



## Advancing age and trauma: Triage destination compliance and mortality in Victoria, Australia



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### ABSTRACT

**Objective:** To describe the association between increasing age, pre-hospital triage destination compliance, and patient outcomes for adult trauma patients.

**Methods:** A retrospective data review was conducted of adult trauma patients attended by Ambulance Victoria (AV) between 2007 and 2011. AV pre-hospital data was matched to Victorian State Trauma Registry (VSTR) hospital data. Inclusion criteria were adult patients sustaining a traumatic mechanism of injury. Patients sustaining secondary traumatic injuries from non-traumatic causes were excluded. The primary outcomes were destination compliance and in-hospital mortality. These outcomes were evaluated using multivariable logistic regression.

**Results:** There were 326,035 adult trauma patients from 2007 to 2011, and 18.7% met the AV pre-hospital trauma triage criteria. The VSTR classified 7461 patients as confirmed major trauma (40.9% > 55 years). Whilst the trauma triage criteria have high sensitivity (95.8%) and a low under-triage rate (4.2%), the adjusted odds of destination compliance for older trauma patients were between 23.7% and 41.4% lower compared to younger patients. The odds of death increased 8% for each year above age 55 years (OR: 1.08; 95% CI: 1.07, 1.09).

**Conclusions:** Despite effective pre-hospital trauma triage criteria, older trauma patients are less likely to be transported to a major trauma service and have poorer outcomes than younger adult trauma patients. It is likely that the benefit of access to definitive trauma care may vary across age groups according to trauma cause, patient history, comorbidities and expected patient outcome. Further research is required to explore how the Victorian trauma system can be optimised to meet the needs of a rapidly ageing population.

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### Introduction

Consistent with other developed countries, the population in Australia is ageing rapidly [1]. The Australian Bureau of Statistics (ABS) has predicted that by the year 2056, 25% of the Victorian population will be aged  $\geq 65$  years [2]. With an increased proportion of older people in the community, comes an increase in the number of older trauma patients attended by emergency medical services and triaged to hospital emergency departments [3]. It is unclear whether current clinical management protocols

are optimal for the care of this patient group [3]. Understanding the relationship between age and trauma is critical to improving the management and outcomes of older trauma patients [4].

Trauma triage is predicated on the idea of 'getting the right patient to the right hospital as quickly as possible' [5,6]. It is widely accepted that morbidity and mortality can be reduced by effective triage of trauma patients to specialised trauma hospitals [7–9]. There is evidence to suggest that the adjusted risk of death is 25% lower when care is provided at a specialised trauma service [10].

Compared to younger patients, older trauma patients are known to have poorer outcomes and require far less forceful mechanisms to produce serious injuries [11–14]. Age related physiological changes, together with pre-existing medical conditions and medications (e.g. anticoagulants, antiplatelets) can further complicate traumatic injuries and result in worse

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outcomes for older patients [15,16]. With advancing age, outcomes for trauma patients have been shown to deteriorate, with each one year increase in age resulting in an increase in mortality of 6% [11,17].

Despite the known benefits of definitive trauma care, studies have shown that older trauma patients are less likely to be triaged to specialised trauma services [18–26]. Proposed reasons for hospital destination non-compliance for older trauma patients include age-inappropriate pre-hospital trauma triage criteria [19,20,23,27,28], proximity to specialised trauma services [24], patient/family destination preference [29], paramedic discretionary decision making [30] and patient acuity [23]. While numerous international studies have investigated factors associated with the triage of older trauma patients, the drivers of triage destination compliance have not been investigated in the Australian pre-hospital environment.

With an ageing population it is important to have in place a trauma system that is optimised to care for the needs of older trauma patients. Identifying potential factors that may contribute to poor outcomes for older patients is a critical first step in determining how the trauma system may be optimised to meet the demands of a rapidly ageing Victorian population. This descriptive study aims to:

1. Determine the clinical utility of the Victorian State adult pre-hospital trauma triage criteria overall, and for older and younger trauma patients.
2. Determine whether the clinical utility of the pre-hospital trauma triage criteria matches actual system performance with respect to trauma triage destination compliance.
3. Investigate whether destination non-compliance leads to poorer outcomes for older trauma patients.

## Methods

### Study design

A retrospective review of data of all adult trauma patients attended by AV during a five-year time period (2007–2011) was conducted.

### Study setting and selection of participants

The study was conducted in Victoria, a state of Australia that covers 227,590 km<sup>2</sup> [31]. During the study period Victoria had a population of approximately 5.4 million people, 4 million of whom lived in metropolitan Melbourne [32].

Established in 2000, the Victorian State Trauma System (VSTS) coordinates all pre-hospital paramedic and acute medical services across the state of Victoria. The VSTS works to reduce mortality and morbidity by matching severely injured patients with an appropriate level of care in a timely manner [5]. Victoria follows a two-tiered emergency response model, which has been described previously [5,6,33]. There are two adult hospitals and one paediatric hospital designated as major trauma services (MTSs), which are the equivalent of international 'level-1 trauma centres' [5]. Several metropolitan and regional hospitals have lower levels of designation. These hospitals are hierarchical and provide lower levels of trauma care delivery prior to patient transfers to MTSs [5,6,34]. Within the VSTS patients can also be transferred from first receiving hospital to one of three specialised metropolitan neurological or spinal hospitals designated to treat isolated head or spinal injuries. This is an inter-hospital transfer protocol, which is not currently indicated in the pre-hospital trauma triage criteria.

The Victorian state adult pre-hospital trauma triage criteria [35] have been described previously [6]. The current triage criteria consist of physiological, anatomical, mechanistic and logistic elements [35]. When a trauma patient meets one or more of these criteria, and ambulance transport time is less than 30 min, the patient should be transported to a MTS, or next highest level of care within 30 min [6,33]. Based on geographic location, the majority of trauma scenes within metropolitan Melbourne are considered to be within 30 min of the MTSs. This does not take into account possible confounders like traffic congestion, road works, time of day or day of week. No regional scene locations are considered to be within 30 min of the MTSs by road, however the same triage criteria apply to rural cases, and air transport can be arranged for more severe trauma cases.

Patients aged  $\geq 16$  years who experienced a traumatic mechanism between January 1st 2007 and December 31st 2011 were included in this study. Data were extracted for blunt, penetrating and burns related trauma. Injured patients were only excluded if injuries were secondary to a non-traumatic cause. Patients who meet one or more of in-hospital death, ISS > 12, ICU admission with mechanical ventilation > 24 h or urgent surgery are defined as 'confirmed major trauma' by the VSTR [36].

### Methods of measurement, outcome variables and covariates

Pre-hospital data were captured via VACIS, an in-field electronic data capture application that is linked to the AV data warehouse. Hospital trauma data were sourced electronically from the VSTR.<sup>1</sup> Pre-hospital and hospital data were matched via probabilistic linkage using LinkageWiz Software (LinkageWiz Inc, Adelaide, SA). Record linkage was manually reviewed to ensure a 100% match rate.

'Destination compliance' is defined as access to the highest level trauma service within 30 min transport time, for patients who meet the pre-hospital trauma triage criteria. 'Mortality' is defined as 'in-hospital death'. Covariates included age, gender, trauma cause, injury severity, paramedic type, vital signs, mechanism of injury, pain score  $\geq 3$ , significant comorbidity, inter-hospital transfer, air ambulance transport, transport time, injury count, paramedic judgement of major trauma and scene location region.

### Statistical analyses

Analyses were performed using SPSS Version 20.0 (SPSS Inc, Chicago, IL). Statistical significance was set at  $p < 0.05$ . Summary statistics were used to describe the characteristics of trauma patients. Chi square tests for categorical variables were performed to compare proportions across older and younger patient groups. Categorical data is summarised as counts and percentages.

Sensitivity ( $a/(a+c)$ ), specificity ( $d/(b+d)$ ), accuracy ( $(a+d)/(a+b+c+d)$ ),<sup>2</sup> under-triage ( $1 - \text{sensitivity}$ ) and over-triage ( $1 - \text{specificity}$ ) were calculated for the current Victorian adult pre-hospital trauma triage criteria.<sup>3</sup> Over and under-triage values were based on the number of trauma patients identified by trauma triage criteria, not on triage destination.

Logistic regression analyses were performed to determine univariate associations and to construct two multivariable

<sup>1</sup> Rural data for road transported confirmed major trauma patients were not available at the time of the study.

<sup>2</sup>  $a$  = true positive;  $b$  = false positive;  $c$  = false negative;  $d$  = true negative.

<sup>3</sup> Patients with insufficient information for classification according to the pre-hospital trauma triage criteria were excluded from calculations of diagnostic statistics.

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