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The organisation of trauma services for rural Australia

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ABSTRACT

This review discusses the development of trauma care and the retrieval process in Australia, particularly as it impacts on the rural population. In rural and remote settings, trauma is a major cause of death and disability with the death rate from injuries increasing with progressing remoteness. Time is a critical factor in trauma care and the length of time it takes to reach definitive care has a significant impact on patient outcome. In rural areas people have difficulties accessing medical services within a reasonable time period and the delays associated with the provision of trauma care contribute to an unacceptable level of mortality and morbidity. Since it is impractical to provide sophisticated medical services capable of managing severe trauma in rural areas, referral and retrieval form a vital part of the process of rural trauma care. The focus of this review is the management of severe trauma in rural areas. It will discuss the utilisation of clinical guidelines to improve the process of trauma care and examine if they can be used to reduce the time taken by rural health facilities to seek advice and request retrieval services. The evolution of trauma care in Australia, including the referral and retrieval processes, will be discussed and strategies aimed at improving tertiary hospital referral identified.

Keywords: *emergency medical services; inter-hospital transfer; retrieval services, rural trauma; trauma guidelines; trauma systems*

Introduction

Trauma is the term assigned to a vast array of physical injuries to the body. Because of its frequency and contribution to the burden of disease, it is often said that trauma is an epidemic that can have catastrophic physical, psychological and economic consequences for its

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victims.¹ In this work it is defined as injuries that result from exposure to physical agents, such as mechanical energy, heat, electricity, chemicals and ionising radiation at levels beyond human tolerance.² The Global Burden of Disease Study estimates that by the year 2020, road trauma will be the third most common cause of disability worldwide and the second most important public health problem confronting developing nations. It is believed that trauma will continue to be a problem in developed countries too, where it is projected to be the fifth most common cause of disability by 2020.³

The focus of this review of the literature is the management and referral of severe trauma in rural areas. The evolution of trauma care in Australia, including the referral and retrieval processes, will be discussed and strategies aimed at improving tertiary hospital referral identified. This review will discuss the utilisation of clinical guidelines to improve the process of trauma care and examine if they can be used to reduce the time taken by rural health facilities to seek advice and request retrieval services.

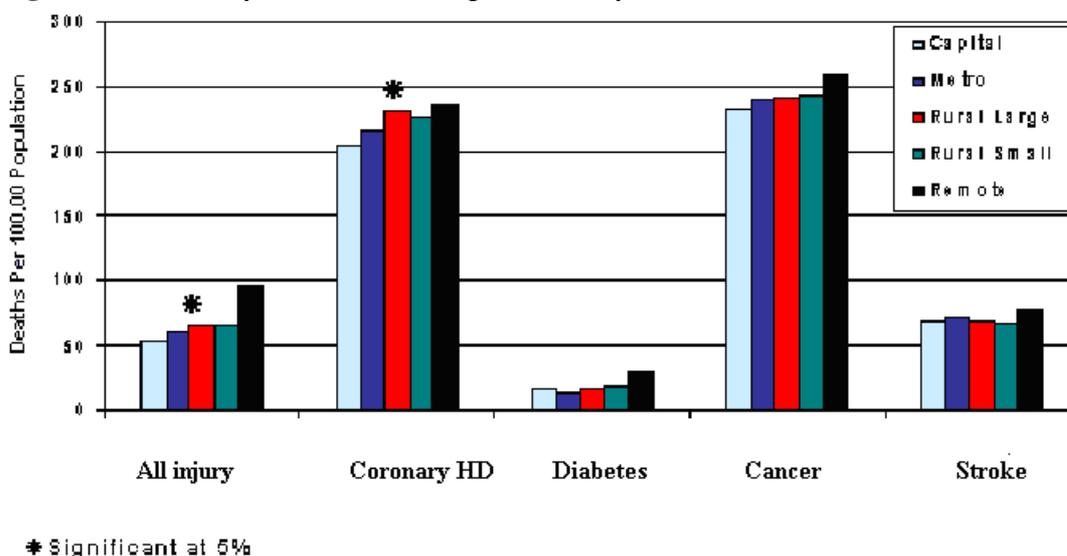
The following information sources were used in the preparation of this review:

- a. Computerised databases: PubMed (Medline - PubMed Services, National Library of Medicine); OVID (Ovid Technologies Inc, version rel 9.1.0) and Infotrac Health Reference Centre Academic. The search was limited to publications from 1985 and 2006.
- b. Citations in articles reviewed, published textbooks and bibliographies and references provided by colleagues and clinical and academic specialists.

For the computerised searches, search terms included: rural trauma, trauma systems, trauma services, definitive care, response time, notification time, retrieval services, inter-hospital transfer, clinical practice guidelines, trauma guidelines, and medical quality assurance.

Trauma is a major contributor to premature mortality in Australia (Figure 1). It is the fourth most common cause of death in the developed world and is the leading cause of death in people under 44 years old.⁴ Trauma accounts for 50% of deaths in children and 75% of deaths in adolescents and young adults.⁵ Since trauma has a significant impact on younger people, life years lost is greater from trauma than from any other disease.⁶ The tragic significance of trauma is not only expressed in the mortality statistics, as there are 31 hospital admissions and 144 emergency department attendances for every death from injury in Australia.⁷

Figure 1: Mortality Rates According to Locality and Disease.⁸



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In Australia, Victorian data showed that in 1991 – 92, the in-patient costs of trauma was \$A 145.9 million, which represented more than 10% of total annual in-patient costs in Victorian public hospitals.^{9,10} There are also considerable additional costs with respect to rehabilitation, ongoing health care, maintenance of emergency services, legal expenses and insurance costs that increase the financial burden on the community significantly. In the United States the annual cost of trauma is estimated to exceed \$US 250 billion.¹¹

Trauma is a major health problem for rural areas and mortality and morbidity rates are significantly higher than in urban areas.¹² It has been suggested that these disproportionate rates are the result of geographic or sociological phenomena unique to rural areas and therefore unpreventable.¹³ This review of the literature, while acknowledging such beliefs, will argue that rural trauma is at least in part due to deficiencies in the delivery of human and health services and therefore amenable to change.

Defining Rurality

A consensus definition of rurality has proven to be evasive and definitions vary not only between countries but also between organisations within individual countries.¹⁴ In the developed world the tendency is to define both rural and remoteness in terms of population and distance from large population centres. While most definitions take into account issues of access to services and distance to these services, Couper¹⁵ points out that rural cannot be defined simplistically as non-urban, or that rural and under serviced are interchangeable terms. In Australia rurality is defined in terms of two paradigms:

- a. Geographically – with respect to the physical distance from major population centres and how that distance restricts access to goods, services and social interactions.
- b. Sociological – whereby socio-economic, behavioural, attitudinal and perceptual characteristics of a community influence their accessibility to services. In this paradigm, the lack of accessibility to services defines remoteness.

From these paradigms three systems have evolved to measure rurality:

- i. Accessibility/Remoteness Index of Australia (ARIA). This is a geographical measure of remoteness in terms of accessibility.¹⁶ The Index is expressed as a continuous variable, which apportions a remoteness score between 0 and 12. The more remote the area, the greater the score. This index is ideally suited to statistical analysis with other variables. The ARIA index deliberately avoids defining rurality as such, and non-metropolitan areas are assigned on their degree of remoteness as measured by accessibility to service centres.
- ii. The Rural Remote and Metropolitan Areas (RRMA) Classification. This measure is based on the size of population centres and the level of their remoteness.¹⁷ There are seven RRMA categories organised within three zones:
 1. Capital cities (Metropolitan Zone)
 2. Other Metropolitan Centres (Metropolitan Zone)
 3. Large Rural Centres (Rural Zone)
 4. Small Rural Centres (Rural Zone)
 5. Other Rural Areas (Rural Zone)

6. Remote Centres (Remote Zone)
7. Other Remote Areas (Remote Zone)

The Australian Bureau of Statistics has assigned a RRMA category to each of its Statistical Local Areas thereby enabling comparisons using census data.

- iii. The Australian Standard Geographic Classification (ASGC) Remoteness Structure. This is a six level classification system based on measuring road distance from any point to the nearest Australian Bureau of Statistics Urban Centre in each of the population size classes. It is the newest and least used of the classification systems.¹⁸

Trauma researchers in the United States of America have attempted to define rural in their own terms using population density and geographic location. Hulka et al,¹⁹ defined rural as an area in which the population density was less than 50 persons/square mile. But rural can also be defined from a clinical perspective, particularly as it relates to trauma. The Committee on Trauma of the American College of Surgeons,²⁰ defined rural as:

An area where geography, population density, weather, distance or availability of professional or institutional resources combine to isolate the trauma victim in an environment where access to definitive care is limited.

However, this definition lacks the objectivity of the ARIA and RRMA definitions.

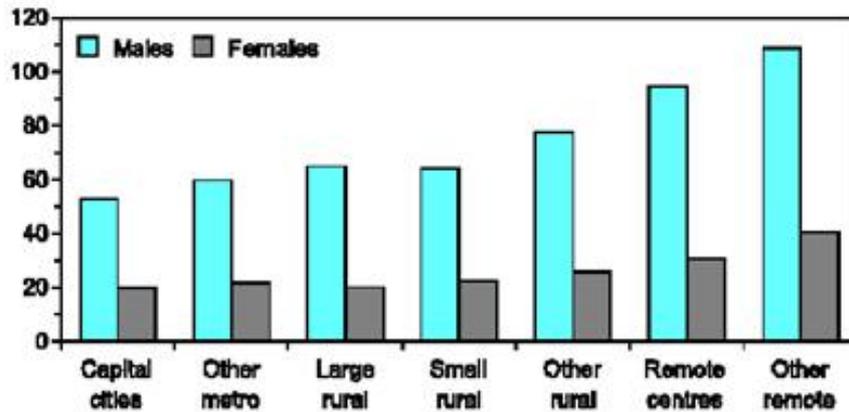
Epidemiology

Trauma is heterogenous, and traumatic injury must be considered in terms of its severity as well as its nature because it is inclusive of a spectrum from trivial injury to death. For this reason it is difficult to quantify significant trauma on a population-basis. Since fatality rates and hospital separations are available they are used as an indication of incidence of significant trauma within a population.

In Australia, between 2002 – 2004, injury was responsible for six per cent of all deaths and approximately 18% and 26% of excess deaths in regional and remote areas respectively.²¹ Between 1992 and 1996 the death rate for all causes of injury was 59.5 and 21.4 per 100,000 for males and females respectively.⁴ The trauma death rate has increased only slightly over the last decade with people living in larger regional areas and with males living in major cities experiencing the greatest increases (2% and 1% per annum respectively).⁴ The total death rate from trauma in the Australian population increases with remoteness, with very remote areas having a rate 2.4 times higher than that of the major cities. When compared to major cities the relative death rate due to injury increased in very remote areas from 2.4 in 1997 – 1999 to 3.2 in 2002 – 2004 statistical periods.²¹

Figure 2 details death rates due to trauma between 1992 and 1996, as a function of locality.

Figure 2: Death Rate All Cause Injury 1992 – 1996.²²
Deaths per 100,000 population

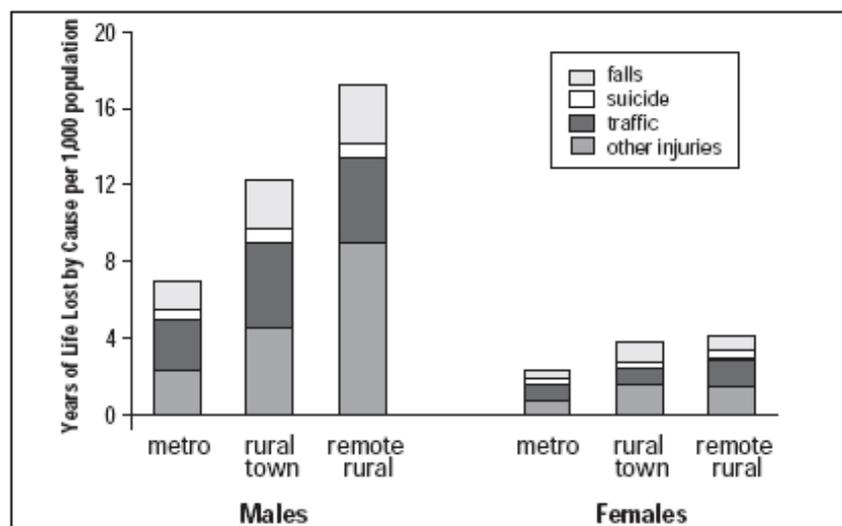


Injury patterns resulting in death vary with age. Drowning is the principal cause of death in early childhood, whereas self-harm and road traffic crashes (RTCs) are the major causes among young adults. Trauma death rates are highest in young adults and the elderly.²² The single most common cause of trauma is road traffic crashes, accounting for 40% of all deaths in the 15 to 25 year age group.²³

Trauma deaths in males exceed that in females by more than 2 to 1. Most excess death occurs among the young with 70% of excess deaths the result of road traffic crashes in the 15 to 44 year age group.²² Suicide is also a major cause of excess deaths, with the vast majority of these deaths occurring in males.⁴ Furthermore, there is an increase in life years lost due to trauma in rural and remote areas when compared to urban areas, with males experiencing greater losses than females.^{19,24,25} Figure 3 uses Victorian data to illustrate trends that are observed across a large number of different rural settings.

Road traffic crashes and suicides are the most common causes of trauma outside the major Australian cities, with the death rates increasing with remoteness. The death rate due to RTCs was 3.6 times higher in the very remote areas, whereas the suicide rates were 1.4 times higher in remote areas and 1.6 times higher in very remote areas. While RTCs were responsible for the greatest number of excess deaths, suicide also contributed substantially more excess deaths than expected annually in rural and remote areas.⁴

Figure 3: Years of Life Lost by Injury Cause per 1000 Population²⁴



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Overall, interpersonal violence and shootings accounted for less than 4% of all deaths, however they are a much greater problem in remote areas where there is an excess of 20 deaths per annum compared to the larger regional areas.⁴ Workplace injuries are also a major cause of death in the rural and remote zones, and accidents with farm and mining equipment and road transport are responsible for considerable premature death.⁴

The trauma mortality of indigenous people is 3.5 to 4 times greater than that for non-indigenous people whereas the death rate from interpersonal violence is 7 times that of their non-indigenous counterparts.^{21, 22} Although the injury death rates for indigenous males decreased by 2.3% per annum between 1986 and 1994,²⁶ the overall injury mortality rate for the indigenous population has not declined to the rate of non-indigenous Australians.²²

Trauma is a leading reason for hospitalisation in Australia, and it accounted for almost 400,000 hospital separations in 1995-96. Hospitalisations due to trauma exceed trauma related death by 40 to 1. Males are hospitalised at a higher rate than females, with the male rate being almost twice the female rate in both the metropolitan and rural zones.²²

Trauma hospital separation rates increase with increasing remoteness, and for males the hospital separation rate is 145% higher in remote centres when compared with that in capital cities. The remote zone hospital separation rate due to trauma for females is twice that of the rate in the metropolitan zone. The ratio of male to female trauma death rates is greater than the ratio of male to female hospital separation rates, implying that males are more likely to be involved in fatal incidents.²²

Major Trauma

An internationally agreed classification of trauma is provided by the World Health Organization.²⁷ Modified for Australian use it describes injuries in terms of mechanism and intent and divides trauma into 179 categories of primary injury (categories S00 to S99 and T00 to T78).²⁸ Major trauma can be defined as involving the presence of at least one of the following:⁵

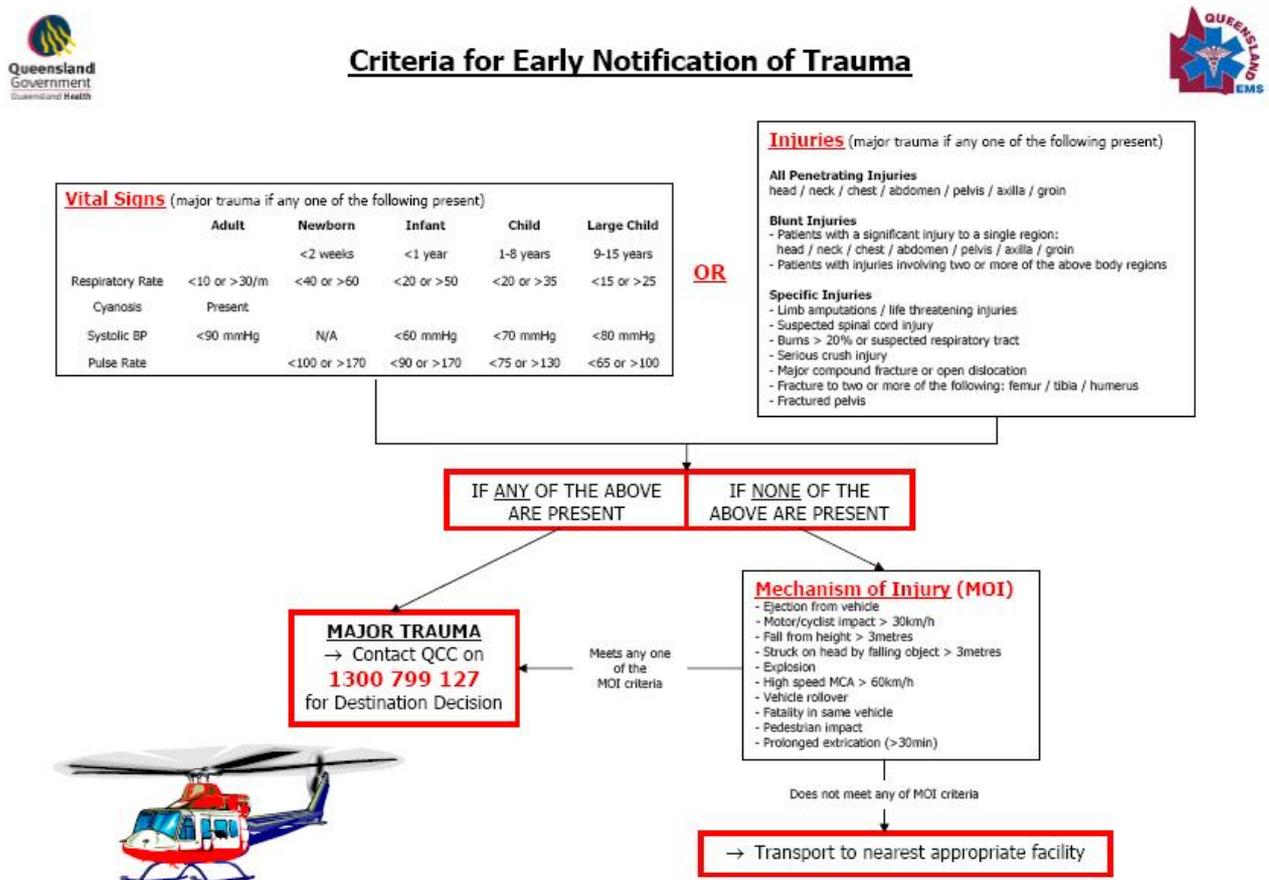
- i. Death after injury
- ii. Admission to an Intensive Care Unit for more than 24 hours requiring mechanical ventilation
- iii. Serious injury to two or more body systems (excluding the skin)
- iv. Injury Severity Score (ISS) > 15
- v. Urgent surgery for intracranial, intrathoracic or intraabdominal injury or for fixation of pelvic or spinal fractures

The difficulty for clinicians is that this definition requires retrospective assessment once diagnosis is complete. However in trauma, diagnosis tends to evolve over time as injuries that were initially occult reveal themselves in the face of ongoing assessment. Clinicians, particularly those who manage trauma during the initial post injury phase, require criteria that are predictive of major trauma as it is defined above. Triage systems have been devised that use three criteria:⁶

- i. The physiological status of the patient
- ii. The anatomical pattern of injury
- iii. The mechanism of causation

An example of one such triage system is illustrated in Figure 4.

Figure 4: Trauma Triage Criteria – Early Notification of Trauma Protocol (Queensland).²⁹



Definitive care and the golden hour

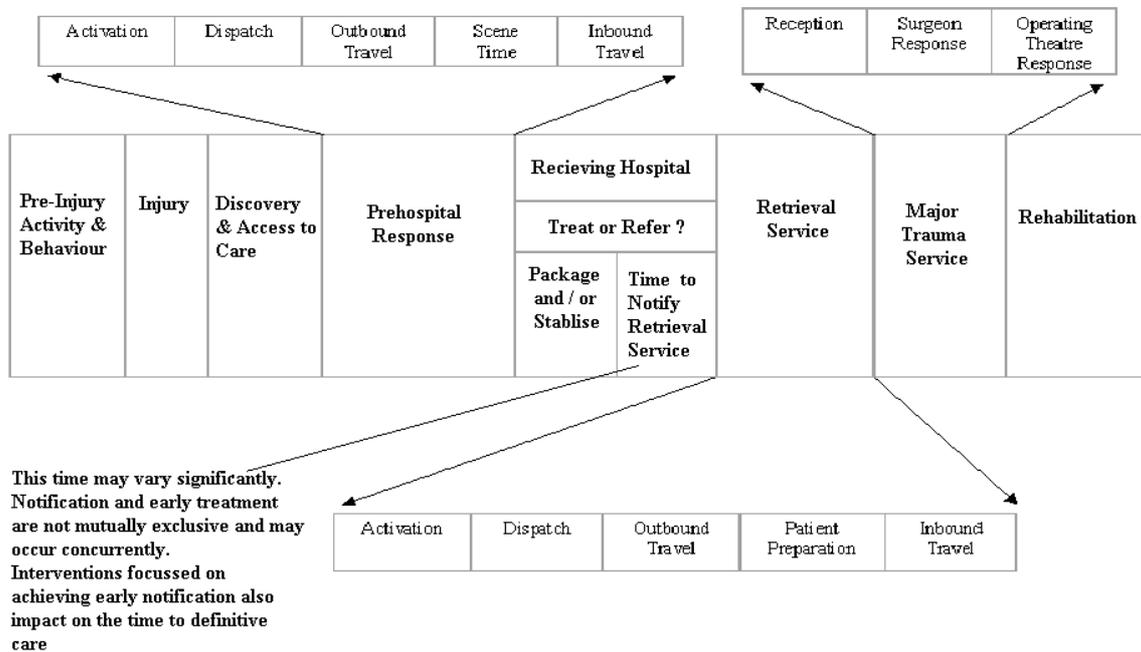
Definitive care is the end of a phase in a cycle of patient care and is a curative action. Examples of definitive care in trauma are haemostasis and the restoration of blood volume in order to correct hypovolemic shock secondary to internal haemorrhage. Fluid resuscitation is not definitive care as it alone is unable to achieve haemostasis. Life-threatening traumatic injuries require the skills of surgical teams and appropriately prepared operating theatres. Anything that delays the delivery of their definitive interventions will compromise patient outcome and result in death or long term disability.

The importance of the time taken to deliver definitive care was conceptualised into the notion of a “golden hour”, by which it was recognised that there is a critical time period within which the seriously injured patient must receive definitive treatment to maximise their chances of survival. In reality, the time frame for delivering definitive care varies from patient to patient and is more appropriately termed a “golden period”.³⁰

This golden period can vary from only a few minutes to many hours depending on the nature and extent of the patient’s injuries. Nonetheless, failure to deliver the appropriate care within the golden period will result in an irreversible pathological state that ultimately ends in death. Research has consistently shown that the time to definitive care is the most significant predictor of trauma survival.^{31,32} Time to definitive care measures the length of time from injury to delivery of corrective (i.e. definitive) medical techniques. It is clear that future gains

will be made by focussing attention on improvements to the speed at which patients can be delivered to definitive care. The components of the pathway to definitive care are shown in Figure 5.

Figure 5: An Integrated Schema Indicating the Continuum of Trauma Care



In many urban areas ambulance services are offered a choice of hospitals into which to deliver their trauma patients. In rural areas there is frequently no choice and the only available hospital may lack the capacity to provide definitive care. In such circumstances subsequent transfer to a more appropriate facility is necessary. However, such transfers can be associated with a poorer outcome as the referral and retrieval process can take considerable time and significantly increase the time to definitive care.³⁰ There is a paucity of research directed at evaluating strategies directed at reducing this delay, yet it is of considerable importance.

Rural Trauma

While even a single trauma death is catastrophic, deaths are only a small proportion of the total human cost of trauma and an undue emphasis on death does not indicate the extent of the problem. As noted previously for every death from injury, there were 31 hospital admissions and 144 emergency department visits.^{5,33} A failure to rapidly manage serious head trauma is just one example of an injury pattern that results in significant long-term disability.

The higher death and hospital separation rates due to RTCs in the remote zone, tends to highlight the differences in conditions in this zone including roads, distances travelled, driver behaviour and the availability of hospital and prehospital care. Can systematic differences between urban and rural areas explain why trauma death and hospital separation rates are greater in rural areas? The fact that the mortality rates for all causes of trauma increases with increasing remoteness suggests that the problem extends beyond merely physical and ecological factors such as roads and weather. It is more than coincidence that in contrast to the increasing trauma mortality, the availability of health services diminishes with increasing remoteness.

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Rural areas can have as few as one-third the number of doctors per capita as urban areas.¹⁴ Furthermore, few medical specialists (particularly surgeons, anaesthetists and emergency physicians) are prepared to practice outside urban areas. Without appropriate medical support the availability of definitive trauma care in rural areas is limited. This lack of support is at least in part responsible for the increasing rate of mortality and morbidity with increasing rurality. The reasons for the skewed rural statistics are complex and most likely multifactorial. Psychosocial and attitudinal factors also contribute to the high death and separation rates.^{13,34}

What is problematic in rural areas is the time it takes to discover the victims of significant trauma and hence deliver them to definitive care. Grossman and co-workers³² used a population-based retrospective cohort study to examine rural RTCs and concluded that death was a "... function of the severity of injuries, prolonged discovery time, or both." Vane and Shackford³⁶ used a similar design to study trauma deaths in rural children and found that death rates were twice that of their urban counterparts. Eighty-five per cent of those deaths occurred out of hospital. The authors concluded that in order to improve trauma outcomes in rural areas, it will be necessary to improve access to major trauma services and hence definitive care.

Trauma Systems

An organised system of managing trauma reduces both mortality and morbidity and manages interventions from prevention to rehabilitation. Even though mortality and morbidity are higher in rural areas, historically, trauma system development has been centred on metropolitan based hospitals.^{37,38} The prime objective of a Trauma System is to match the trauma patient's medical requirements with the appropriate hospital facility so as to optimise care and minimise cost. The National Road Trauma Advisory Council (NRTAC) Working Party on Trauma Systems describes standards for the organization and resourcing of trauma systems within Australia. Furthermore, this Working Party has developed guidelines for assessing facilities and outcomes of trauma systems.²³

Prehospital Care

Severely injured patients should wherever possible, be transferred directly from the injury scene to a hospital capable of providing definitive care, as this leads to outcomes that are superior to those involving an inter-facility transfer.³⁹ Several authors suggest that "safe" prehospital transport times may span up to 60 minutes provided they occur within a system where the skill level of paramedics is high and that the patients can be delivered to a hospital with the capacity to definitively manage severe trauma.^{40, 41} The Victorian Trauma Working Party determined that in the first instance, a transport time of up to 30 minutes is appropriate in cases of severe trauma.⁵

Retrieval Services

Much of rural Australia is far removed from the medical services required for the management of severe trauma so that, for many patients, direct transport from the scene of injury to a Major Trauma Service is completely unrealistic. Therefore, by necessity primary transport is to a local health facility for early management and, if possible, stabilisation prior to transfer to a Major Trauma Service.

Coordination of retrieval services is essential if time delays are to be minimised. An effective retrieval service requires:⁴²

- i. A designated single point of contact for referral communication and dispatch.
- ii. Medical control providing expert and timely clinical advice.
- iii. A capacity to task and utilise the most appropriate transport platform.
- iv. Assignment of a crew mix which satisfies the clinical requirements of the retrieval task (e.g. adult, paediatric, neonatal).

In addition to differences in care provided by a Major Trauma Service and a local hospital, the retrieval process itself may affect the patient outcome in at least two ways: firstly by increasing the delay to definitive care and secondly by the imposition of additional physiological stress during transport. The aim of the retrieval process is to achieve a level of patient care that is equal to, or better than, that at the point of referral.⁴³ Retrieval services are not simply about increasing the patient flow to tertiary hospitals.

Early recognition of patients requiring retrieval is vital if the time to definitive care is to be minimised. Early recognition should lead to early consultation with the retrieval coordinator, thus setting in motion a chain of events leading to the efficient and timely retrieval of the patient (see Figures 4 and 5).

In a Victorian study the time taken by rural hospitals to request retrieval services exceeded 2 hours in 15 out of 22 major trauma patients. Several factors can lead to delayed notification by the referring hospitals including:⁴²

- i. Triage errors and failure to recognise the severity of injuries by the referring medical practitioner.
- ii. Overestimation of the capability of the receiving hospital/clinicians to manage the situation.
- iii. Lack of awareness of support available and the mechanism with which to activate the retrieval service.
- iv. A perception in rural areas that the retrieval service was incapable of meeting their need for a timely response to severe trauma.

Time to definitive care remains high for rural trauma patients. Rogers and co-workers³⁴ found that the average time patients waited in referring hospitals for transfer to a trauma centre was 3 hours, with inter-facility transport adding a further hour to the time to definitive care. A study of major trauma transfers in Western Australia found that the median transfer time was 9 hours 12 minutes with 93% of patients arriving at the Major Trauma Service (Royal Perth Hospital) within 24 hours. The study was not able to determine whether time delays were due to delays in initiating the transfer, prolonged travelling times, or delays in the preparation of the patient for travel.⁴⁴

A survey conducted in the Barwon and Western Region of Victoria determined that the average time taken to transfer a seriously ill patient was 7.5 hours (Barwon and Western Region Emergency and Critical Care Committee 2000).⁴⁵ In placing this in perspective it was noted that, at a minimum, the expected time of arrival at the tertiary receiving hospital was three times the one way travel time between the referring and the receiving hospital. The overall time to definitive care involved additional time in retrieval team activation and in patient preparation.

Schoettker and co-workers⁴⁶ demonstrated that a trauma management checklist provided to referring hospitals servicing a major trauma service significantly shortened the time spent in the referring hospital, and reduced the overall time to definitive care on average by 116 minutes. However, the checklist failed to improve the time taken to request retrieval services by the referring hospital (112 ± 80 mins pre-checklist vs 122 ± 95 mins post-check list, $P = 0.65$). This checklist incorporated concepts in trauma management but did not address the issue of identification criteria indicating the need for referral.

Conclusion

In Australia, trauma is a major cause of death and disability in rural and remote settings with the death rate from injuries escalating with increasing remoteness.¹⁸ However, even though mortality and morbidity are higher in rural areas, trauma system development has been centred on urban-based systems.^{37,38}

Time is a critical factor in trauma care and the length of time to definitive care has a significant impact on patient outcomes. Over 80 per cent of trauma deaths occur within the first four hours after injury; many of these deaths can be prevented if timely care was provided. Injured people who live in rural and remote areas of Australia have difficulty accessing care within an appropriate time frame, with the delay compromising their outcomes.

Retrieval of severe trauma to a facility capable of providing definitive care is fundamental to a rural trauma system and early transfer of such patients to a Major Trauma Service has been associated with improved outcomes.³⁶ However, long time frames have been associated with rural trauma retrieval and these delay the delivery of definitive care with the potential to further compromise patient outcomes.

Several studies have shown that severely injured patients fare better when transported directly to a major trauma service instead of simply to the nearest health care facility.^{5,39,47} However, the data supporting this assertion is taken largely from urban studies and has little relevance to the management of severe trauma in the vastness of rural and remote Australia.

In rural trauma systems problems can be addressed through a range of strategies, including:

- i. the development of guidelines to assist referring practitioners and to increase the utilisation of referral and retrieval services
- ii. an increased capacity of the system to provide rapid retrieval services
- iii. the follow up of individual cases that have been compromised by delayed notification or retrieval service delivery
- iv. improved research and data collection and analysis to identify both positive and negative outcomes

Only by evaluating the effectiveness of these interventions can the problems of suboptimal patient outcomes, delayed referral and lengthy retrieval times be addressed in the context of rural trauma. The development of effective referral guidelines to expedite the retrieval process is currently the subject of collaborative research in North Queensland. Projects evaluating the effectiveness of interventions formulated to improve outcomes in rural trauma are a fertile area for future research and are urgently needed.

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