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From roadside to hospital: A pilot study to investigate the factors influencing the time taken to deliver trauma patients to a regional hospital

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Abstract

Objectives

One of the trauma system objectives for the ambulance service is to get the right patient to the right hospital in a timely manner. The Review of Trauma and Emergency Services in Victoria, Australia, identified prolonged prehospital scene times of greater than 20 minutes for non trapped patients as a deficiency that may have adverse outcomes for severely injured trauma patients. The objective of this pilot study was to identify the factors that impact on the timely transfer of trauma patients from the scene of an incident to a regional hospital emergency department and justification for the delays, as the basis for a further detailed study.

Methods

A retrospective pilot cohort study of trauma patients transported by ambulance to the emergency department of the Latrobe Regional Hospital over a six-month period who had an emergency department triage category of 1, 2 or 3 was undertaken. Data relating to the prehospital care of trauma patients with scene times > 20 minutes and transport times > 30 minutes were extracted from Rural Ambulance Victoria patient care records and hospital patient records. Ethics approval was granted.

Results

There were 70 trauma patients transported to the hospital during the collection period. Of these 49 patients were available for analysis, 21 cases were excluded due to incomplete time or ED triage details. There were 12 cases where scene times were > 20 minutes. Only one paramedic crew spent an unjustifiably long time at the scene and only one patient had a transport time to hospital > 30 minutes.

Conclusion

This pilot study confirms that there are prolonged prehospital scene times involving paramedics, however, the study suggests that most of the extended times are explained by factors outside the control of the attending paramedics. There was only one case where the

scene time was not justified. One patient had a transport time > 30 minutes which was due to the patient being taken to a higher level of care. Experiences from this pilot study have led to changes in subsequent prehospital trauma studies.

Keywords: *emergency medical services; emergency medical technicians; prehospital emergency care; trauma.*

Introduction

One of the objectives of the trauma system that the ambulance service has the major responsibility for is getting the right patient to the right hospital within as short a time frame as possible.^{1,2} Previous prehospital trauma literature has been criticised for a lack of consensus on the impact of this, and other system components, on patient outcomes.³

The Victorian Taskforce on Trauma and Emergency Services report, Review of Trauma and Emergency Services in Victoria – 1999 (ROTES), has addressed these shortcomings, through its identification of a number of system-wide deficiencies that adversely impact on the outcomes for severely injured patients.⁴ One of these deficiencies is the prolonged time at the scene of accidents of more than 20 minutes for non-trapped patients.⁵ Apart from airway management deficiencies, delay at the scene was identified as the largest prehospital care problem. While this is often attributed to the rural contexts characterised by significant travel distances and scattered medical resources, delays in getting patients to appropriate hospitals for definitive care are also an issue in urban settings. Solutions will vary in different geographical regions.

Factors known to be associated with on scene and transport delays include the degree of isolation from major hospitals, extrication of patients, resourcing of ambulance services, such as the availability of a two person ambulance crew and additional resources for multi patient incidents, and prehospital clinical intervention associated with paramedics using advanced skills. These factors had not been previously investigated in Australia.

The objective of this pilot study was to identify the factors that impact on the timely transfer of trauma patients from the scene of an incident to a regional hospital emergency department and justification for the delays, as the basis for a further detailed study.

Methods

A retrospective pilot cohort study of trauma patients transported by ambulance to the emergency department (ED) of the Latrobe Regional Hospital (LRH) between the 1st of July 2001 and 31st December 2001 who had an emergency department triage category⁶ of 1, 2 or 3. The setting for this study was the catchment area of the LRH. The LRH is a 257 bed hospital and is one of Victoria's regional trauma services and is located in the east of the state some 160km from Melbourne. The definition of a regional trauma service is contained in ROTES.⁴ The hospital is situated between Morwell and Traralgon in the Latrobe Valley and services approximately 240,000 people across the Gippsland region, a rural region of Victoria, Australia.

Hospital and RAV patient data was included if trauma had been sustained through road traffic accidents, workplace incidents, burns, assaults, falls, or sporting injuries, and were transported to LRH by emergency ambulance and assigned an ED triage category of 1, 2 or 3. Patient data was excluded if the patient was transported to LRH as an inter-hospital transfer, or where the Patient Care Record (PCR) had insufficient information about the patient and their trauma incident, or was assigned an ED triage category of 4 or 5.

The investigators reviewed each trauma PCR to establish eligibility as predetermined by the inclusion criteria. The PCRs that met the inclusion criteria had specific data entered into a secure relational database (Microsoft Access™ Version 10 SR2, Redmond, Washington, U.S.A.) Additional patient data was gathered from the hospital patient record and entered into the database.

Additional prehospital data extracted from the PCR included the clinical status of the patient, the number and type of prehospital interventions, problems accessing the patient because of entrapment, e.g. waiting for Road Accident Rescue crew, or paramedic safety, number of crew on the initial ambulance vehicle, and the geographic location of the incident, including distance to hospital and distance of additional resources from the scene. A specifically rural issue is whether ambulances are staffed by Mobile Intensive Care Ambulance (MICA) Paramedics, Ambulance Paramedics or Community Ambulance Officers (first responders). Additional hospital data extracted from the hospital patient record included patient outcome, hospital procedures, and hospital length of stay.

Reasons for delay in reaching the LRH were investigated using ambulance PCRs, and when necessary, subsequent interviews with the attending paramedics, were conducted, on their next rostered day shift, if available. The reasons for delay were categorised according to whether they were clinical, environmental, or system factors. These categories were a modified version of those used by the Victorian Consultative Committee on Road Traffic Fatalities (CCRTF).⁷ The clinical category included the prehospital interventions undertaken and whether they were deemed clinically appropriate. The environmental factors included scene conditions, e.g. motor vehicle down an embankment, time of day, and weather conditions. The system issues included ambulance staffing configurations and mode of transport.

An inter-disciplinary expert panel was formed to review all aspects of the patient's management, including the clinical, environmental, and system issues involved in each case. The expert panel consisted of:

- an emergency medicine physician;
- a general surgeon;
- an intensive care specialist;
- an emergency department nurse;
- a senior ambulance clinician; and
- an Ambulance Service Medical Officer (ASMO).

The same panel determined, through consensus, the clinical justification of delays in the arrival of trauma patients to the ED. Both ambulance and hospital patient records were reviewed to determine the outcome of each patient. Clinical justification of delays were analysed using the Limited Adverse Occurrences Screening (LAOS) methodology, developed at Wimmera Base Hospital by Wolff et al.⁸ This critical incident monitoring methodology uses key indicators and external factors to identify actual/potential adverse events that impacted on patient outcomes.

Descriptive statistics were used to describe the demographics of the study data. Statistical analysis was undertaken using SPSS (Statistical Package for the Social Sciences Version 15.0, SPSS Inc., Chicago, Illinois, U.S.A.).

Ethics approval was granted by the Monash University Standing Committee for Ethics in Research on Humans and the Latrobe Regional Hospital Ethics Committee.

Results

There were 70 trauma patients transported to the LRH during the data collection period who met the inclusion criteria. Of these, 21 cases were excluded due to incomplete time details on the ambulance PCR or insufficient ED triage information, leaving 49 patients for review.

The gender distribution consisted of 61% males, median age was 25 years (range 7 years to 92 years), and 39% females, median age of 45 years (range 12 years to 97 years).

Sixty four percent of incidents were located in the immediate Latrobe Valley area, 31% from Traralgon, 17% from Morwell, and 16% from Moe. The remaining cases came from more distant central and south Gippsland areas that are in the primary catchment zone for LRH.

The causes of the trauma injuries are summarised in Table 1.

Table 1: Causes of Trauma

Identified Cause	Number (n)	% (N)
MVA	19	39
Fall from standing	11	22
Sporting Accident	8	16
Assault	4	8
Industrial accident	3	6
Fall from horse	1	2
Fall from ladder	1	2
Struck by solid object	1	2
Farm Accident	1	2
Total	49	100

The majority of patients involved in a motor vehicle accident were between the ages of 18 and 35, patients involved in a fall from standing were generally > 65 years of age, and patients involved in sporting accidents were predominately < 25 years of age.

Triage categories as allocated on arrival in the LRH ED are summarised in Table 2.

Table 2: Triage Categories on arrival at the ED

Triage category	Number	%
1	1	2
2	7	14
3	41	84
Total	49	100

Median scene time was 17 minutes, interquartile range (IQR) 11 minutes, range 0 minutes to 81 minutes. For scene times > 20 minutes, median was 26.5 minutes, IQR 7 minutes, range 22 minutes to 81 minutes. Twelve (24%) cases had a scene time > 20 minutes. Of these cases, MICA (including four helicopter incidents) was in attendance for seven, a general ambulance

(including Advanced Life Support [ALS]) for four, and one case was not able to be determined.

Classification of scene time delays, as determined by the expert panel, are shown in Table 3

Table 3: Classification of Scene Time Delays

Delay Type	n
Clinical	4
Environmental	2
System	3
Unable to define	3
Total	12

For cases involving the helicopter ambulance, reasons for increased scene times, included:

- distance from the landing site to the actual incident;
- transport availability from the landing site to the incident site;
- time taken to prepare the patient in the helicopter prior to lift off;
- lack of assistance when no other ambulance crew was on scene; and
- availability and the time taken for the rescue authority to arrive on scene.

For cases involving road ambulances, reasons for increased scene times included:

- waiting for the rescue authority;
- time taken to extricate the patient from the vehicle;
- multiple patients involved, waiting for additional resources before transporting; and
- no obvious reason.

The expert panel's judgement of whether the scene time was justified or not is outlined in Table 4.

Table 4: Assessment of extended scene times by expert panel

Ambulance Crew	Justified	Not justified	Total
MICA	3	0	3
Helicopter	4	0	4
ALS	3	1	4
Indeterminate	1	0	1
Total	11	1	12

Only one incident had a transport time of > 30 minutes. The transport time was 45 minutes and involved the transport of a patient to LRH as second choice hospital. The expert panel determined that the patient's outcome was not adversely affected by this increased transport time.

In total, 29 (41%) of the patients transported to LRH ED had prehospital potential major trauma as defined by ROTES⁴ and Ambulance Service Victoria Clinical Practice Guidelines⁹. These patients had predominately blunt trauma. Of the patients with an assigned ED triage category of 3, 24 (83%) had prehospital potential major trauma (Table 5). Two of these patients also had physiological distress, according to ROTES, in the prehospital phase of their

management.⁴ The median time taken for a doctor to see these triage category 3 patients after their arrival in the ED was 35 minutes, IQR 33 minutes (range 15 minutes to 2 hours 13 minutes).

Table 5: Study Patients with Prehospital Major Trauma by Triage Category

Hospital Triage code ⁶	Prehospital Major Trauma ⁴
1	1
2	4
3	24
Total	29

Of the 23 trauma patients admitted to LRH wards, none were admitted to the intensive care unit (ICU), and no patient died. The median hospital length of stay was 2.5 days, IQR 4 days (range 1 day to 12 days). Three patients were discharged home from the ED and three patients were transferred from the ED to a tertiary hospital in Melbourne. The main reason given for these transfers was medical service availability, such as plastic surgery, a lack of hospital beds at LRH, or for additional orthopaedic management not available at LRH.

Discussion

Prolonged Prehospital Trauma Times

This retrospective pilot cohort study found that there were increased prehospital scene times, but the majority appear to be explainable and reasonable in the circumstances. There was insufficient data to comment on prolonged transport times.

The percentage of males (61%) and females (39%) in this study involved in trauma is consistent with figures published internationally.¹⁰⁻¹⁷ However, some international studies have reported significantly higher percentages of male patients when compared to the findings of this study.¹⁸⁻²⁴ The overall median age of 29 years identified in this study is also consistent with some of the international prehospital literature,^{12,15,17,19,22} although some studies based in the United States of America (U.S.A.) reported higher mean ages.^{11,14,25} Again, this could be due to the variation in study sample sizes, the sample populations, and the geographical location of the study populations.

MICA road ambulances were delayed at the scene because the patient was still in the vehicle and required removal with or without the assistance of the rescue authority. This reflects the situation in rural areas where predominately volunteer rescue services take longer to arrive at incident scenes than professional ambulance or police personnel. Activation of volunteer rescue crews is under the control of the police, therefore adding a link in the chain of activation from ambulance to police to rescue service. Analysis of this procedural issue is outside the scope of this study.

Extended scene times are also of concern in other developed countries. In the United Kingdom, Cooke extends the argument beyond “scoop and run” and “stay and play”.²⁶ Cooke discusses the organisational structure of ambulance services and the training and education of ambulance paramedics. His suggestion is that more highly trained staff with improved patient assessment capabilities will make informed decisions about what is appropriate at the scene. A Swedish study suggests that the decision on the time spend at the scene treating the patient must be adapted according to the needs of the injured.²⁷ In Denmark, Birk and Henriksen studied the relationship between the number of basic prehospital interventions used and the ‘at scene’ time.²⁸ They noted that as there is little

evidence of a positive effect on outcome from most prehospital outcomes and that a shorter prehospital time may be an important factor in survival for trauma patients. In Mexico, Arreola-Risa et al. reported improvements in prehospital outcomes associated with improved response times and the introduction of a Prehospital Trauma Life Support course.²⁹ The improved prehospital treatment did not increase the mean scene time in the six-month study.

Only one patient in the study was found with a transport time greater than 30 minutes. This patient was transported from a locality closer to another hospital which was lacking in the medical specialities that are available at LRH. In this case, the availability of an orthopaedic surgeon determined the destination of the patient.

The North American literature brings a rural and remote perspective on prehospital care in trauma systems. Grossman et al. conducted a study to examine the role of rural hospitals and prehospital agencies in the care of motor vehicle accidents prior to the regionalization of trauma care.¹ As part of the study, they examined prehospital time intervals, with ambulance median scene time of 15 minutes reported, and scene to ED arrival of 36 minutes. In a study by O'Meara, rural Victorian ambulance service data indicates that median scene times are similar to those reported internationally, while median scene to hospital times are considerably shorter at 5 to 15 minutes depending on the station's rurality.³⁰ Ambulance stations in areas classified as remote experience considerably longer travel times than those located larger centres and at the 60th percentile match the performance reported in overseas studies.

In another study, Grossman et al. compared the time intervals of advanced paramedics to trauma incidents in rural and urban locations in the state of Washington.²⁵ Mean scene times in rural areas were slightly longer than in urban areas, while mean response times and transport times were significantly greater. Longer response times in rural areas were associated with higher mortality rates. Their study was unable to find any association between the severity of injuries and the length of prehospital time intervals. A longer scene time for more severely injured patients was expected as they require a higher number of ALS procedures. Their study did not have information regarding the use of procedures and therefore we were unable to assess whether more severely injured patients actually received more procedures.

We found the scene times that were in excess of twenty minutes by MICA Paramedic crews, including the helicopter, were all justified, however, one extended scene time by an ALS crew was considered not justified. However, the expert panel did not believe the patient's outcome suffered because of this delay. The significance of this particular case is that, at the time of the study, the implementation of ALS was in its early stages. The panel concluded that the paramedic crew may not have been time conscious due to the addition of ALS procedures that were relatively new to them. In some aspects Windsor and Pong support this view, noting that an inexperienced clinician was more likely to make mistakes and likewise when new technologies were introduced the likelihood of mistakes was increased.³¹ The prehospital environment is highly susceptible to an increase in "errors" following the introduction of new procedures and drugs, especially if there is a lack of close supervision.

Scene times in rural and remote areas may be prolonged due to factors outside the control of the ambulance crews. Therefore extended scene times in some circumstances in rural and remote areas may be the norm. Each case where there is an extended scene time should be analysed to assess the causes and identify specific aspects that may be changed to assist in decreasing the scene time. The use of a clinical performance indicator, e.g. scene time greater

than 20 minutes, without further analysis, such as that used by the Victorian Consultative Committee on Road Traffic Fatalities,⁷ demonstrates that the number of actual unjustifiable scene times in excess of twenty minutes may be artificially high as suggested by this pilot study. Caution should also be exercised in undertaking routine clinical audit in ambulance services using similar clinical indicators without secondary analysis.

This study is potentially limited by the critical incident methodology used to determine the effects of time delays on the patient's outcome. As there are many other critical incident methodologies available, determining which methodology is the best, is problematic.³² Secondly, due to industrial action during the data collection phase completeness of information on the PCR may have affected. However, we were unable to determine the affect industrial action may have had on the completeness of the PCR, and our ability to identify potentially missing data. Thirdly, in retrospect, the selection of trauma patients who were identified using hospital triage codes was flawed. We should have identified trauma patients from the ambulance PCRs, followed up the patient outcomes, and then identified the hospital triage code.

Finally, as this was a pilot study using a small sample size, the results potentially lack external validity and should be interpreted with caution. However, this study does provide the basis for a more detailed state-wide study of delays in getting trauma patients to the appropriate hospital.

Value of a Pilot Study

This pilot study highlighted implications and influenced the design of a subsequent major prehospital trauma study undertaken by Boyle et al.^{17, 33, 34} The major influences included:

- the small trauma numbers in this large Victorian rural region led to a subsequent study being conducted state-wide over a twelve month period;
- the limitations using hospital data classification as the prime entry criteria led to a subsequent study using ambulance data classification as the prime determinant of entry criteria;
- difficulties in data entry led to the establishment of a subsequent study database being designed for ease of data entry using the normal Windows™ look and feel;
- inconsistencies between prehospital and hospital triage classifications for the same patient led to the review of this observation in a subsequent study;
- the finding that 27% of ambulance PCRs did not have complete time data, led to the need for a more rigorous, and hence time consuming, quality process of data collection in a subsequent study; and,
- definitions, categories, and criteria used in this study led to clarifying these elements in a subsequent study.

This study also highlighted issues to contemplate for future research in prehospital trauma, including:

- issues of process, e.g. the time taken and additional requirements to gain ethics approval from individual hospitals;
- the time taken to source and review the ambulance PCR and hospital patient records;
- the time taken for data entry;
- the need to clearly define and test inclusion and exclusion criteria;
- undertaking prehospital research using paper based documentation is time consuming and requires additional staff to ensure the project is completed on time;

Given the developing nature of paramedic-led research in the prehospital sector, this study demonstrated the benefits of undertaking pilot studies which enable research questions and methodologies to be refined before undertaking costly and time consuming major studies.

Conclusion

This pilot study confirms that there are prolonged prehospital scene times in trauma patients, however, the study suggests that most of the extended times are explained by factors beyond the control of attending paramedics. There was insufficient data on extended transport times to hospital to make any informed judgement. This area of research is important because of its impact on how the overall trauma system is structured in terms of the clinical processes in the prehospital setting. Further research and ongoing ambulance service review of scene time delays is required to identify the reasons for delay and to develop strategies that can alleviate or decrease the delays.

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