/New Zealand were reviewed, collated and summarised (see Table 1). In Aotearoa/New Zealand, St John New Zealand provide ambulance services to all areas excluding greater Wellington (8140 km^2), which is serviced by Wellington Free Ambulance. In Australia, state ambulance services are responsible for providing services for each state or territory (see Table 1).

Identification of major trauma

Variability in the identification and triage of major trauma patients by EMS was evident in the present study (see Table 4). The most common approach to trauma triage included a three-step assessment process (physiology, injury and mechanism); however, not all EMS included all three elements in their approach. Differences were identified in the specific physiological values between all services, with no common agreement on normal limits for heart rate, BP or respiratory rate. Similarly, variation in the anatomical injury criteria were identified. While common themes were present (head, neck, thoracic, etc.), there was no common language or injury descriptions used. Lastly, mechanism of injury criteria varied between all services, with one service including mechanism of injury criteria in their guideline. Common over-arching themes were present, like 'high energy trauma' mechanisms; however, multiple variations were present in regard to exact mechanism, or speed of impact. Only two guidelines, from Ambulance Victoria and Ambulance Tasmania included special risk populations (e.g. age > 55, pregnancy), which direct paramedics to comparatively over-triage these higher risk populations to a major trauma centre.

TABLE 3. *Lifesaving intervention*

Region	Fundamental	Advanced
VIC	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA(p), PRBC, US
NSW	NT, NaCl, Binder, Torniquet, SGA	FT‡, PHEA(p)‡, PRBC‡, US‡
QLD	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA(p), PRBC, ELP, Fibrinogen. US
ACT	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA
NT	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA, PRBC, US
WA	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA, PRBC, US
SA	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA, PRBC, US
TAS	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA(p), PRBC, US
Aotearoa/New Zealand	NT, NaCl, Binder, Torniquet, SGA	FT, PHEA, PRBC†

†Location dependant. ‡Physician lifesaving intervention. ELP, extended life plasma; FT, finger thoracostomy; NT, needle thoracostomy; PHEA, pre-hospital emergency anaesthesia (age > 11); PHEA(p), PHEA for paediatric patients; PRBC, packed red blood cells; SGA, supra glottic airway; US, ultrasound/eFAST.

Pre-hospital lifesaving interventions

All EMS organisations had fundamental LSI included in their trauma guidelines (see Table 3). Guidelines included use of haemorrhage control devices (arterial tourniquets, pelvic binders, haemostatic dressings, etc.), airway and breathing interventions (supraglottic airway, face mask ventilation) and pleural decompression (needle thoracostomy). Several EMS included escalation of care in the trauma guidelines, using more advanced lifesaving interventions (finger thoracostomy, blood products and pre-hospital emergency anaesthesia). A greater level of variation in the guidelines was evident with advanced LSI. In most services, advanced LSI were delivered by the Helicopter EMS (HEMS) based resources, with *ad hoc* processes for these resources to be used in urban settings.

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

TABLE 4. *Trauma criteria*

Region	Physiological criteria	Injury criteria	Mechanism criteria
VIC	HR <60/>120, BP <90, SPO_2 <90, RR <10/>30 GCS <13 (or <15 for paeds)	Penetrating (all), blunt (significant), amputation/limb threat, SCI, burns >20% or airway, high voltage burns, crush, major compound #/disloc, ≥2 major #, pelvic #	(Motor)cyclist >30 kph, MVC >60, vehicle *versus* ped, ejection, prolonged extraction, fall >3 m, struck on head >3 m, explosion and age <12/>55, pregnant, significant medical conditions
NSW	HR >120, SBP <100, RR <10/>29, SPO_2 <90%, GCS ≤13	Penetrating (all). Regionalised injuries to head/neck/face/chest/abdomen/pelvis/limbs/spinal/burns	Death in same, >30 cm cabin intrusion, steering wheel deformity, pt side impact, (motor)cyclist, vehicle *versus* ped, ejection from vehicle, entrapment and compression, ag machinery/quad bike, *versus* livestock, crush, falls >3 m, fall ladder >1 m, high voltage injury, rapid deceleration, focal blunt trauma, hanging.
QLD	HR >120, SBP <90 RR <10/>30, SpO_2 <95% GCS = ALOC	Penetrating/blast injuries/≥2 of (head/neck/chest/abdomen/pelvis/axilla/groin), amputation, SCI, burns >20% or complicated (face/airway), crush, major open #/disloc, pelvic #, ≥2 # long bone	Ejected, fall >3 m, explosion, high impact MVC with intrusion, rollover, MVC with fatality in same, entrapment >30 min
ACT	HR <40/>120, SBP <90 GCS <13 and RR <5/>36	Penetrating (head/neck/torso/axilla/groin), amputation, limb ischemia, pelvic #, crush, paralysis, significant injury to one region, or lesser injury to multiple, burns >10%/complicated area	MVC >60 kph and intrusion, rollover, eject, death/sig inj in same, entrapment >20, ped >30 kph, (motor)cyclist >30 kph, fall > pt height, struck >5 m, explosion
NT	GCS <13, Primary survey problem, 'Trauma Call' criteria.	Burns >5%	NA
WA	No	Flail, pelvic #, amputation/crush, ≥2 long bone #, SCI, polytrauma, open/dep skull #, degloving/'mangled'	MBA >30/MVC >60 with injuries, ejection, pen inj to head/neck/torso/extremities, fall >3 m, fatal in same vehicle, ped/cyclist >25 kph
SA	HR <50/>120, SBP ≤100, RR <10 or >30, GCS ≤13	Flail chest or subcutaneous emphysema, ongoing uncontrolled significant haemorrhage, penetrating injury to head, neck or torso, major pelvic #, SCI with neurological signs, femur fracture + one other long bone #, amputation or severe crush proximal to wrist or ankle, burns >20%, high voltage electrical injury (>1000 V)	Ejection from vehicle or death of occupant, pedestrian struck ≥30 kph, cyclist (motor or pedal) struck/fall ≥30 kph, extrication >30 min, fall ≥3 m, pregnant and gestation >20 weeks, fall/kicked by horse, hanging/asphyxiation, drowning, GSW
TAS	HR <50/>150, BP <90, RR <12/>24, SpO_2 < 90%, GCS <13	Penetrating (head/neck/chest/abdomen/pelvis/axilla/groin), blunt injuries (significant single/two or more), amputations/limb threat, SCI, burns >20%, crush, major compound #/disloc, # ≥2, pelvic #	(Motor)cyclist >30 kph, MVC >60, vehicle *versus* ped, ejection, prolonged extraction, fall >3 m, struck on head >3 m, explosion and age <12/>55, pregnant, significant medical conditions.

(*Continues*)

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

TABLE 4. *Continued*

Region	Physiological criteria	Injury criteria	Mechanism criteria
StJNZ and Wellington	Includes 'shock', brain injury, motor score <5 and respiratory distress, but no specific parameters	(i) TBI, neurotrauma (ii) Multisystem trauma (iii) Airway obstruction, burns (+/−airway), respiratory distress, shock, GCS m = <5, pen neck/torso, flail, sig facial inj, pelvic #, >1 long bone #, limb inj (amputation/bleed/tissue disruption) (iv) SCI (v) Burns >10%/5%	Consider transport if mechanism is significant – includes ejection from vehicle and fall greater than twice patients' height

#, fracture; GSW, GunShot Wound; MBA, MotorBike Accident; MVC, Motor Vehicle Collision; Ped, Pedestrian; Pt, patient; sig inj, significant injury.

Training

There was no consensus on the clinical training level required to undertake LSI between EMS organisations. In some guidelines, access to advanced LSI was only available from physicians, while other organisations included advanced LSI in the guidelines for ICP or CCP.

Transport to definitive care

Once patients were identified as major trauma, all EMS guidelines prioritised timely transport to a major trauma service, which may result in bypassing closer emergency departments. Bypass within 60 min was a common time frame; however, three guidelines did not specify a bypass time frame. New South Wales (NSW) was the only service to have a different time frame for regional patients (90 min). NSW and Aotearoa/New Zealand both included staging guidelines, a formalised approach to staging at a closer non-trauma hospital while awaiting transport to definitive care. All EMS included the use of at least one aeromedical (HEMS) platform (see Table 1).

Discussion

The present study has shown that the guidelines used by EMS in Australia and Aotearoa/New Zealand to identify and treat major trauma showed considerable variability. Despite the use of consensus guidelines internationally, there was little standardisation of triage guidelines, or LSI. Variations in guidelines, albeit minor, make comparisons and evaluations more challenging, and there has been little literature published to identify which guideline is the most accurate.

Several commonalities were identified in all EMS trauma guidelines in Australia and Aotearoa/New Zealand, including a common structure to trauma triage guidelines (physiology, injury and mechanism) and inclusion of common fundamental LSI in trauma guidelines. There was, however, no universal guideline used by all services in the region, no standardisation or definition of trauma triage criteria and discrepancy in the inclusion of advanced LSI in all EMS guidelines.

Nationalised trauma pre-hospital guidelines have been adopted in a number of regions internationally, including throughout the UK (Joint Royal Colleges Ambulance Liaison Committee),[13] the USA (FTDS)[15] and France[10] (Vittel). These national criteria ensure a common approach to the identification of major trauma. This common approach to the identification of trauma patients allows for benchmarking between jurisdictions and the optimisation of management processes across the region.[9,15,29] While international populations will vary in their demographics, underlying health factors and geography, these factors can be incorporated into regionalised guidelines.

The variations in triage guidelines identified in this paper, although minor in some cases, limit the capacity to benchmark and compare trauma systems. Numerous published articles, including systematic reviews, have examined the validity and accuracy of pre-hospital trauma triage criteria.[9,12] However, the variations and decentralised approach to pre-hospital trauma triage, and interventions, makes comparison difficult. The challenges in understanding the sensitivity (under-triage) and specificity (over-triage) of all EMS is compounded by the differences between guidelines.

Optimising trauma triage guidelines is an important aspect of a robust and evidence-driven trauma system. Reducing under-triage of major trauma patients is one of the primary goals of trauma triage guidelines.[30] The under-triage of major trauma patients often discriminates against specific populations, such as older patients[14,31] and children,[32] and can lead to a delay in definitive care. Previous literature by Dinh *et al.*[31] and Cox *et al.*[14] have both examined the under-triage of older trauma, with low level falls the predominate mechanism for these patients. However,

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

no guideline examined in this paper included low level falls for older patients, and only two guidelines (Vic & Tas) included modifications for patients >55 years. Conversely, over-triage of patients can lead to increased costs and burden on the healthcare system, as inappropriate patients are transported to trauma centres without need or benefit.[11] Dinh *et al*.[31] reported an over-triage rate of 77% in NSW while Cox *et al*.[33] reported an over triage rate of 37%; however, with the acknowledged differences in triage criteria between services, the extrapolation of these findings to other services is difficult.

Triaging of patients to the correct destination has been shown to improve patient outcomes after major trauma.[3,4,34,35] Once trauma patients are identified, through validated and robust trauma triage guidelines, a trauma system which ensures access to LSI and definitive care in the shortest time possible is essential. The integration of aeromedical services can assist in reducing the time to definitive care. Additionally, access to LSI in the pre-hospital setting is an important component of this process. The aeromedical platforms explored in the present study all provided a higher level of clinical intervention. Centralising specialist LSI to aeromedical clinicians can accommodate the specialist credentialling that may be required due to the reduced number of clinicians who staff these resources, compared to road-based paramedics. The greater specialisation of aeromedical clinicians may also allow for greater proficiency due to increased clinical exposure; however, this model may be replicated in urban centres, where aeromedical services are seldom accessible.

There has been no analysis of all available LSI to understand what value these interventions have in the pre-hospital setting in this region. Without common definitions of trauma patients, a comparison of these interventions is difficult. While there was common access to fundamental LSI, there remained an *ad hoc* approach to more advanced interventions. The capacity to investigate and examine which specialist LSI improve patient outcomes is an important step for specialist trauma systems, and a common, bi-national approach to these interventions would increase the capacity for potentially improving patient outcomes. Having a common approach to available LSI, both fundamental and advanced, is key for evaluating their impact on patient outcomes.

Similarly, while the education requirements of ALS paramedics in Australia and Aotearoa/New Zealand have been clearly defined,[36,37] education requirements for advanced clinical scope of practice (ICP/CCP) varies between services. The cost/benefit analysis of training and maintaining high clinical standards of advanced LSI has not been comprehensively assessed. While some studies have examined the cost effectiveness of aeromedical services[38] or introduction of clinical interventions,[39] broader evaluations of all interventions, and pre-hospital systems of care has not been possible. An evidence-based, consensus approach to pre-hospital lifesaving interventions, and the standards for education and training should be an essential component of a specialist trauma system in Australia and Aotearoa/New Zealand.

Differences in geography and patient access will mean that variation in trauma guidelines are inevitable. How long it takes to access and transport a patient in outback Western Australia will be vastly different to inner city Wellington. While operational decisions will vary depending on the location of the patient, the identification and triage of these patients should remain the same. Standardisation of trauma patient care should be the goal, to ensure robust evidence-based practice, and continual evaluation of these pre-hospital trauma systems to ensure the best possible patient outcomes. The differing triage criteria makes comparing trauma outcomes between jurisdictions challenging. Currently there is no evidence to compare the efficacy of individual EMS guidelines, or pre-hospital systems of care more broadly, in comparison to other systems.

The present study only examined publicly available and published clinical guidelines from services in Australia and Aotearoa/New Zealand. While we corroborated the accuracy and completeness of the information examined through regional EMS representatives, there may be unidentified considerations that were not examined.

Future recommendations

The future endeavours of a centralised and validated approach to pre-hospital trauma care, both in the triage and identification, and the understanding of what interventions improve patient outcomes, is an important next step for Australia and Aotearoa/New Zealand.

To achieve this, there would need to be the development and endorsement of a common triage criteria, which would define potential major trauma patients in the pre-hospital setting. The promotion of a trauma system, which includes both urban and regional trauma patients, ensures equality in access to care and accounts for the variation in population density across this region would be an important inclusion. Similarly, the setting of minimal standards for access to lifesaving interventions in the pre-hospital setting would ensure equality of access for all patients in the region. Finally, a collaborative approach to trauma quality improvement projects, and better integration of pre-hospital systems with trauma registries would allow for meaningful evaluation and a better understanding of meaningful interventions in the pre-hospital setting.

Conclusion

The lack of consensus in trauma triage identified in the present study makes benchmarking and comparison of trauma systems difficult. The goal of researching and delivering evidence-based trauma care in the pre-hospital setting is limited by the lack of consensus on trauma triage, transport and the variability in the application of subsequent clinical interventions.

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

Competing interests

PC is a section editor of EMA and a co-author of this article. To minimise bias, they were excluded from all editorial decision-making related to the acceptance of this article for publication.

Acknowledgement

Open access publishing facilitated by Monash University, as part of the Wiley - Monash University agreement via the Council of Australian University Librarians.

Data availability statement

The data that support the findings of this study are available from each jurisdictional ambulance service websites. These data were derived from the official online resources, published by each individual ambulance service.

References

1. Mitra B, Bade-Boon J, Fitzgerald MC, Beck B, Cameron PA. Timely completion of multiple life-saving interventions for traumatic haemorrhagic shock: a retrospective cohort study. *Burns Trauma* 2019; **7**: 22.
2. Celso B, Tepas J, Langland-Orban B *et al*. A systematic review and meta-analysis comparing outcome of severely injured patients treated in trauma centers following the establishment of trauma systems. *J. Trauma Acute Care Surg*. 2006; **60**: 371–8.
3. Cameron PA, Gabbe BJ, Smith K, Mitra B. Triaging the right patient to the right place in the shortest time. *Br. J. Anaesth*. 2014; **113**: 226–33.
4. Cameron PA, Gabbe BJ, Cooper DJ, Walker T, Judson R, McNeil J. A statewide system of trauma care in Victoria: effect on patient survival. *Med. J. Aust*. 2008; **189**: 546–50.
5. Gabbe BJ, Biostat GD, Simpson PM *et al*. Improved functional outcomes for major trauma patients in a regionalized, inclusive trauma system. *Ann. Surg*. 2012; **255**: 1009–15.
6. Moran CG, Lecky F, Bouamra O *et al*. Changing the system – major trauma patients and their outcomes in the NHS (England) 2008–17. *eClinicalMedicine* 2018; **2**: 13–21.
7. Royal Australaian College of Surgeons New Zealand Trauma Committee. *Guidelines for a Structured Approach to the Provision of Optimal Trauma Care*. Aotearoa/New Zealand: Royal Australasian College of Surgeons, 2012.
8. American College of Surgeons and the Committee on Trauma. *Resources for Optimal Care of the Injured Patient*. Chicago, IL: American College of Surgeons, 2014.
9. van Rein EAJ, Houwert RM, Gunning AC, Lichtveld RA, Leenen LPH, van Heijl M. Accuracy of prehospital triage protocols in selecting severely injured patients: a systematic review. *J. Trauma Acute Care Surg*. 2017; **83**: 328–39.
10. Cassignol A, Marmin J, Cotte J *et al*. Correlation between field triage criteria and the injury severity score of trauma patients in a French inclusive regional trauma system. *Scand. J. Trauma Resusc. Emerg. Med*. 2019; **27**: 71.
11. van Laarhoven JJEM, Lansink KWW, van Heijl M, Lichtveld RA, Leenen LPH. Accuracy of the field triage protocol in selecting severely injured patients after high energy trauma. *Injury* 2014; **45**: 869–73.
12. Gianola S, Castellini G, Biffi A *et al*. Accuracy of pre-hospital triage tools for major trauma: a systematic review with meta-analysis and net clinical benefit. *World J. Emerg. Surg*. 2021; **16**: 31.
13. Lockey D, Deakin CD. Pre-hospital trauma care: systems and delivery. *Contin. Educ. Anaesth. Crit. Care Pain* 2005; **5**: 191–4.
14. Cox S, Morrison C, Cameron P, Smith K. Advancing age and trauma: triage destination compliance and mortality in Victoria, Australia. *Int. J. Care Injured* 2014; **45**: 1312–9.
15. Newgard CD, Zive D, Holmes JF *et al*. A multisite assessment of the American College of Surgeons Committee on Trauma field triage decision scheme for identifying seriously injured children and adults. *J. Am. Coll. Surg*. 2011; **213**: 709–21.
16. Lupton JR, Davis-O'Reilly C, Jungbauer RM *et al*. Under-triage and over-triage using the field triage guidelines for injured patients: a systematic review. *Prehosp. Emerg. Care* 2023; **27**: 38–45.
17. David JS, Bouzat P, Raux M. Evolution and organisation of trauma systems. *Anaesth. Crit. Care Pain Med*. 2019; **38**: 161–7.
18. Australian Trauma Quality Improvement (AusTQIP) Collaboration. *Australia New Zealand Trauma Registry. Management of the Severely Injured. Annual Report, 1 July 2020 to 30 June 2021*. Melbourne: Alfred Health, 2021.
19. The ATLS Subcommittee; American College of Surgeons' Committee on Trauma; International ATLS Working Group. Advanced trauma life support (ATLS®): the ninth edition. *J. Trauma Acute Care Surg*. 2013; **74**: 1363–6.
20. Sharrock MK, Shannon B, Garcia Gonzalez C *et al*. Prehospital paramedic pleural decompression: a systematic review. *Injury* 2021; **52**: 2778–86.
21. Crombie N, Doughty HA, Bishop JRB *et al*. Resuscitation with blood products in patients with trauma-related haemorrhagic shock receiving prehospital care (RePHILL): a multicentre, open-label, randomised, controlled, phase 3 trial. *Lancet Haematol*. 2022; **9**: e250–61.
22. Brun P-M, Bessereau J, Chenaitia H *et al*. Stay and play eFAST or scoop and run eFAST? That is the question! *Am. J. Emerg. Med*. 2014; **32**: 166–70.
23. Berger-Groch J, Rueger JM, Czorlich P, Frosch KH, Lefering R, Hoffmann M. Evaluation of pelvic circular compression devices in severely injured trauma patients with pelvic fractures. *Prehosp. Emerg. Care* 2022; **26**: 547–55.
24. Mitra B, Mazur S, Cameron PA *et al*. Tranexamic acid for trauma: filling the 'GAP' in evidence. *Emerg. Med. Australas*. 2014; **26**: 194–7.

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License

25. Australian Bureau of Statistics. *Snapshot of Australia*, 2022. [Cited 17 Oct 2022.] Available from URL: https://www.abs.gov.au
26. Beck B, Bray JE, Smith K *et al*. Description of the ambulance services participating in the Aus-ROC Australian and New Zealand out-of-hospital cardiac arrest Epistry. *Emerg. Med. Australas.* 2016; **28**: 673–83.
27. Graham ID, Harrison MB. Evaluation and adaptation of clinical practice guidelines. *Evid. Based Nurs.* 2005; **8**: 68.
28. Johansson J, Blomberg H, Svennblad B *et al*. Prehospital trauma life support (PHTLS) training of ambulance caregivers and impact on survival of trauma victims. *Resuscitation* 2012; **83**: 1259–64.
29. van Rein EAJ, van der Sluijs R, Houwert RM *et al*. Effectiveness of prehospital trauma triage systems in selecting severely injured patients: is comparative analysis possible? *Am. J. Emerg. Med.* 2018; **36**: 1060–9.
30. van Rein EAJ, van der Sluijs R, Raaijmaakers AMR, Leenen LPH, van Heijl M. Compliance to prehospital trauma triage protocols worldwide: a systematic review. *Injury* 2018; **49**: 1373–80.
31. Dinh MM, Oliver M, Bein KJ, Roncal S, Byrne CM. Performance of the New South Wales Ambulance Service major trauma transport protocol (T1) at an inner city trauma centre. *Emerg. Med. Australas.* 2012; **24**: 401–7.
32. Phillips S, Rond PC III, Kelly SM, Swartz PD. The need for pediatric-specific triage criteria: results from the Florida trauma triage study. *Pediatr. Emerg. Care* 1996; **12**: 394–399.
33. Cox S, Currell A, Harriss L, Barger B, Cameron P, Smith K. Evaluation of the Victorian state adult pre-hospital trauma triage criteria. *Injury* 2012; **43**: 573–81.
34. MacKenzie EJ, Rivara FP, Jurkovich GJ *et al*. A national evaluation of the effect of trauma-center care on mortality. *N. Engl. J. Med.* 2006; **354**: 366–78.
35. Cudnik MT, Newgard CD, Sayre MR, Steinberg SM. Level I versus level II trauma centers: an outcomes-based assessment. *J. Trauma Acute Care Surg.* 2009; **66**: 1321–6.
36. Paramedicine Board of Australia. *Qualifications for Registration: AHPRA*, 2022. [Cited 12 Aug 2023.] Available from URL: https://www.paramedicineboard.gov.au/Qualifications.aspx
37. Council KMNP. *Pathways to Registration*. [Cited 21 Oct 2022.] Available from URL: https://paramediccouncil.org.nz/Public/_Web/Public/How-to-Register/How-to-Register.aspx
38. Taylor CB, Stevenson M, Jan S, Middleton PM, Fitzharris M, Myburgh JA. A systematic review of the costs and benefits of helicopter emergency medical services. *Injury* 2010; **41**: 10–20.
39. Arreola-Risa C, Mock C, Herrera-Escamilla AJ, Contreras I, Vargas J. Cost-effectiveness and benefit of alternatives to improve training for prehospital trauma care in Mexico. *Prehosp. Disaster Med.* 2004; **19**: 318–25.

© 2024 The Authors. *Emergency Medicine Australasia* published by John Wiley & Sons Australia, Ltd on behalf of Australasian College for Emergency Medicine.

17426723, 2024, 2, Downloaded from https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.14373 by Ben Gurion University, Wiley Online Library on [25/03/2024]. See the Terms and Conditions (https://onlinelibrary.wiley.com/terms-and-conditions) on Wiley Online Library for rules of use; OA articles are governed by the applicable Creative Commons License