Evaluation of the Prehospital Management of Road Traffic Fatalities in Victoria, Australia

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Abstract

Introduction: This study was undertaken to identify prehospital system and management deficiencies and preventable deaths between 01 January 1997 and 31 December 1998 in 243 consecutive Victorian road crash victims with fatal outcomes.

Methods: The complete prehospital and hospital records, the deposition to the coroner, and autopsy findings were evaluated by computer analysis and peer group review with multidisciplinary discussion.

Results: One-hundred eighty-seven (77%) patients had prehospital errors or inadequacies, of which 135 (67%) contributed to death. Three-hundred ninety-four (67%) related to management and 130 (22%) to system deficiencies. Technique errors, diagnosis delays, and errors relatively were infrequent. One of 24 deaths at the crash scene or en route to hospital was considered to be preventable and two potentially preventable.

Conclusion: The high prevalence of prehospital deficiencies has been addressed by a Ministerial Task Force on Trauma and Emergency Services and followed by the introduction of a new trauma care system in Victoria.

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Introduction

In 1992, the Consultative Committee on Road Traffic Fatalities in Victoria (CCRTF) was established by the Victorian Road Trauma Committee of the Royal Australasian College of Surgeons and the Victorian Institute of Forensic Medicine. Since 1992, it has undertaken a multidisciplinary evaluation of the prehospital and hospital management of road traffic fatalities who were alive on arrival of ambulance services to the scene.[1–10] Its principal objective has been the identification of organizational and clinical errors and inadequacies including those contributing to individual deaths. The Committee's findings and subsequent recommendations developed in association with representatives of the learned colleges and specialist societies[11] resulted in the establishment of a Ministerial Task Force on Trauma and Emergency Services that is implementing a new Victorian trauma care system.[12]

Abbreviations:
AIS = Abbreviated Injury Scale
ATLS = advanced trauma life support
BTLS = basic trauma life support
CCRTF = Consultative Committee on Road Traffic Fatalities in Victoria
CPR = cardiopulmonary resuscitation
ISS = Injury Severity Score
IV = intraveneous
MAIS = Maximum Abbreviated Injury Scale Score
MAS = Metropolitan Ambulance Service
MICA = Mobile Intensive Care Ambulances
min = minutes
PHATLS = prehospital advanced trauma life support

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Ambulance services throughout Victoria (population 4.92 million, metropolitan Melbourne 3.52 million) utilize a two-tier system of basic trauma life support (BTLS) paramedics and prehospital advanced trauma life support (PHATLS)-trained paramedics. Patients usually were transported to the nearest receiving hospital. This paper presents an evaluation of the prehospital management of 243 consecutive road traffic fatalities (of patients who were alive upon arrival of ambulance services) from 01 January 1997 through 31 December 1998.

In the Metropolitan Ambulance Service (MAS), all paramedics operate in two-person crews, whereas in some remote rural areas, only a single BTLS paramedic response is available. Ambulances staffed by PHATLS paramedics are designated as mobile intensive care ambulances (MICA).

Metropolitan and Rural Ambulance Services use a dual response policy based on evidence provided by the caller or following a report from the first attending crew. In cases of road trauma in which the patient has an altered conscious state, respiratory difficulty, is trapped, or has been ejected from a vehicle, a dual response follows with both BTLS and MICA paramedics. The PHATLS-staffed helicopters were called to some crash scenes dependent upon injuries sustained. In all other cases, the closest BTLS paramedics attended, with additional resources being dispatched after initial assessment by the paramedic crew or upon receipt of upgraded information from the crash scene.

The protocols used during the study period[19] advised endotracheal intubation for restless, hypoxic head injuries with a Glasgow Coma Scale (GCS) score <9. If a patient showed resistance to intubation, morphine and diazepam could be given intravenously to assist. There was no established protocol for nasotracheal intubation and while cricothyroidotomy was taught as a protocol, it was subsequently withdrawn following a lack of established need. Endotracheal intubation could be withheld if the patient showed continuing resistance, for example, trismus, or if it was considered that intubation would be unduly difficult.

Methods

The methodology has been previously detailed.[1,2] Briefly, the CCRTF abstracted information from the complete hospital records, ambulance records, the medical deposition to the coroner, and the autopsy report (full autopsy was available in 89%). Injury type and severity were coded using the AIS-90 revision of the Abbreviated Injury Scale (AIS),[13] and the Injury Severity Score (ISS)[14] was derived, and the survival probability estimated using TRISS methodology.[15] Audit filters based on those of the American College of Surgeons Committee on Trauma were applied.[16] A narrative account of the patient's management was prepared. The assessments were undertaken by two multidisciplinary, evaluative panels, which included general surgeons, neurosurgeons, orthopedic surgeons, and cardiothoracic surgeons, emergency physicians, anesthetists, and intensivists from Melbourne teaching hospitals, PHATLS paramedics, and forensic pathologists (Appendix). The prepared narrative case summary, data proforma, audit filter analysis, medical deposition to the coroner, and autopsy results were forwarded to panel members prior to meetings, and one member was given the responsibility for reviewing the complete records of a case and its presentation for multidisciplinary discussion and evaluation.

The criteria used for judgments of appropriate management included those described in the Early Management of Severe Trauma Course Manual of the National Trauma Committee, Royal Australasian College of Surgeons,[17] which is based on the Advanced Trauma Life Support (ATLS) course of the American College of Surgeons Committee on Trauma.[18]

Categorization of deficiencies

Errors and inadequacies were identified and categorized as follows: (1) system inadequacy: failure or insufficiency of the trauma system to deliver care appropriately and timely (i.e., to provide appropriate medical/ambulance staff or facilities); (2) error in treatment/management strategy: therapeutic or diagnostic decision made contrary to available data/management plan for patient not in accordance with recommended optimal standards of practice, e.g., ATLS/EMST guidelines[17,18] and those of the Victorian Ambulance Services;[19] (3) error in technique: technical error during the performance of a diagnostic or therapeutic procedure; (4) error in diagnosis: injury not diagnosed because of misinterpretation, inadequacy, or lack of clinical examination or diagnostic procedure(s); and (5) delay in diagnosis: diagnosis not made in a timely fashion when considered in the context of the patient's overall condition.

An error or inadequacy was defined as contributing to death if it was considered to favor the probability of death or to shorten the life of an individual patient. This does not imply that it was the cause of death. Events following a decision to withdraw active treatment were excluded.

Deaths were classified as: (1) preventable; (2) potentially preventable; or (3) non-preventable.

A preventable death was defined as one in which it was considered in retrospect, with full knowledge of the clinical history and all injuries sustained, that death generally would not have occurred (survival probability ≥75%) had the patient received appropriate prehospital treatment and been transported to a hospital with appropriate facilities in the minimum time, and appropriate management had been provided promptly. A potentially preventable death was defined as one in which it was considered in retrospect, with full knowledge of the clinical history and all injuries sustained, that the chances of survival were 25%–74% with optimal treatment. A non-preventable death was defined as one in which it was considered in retrospect, with full knowledge of the clinical history and all injuries sustained that these injuries are generally non-survivable (survival probability <25%) with optimal management. The reproducibility of death classification by the CCRTF has been demonstrated to have significant Kappa concordance.[3]

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Statistical analysis

Statistical analysis was performed using SPSS V9.0 (Statistical Package for the Social Sciences, SPSS Inc, Chicago, IL). Chi-square, Fisher's exact test, Student's *t*-test, analysis of variance, and non-parametric test of medians were applied where appropriate. Stastical significance was assigned at the 5% level.

Results

Demographics

Description of the road traffic fatality population

Of the total 243 consecutive fatalities alive on arrival of ambulance services from 01 January 1997 through 31 December 1998, 16 (7%) died at the crash scene and eight (3%) died during transit to a hospital (metropolitan Melbourne 14/153 (9%); rural Victoria 10/90 (11%), differences not statistically significant (NS)). Two patients arrived at the emergency department without utilizing ambulance services.

Age and gender

One-hundred sixty-nine (70%) of the patients were males and 74 (30%) of the patients were females. The mean value of their ages was 43.3 ±26.2 years (males: 39.3 ±25.1; females: 52.5 ±26.5; $p < 0.001$). Ages ranged from six months to 97 years. There were no significant age or gender differences between the Melbourne metropolitan and rural Victorian fatalities.

Road user category

There were 71 (29%) motor vehicle driver fatalities and 66 (27%) passenger fatalities: 39 front seat passengers, 11 left-rear seat, four right-rear seat, two center-rear, seven rear passengers of unspecified position and three other passengers (one rear of utility and two bus passengers). There were 22 (9%) motorcycle riders, two motorcycle pillion passengers, and 13 (5%) bicyclist fatalities.

Pedestrian fatalities were more frequent in the Melbourne metropolitan area (54 (35%)) than rural Victoria (15 (17%))($p < 0.001$).

One-hundred fifty-three (63%) fatalities followed crashes/pedestrian injuries in metropolitan Melbourne and 90 (37%) in rural Victoria.

Time of day of crash

Daytime crashes predominated (Figure 1). The time distribution was similar for metropolitan Melbourne and rural Victoria. Most crashes ocurred between 12:00-18:00 hours.

Ambulance time-to-crash and time-at-scene

The ambulance time-to-crash was available for 241 (99%) victims. The mean value of time-to-crash was 9.4 ±6.4 minutes (min) with a median of eight min. The mean values of the times-to-crash for metropolitan and rural scenes were 7.8 ±4.1 and 12.1 ±8.5 min ($p < 0.001$), respectively, with corresponding medians of seven and 10 min.

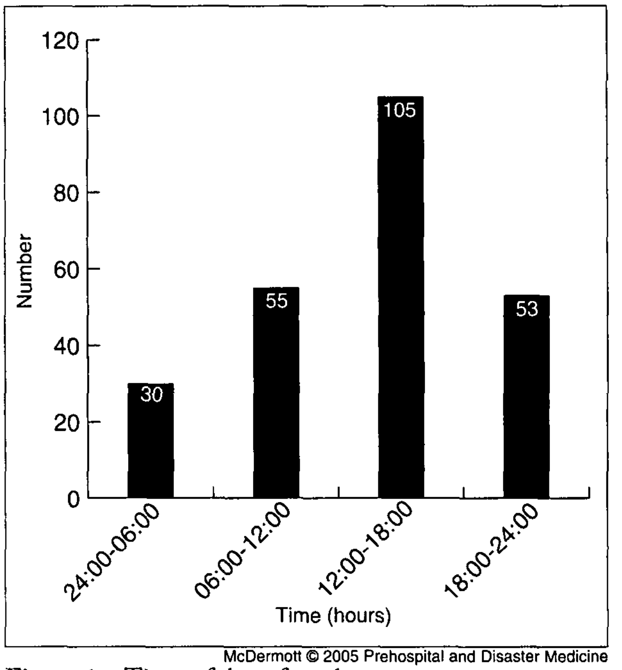

Figure 1—Time of day of crash

Time-at-scene information was available in 239 (98%) patients. The mean scene time was 29.0 ±23.7 min with a median of 22 min. The means for metropolitan and rural scenes were 25.2 ±17.2 and 35.6 ±31.2 min, respectively with corresponding medians of 20 and 25 min ($p < 0.01$).

Extrication

Fifty-one (21%) fatalities were trapped and required extrication: 26 (17%) in metropolitan Melbourne and 25 (28%) in rural Victoria ($p = 0.05$).

Crash scene attendance

Prehospital advanced trauma life support (PHATLS) paramedics attended 134 (88%) crashes in metropolitan Melbourne and 57 (63%) rural crashes ($p < 0.001$). Helicopter PHATLS paramedic crews attended at 37 (18%) Melbourne metropolitan and 25 (19%) rural Victorian crash scenes.

Time from crash to hospital admission

One-hundred fifty-one (69%) fatalities were transported to an emergency department within the "golden hour"—104 (75%) metropolitan patients and 47 (59%) rural patients ($p = 0.01$). Fifty-nine (27%) fatalities arrived within 1–2 hours and nine (4%) after two hours. Twenty-eight (55%) patients requiring extrication arrived in the emergency department more than one hour after the crash.

Maximum Abbreviated Injury Scale Score (MAIS)

One-hundred eight (44%) fatalities had a maximum abbreviated injury scale score (MAIS) 5 and 14 (6%) a MAIS 6. Eighty-nine (37%) fatalities had a MAIS 4, 22 (9%) MAIS 3 and 10 (4%) a MAIS 2 injury. Fatalities with MAIS 5 and 6 injuries were more frequent in the Melbourne metropolitan area (56% vs. 40%)($p = 0.01$).

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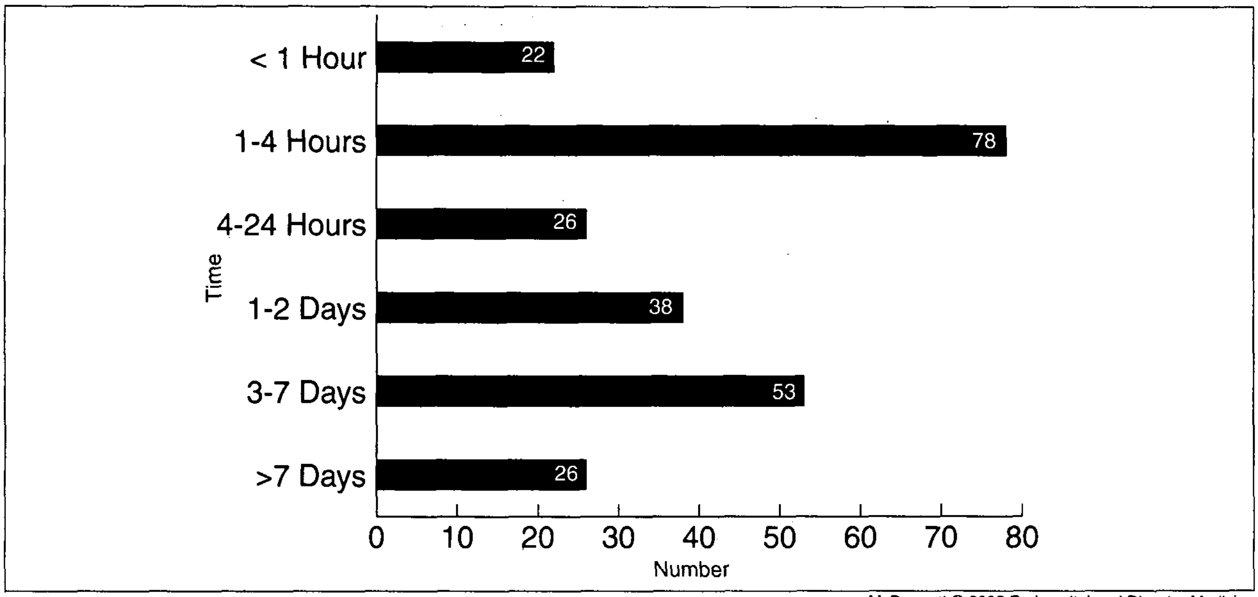

Figure 2—Survival duration distribution

Injury Severity Score (ISS)
Twenty (8%) fatalities had an injury severity score (ISS) of <15. Thirty (12%) had an ISS of 16–25, and 89 (37%) had an ISS of 26–40. For 104 victims (43%) the ISS was >40. The distribution of the ISS was similar for metropolitan and rural patients.

Head injury
One-hundred eighty-eight (77%) fatalities sustained a head injury which was more frequent in metropolitan Melbourne (84% vs. 67%)($p = 0.002$). One-hundred twenty (64%) had associated hypotension (systolic blood pressure <90 mmHg). Fixed and dilated pupils initially were evident in 50 (27%) of the head-injured patients.

Management
Frequent prehospital interventions included airway control with bag-valve-mask (99 (41%)) or endotracheal intubation and ventilation (100 (41%)), intravenous (IV) fluids (167 (69%)), cervical collar (197 (81%)), chest decompression (30 (12%)), and cardiopulmonary resuscitation (CPR) (38 (16%)). In 19 patients for whom CPR was performed, cardiorespiratory function was documented as being re-established. Seven (18%) of the 38 patients receiving CPR died prehospital; 27 (71%) patients died within four hours, two died within 4–24 hours, one died at two days, and another died six days after injury.

One-hundred sixty-seven (69%) patients received intravenous (IV) fluids. Total fluids averaged almost 1.5 liters with approximately half crystalloid and half colloid.

Technical deficiencies included failure to establish IV access (14); failed endotracheal intubation (11); aspiration (6); unrelieved tension pneumothorax (3); esophageal intubation (2); and right main bronchus intubation (2).

Survival duration
Survival duration distribution is shown in Figure 2. One hundred (41%) patients died within four hours. Survival duration was similar for rural and metropolitan fatalities.

Autopsy
A complete autopsy was performed in 215 (89%) fatalities (metropolitan 133 (87%); rural 82 (91%) The immediate causes of prehospital deaths included hemorrhage/hypovolemic shock (13); multiple injuries (8); head injury (5); hypoxia (2); pre-existing condition (2); and tension pneumothorax (1). More than one cause of death was identified in seven patients.

Analysis
A total of 591 deficiencies were identified (Table 1). Of these, 387 (65%) were judged to have contributed to the death of the victims.

One-hundred eighty-seven (77%) of the 243 patients had identified prehospital errors or inadequacies that contributed to death in 135 (56%).

Distribution of problem categories
Details of the frequencies of the different problem categories are provided in Table 1.

Three-hundred ninety-four (67%) deficiencies were related to management and 130 (22%) to system problems. Technique errors, diagnosis delays, and diagnosis errors were relatively infrequent. Ninety-eight (75%) system and 245 (62%) management deficiencies contributed to death. The mean number of deficiencies was 2.44 ±2.15. The mean number of deficiencies per patient was greater in rural Victoria than in metropolitan Melbourne (2.8 ±2.20 vs. 2.24 ±2.09) ($p < 0.05$).

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Category of Deficiency	Total		Contributing to death	
	n	(%)	n	(%)
System	130	22	98	(75) (25)
Management	394	67	245	(62) (63)
Technique	48	8	33	(69) (9)
Diagnosis delay	1	1	1	(100) (1)
Diagnosis error	18	3	10	(56) (3)
Total	591	100	387	(65) (100)

Table 1—Frequency of the categories of deficiency and their contribution to death

System inadequacies

A total of 130 system inadequacies were identified of which 98 (75%) contributed to death. System inadequacies were more frequent in rural Victoria (mean number per patient 0.79 ±1.20 vs. 0.39 ±0.80) (p <0.05).

There were 74 trauma-care deficiencies in delivery including delay in arrival of a MICA (24) prolonged time to the scene (12), and the absence of a PHATLS paramedic at rural crash scenes (9). More than two-thirds of inadequacies in trauma-care delivery contributed to the patient's death.

On five occasions, the chance attendance of a medical practitioner at the scene led to inappropriate interventions. These included: the unrecognized misplacement of an endotracheal tube; undue delay at the scene in waiting for a helicopter instead of immediate transport to the nearest appropriate hospital in a rapidly exsanguinating patient, and the administration of excessive pethidine and IV fluids to a 92-year-old patient.

Of 55 system inadequacies related to resuscitation, 47 (85%) contributed to death. Inadequacies including delay in intubating 12 comatose patients contributed to death in all 12, delay in IV fluid administration in 11 patients contributed to death in nine, lack of skill training for intubation in 10 patients, and in obtaining intravenous access in eight patients contributed to death in nine and seven, respectively.

Management errors and inadequacies

A total of 394 (67%) management deficiencies were identified, of which 245 (62%) contributed to death. The mean number per patient was 1.57 ±1.56 in rural Victoria and 1.71 ±1.63 in Melbourne metropolitan area.

The frequencies of management deficiencies in both trauma care delivery and resuscitation were similar. The most common management deficiencies in delivery were unduly prolonged time at the scene (49) contributing to death in 37 patients and failure to initiate "load and go" in 20 patients contributing to death in 14 (70%). The most frequent resuscitation errors were inadequate fluid resuscitation occurring in 54 patients and contributing to death in 47 (87%). The insertion of only one IV line in 24 hypotensive patients contributed to death in 19 (79%). Other frequent management deficiencies in resuscitation included failure to intubate comatose patients despite the availability of these skills (15 contributing to death in 13 (87%)); inadequate respiratory/ventilatory resuscitation (15 contributing to death in 10 (67%)); and delayed intubation (14 contributing to death in 11 (79%)). Other common management errors were failure to apply or properly fit a cervical collar, excessive sedation, and failure to provide appropriate drugs.

Technique errors

A total of 48 technique errors were identified of which 33 (69%) contributed to death. The most frequent technique errors were failed intubation (22 contributing to death in 15 (68%)), failed IV access (14 contributing to death in 12 (86%)), and esophageal or right main bronchus intubation (four contributing to death in each). The misplaced endotracheal tube rate was 4%.

Diagnosis errors

Ten of 18 diagnosis errors (56%) contributed to death. The errors included failure to identify the following: tension pneumothorax (1); hypovolemic shock (2); misplaced endotracheal tube (1); fractured ribs, bilateral flail chest and respiratory failure (2); severe hypoxia (treated with morphine and not oxygen) (1); fractured pelvis (1); and underestimation of the severity of injury (2).

Diagnosis delays

There was only one diagnosis delay and it contributed to death.

Preventable death assessment

Fourteen (9%) prehospital deaths occurred in the Melbourne metropolitan area and 10 (11%) in rural Victoria. Three (13%) of the 24 deaths that occurred at the scene or en route to hospital were considered to be preventable or potentially preventable. One prehospital death was judged preventable and two potentially preventable.

The one preventable death was that of a 26-year-old male with a single body region injury to the abdomen—a mesenteric laceration. He died two hours after the arrival of ambulance services at the rural crash scene. while in transit to a metropolitan hospital. No MICA or helicopter was available to provide advanced care and rapid transport. The patient was taken to a local medical clinic where IV access was established and approximately 300 mls of fluids were given. Death resulted from massive hemoperitoneum and hypovolemic shock.

The two metropolitan potentially preventable deaths resulted from inadequate airway control in one with multiple injuries complicated by aspiration and airway obstruction and in the other death followed failure to control

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external hemorrhage from a partially amputated lower leg in a patient with multiple injuries.

Discussion

The Consultative Committee's evaluation of prehospital management in 243 fatalities who were alive on arrival of ambulance services during 1997–1998 has identified frequent errors and inadequacies. Two-thirds of the errors/inadequacies were related to clinical management and one-quarter to system inadequacies. Technique errors were appreciably less frequent but more common than were diagnosis errors or delays. About two-thirds of all deficiencies contributed to the patient's death including three-quarters of the system and two-thirds of the management deficiencies. Whereas system inadequacies were almost twice as prevalent in rural Victoria as the Melbourne metropolitan area, management, technique, and diagnosis problems were of similar frequency.

The Committee used the criteria of the Early Management of Severe Trauma Course Manual[17] based on the ATLS course of the American College of Surgeons Committee on Trauma[18] and those of the Victorian Ambulance Service[19] for judgment of appropriate management. These criteria were accepted while recognizing that the value of prehospital IV fluid resuscitation remains uncertain given the absence of supportive evidence from randomized trials. Some argue that although the restoration of blood pressure by IV fluids can improve hypovolemic shock, it may worsen bleeding and outcomes.[20,21] Similarly, the value of prehospital endotracheal intubation is debated. Whereas a retrospective case-control study showed that intubation without drugs significantly reduced mortality in patients with severe head injury,[22] a subsequent study found that mortality was greater with rapid sequence intubation compared to that of matched historical non-intubated controls.[23]

Frequent system inadequacies included delay in PHATLS paramedic arrival, prolonged time-to-crash, and the absence of a PHATLS paramedic at rural crash scenes, which resulted in patients not receiving IV fluids or intubation. During the Committee's initial 1992–1993 study, system inadequacies had accounted for half of all prehospital deficiencies, but improvements including increases in the numbers of rural PHATLS paramedics have appreciably lessened this problem. Initially, the increased attendance of PHATLS at rural crash scenes was associated with more management deficiencies than occurred with Melbourne PHATLS paramedics. This difference, however, was corrected after rural PHATLS paramedics became more experienced.[24–27]

Common management errors included unduly prolonged time at the scene, failure to "load and go", failure to intubate unconscious patients despite the availability of PHATLS skills, inadequate and delayed respiratory/ventilatory resuscitation, and inadequate fluid resuscitation. Many of the fatalities who sustained a head injury and had associated hypotension, which is a recognized cause of secondary brain injury,[28–30] did not receive adequate prehospital IV fluid resuscitation.

The main technical difficulties involved failed attempts at intubation in patients with a Glasgow Coma Scale score <9, esophageal or right main bronchus intubation, unrelieved tension pneumothorax, and failure to establish IV access.

The frequencies of medical interventions including the volumes and types of IV fluids administered were similar to those reported in other countries.[31,32] However, the protocol for the use of morphine and diazepam for intubation has been specific to Victoria in Australia.[33] During the present study, the use of neuroblocking agents had not been approved by the Ambulance Services, but subsequently has been introduced. The use of muscle relaxants by paramedics has been uncommon outside the aeromedical environment with few services worldwide using them. In Europe, the use of relaxants in the prehospital setting is the responsibility of attending doctors.[34]

Almost two-thirds of the fatalities occurred in metropolitan Melbourne. Motor vehicle occupant fatalities predominated followed by pedestrian fatalities who were twice as frequent in the Melbourne metropolitan area as in rural Victoria. Head injury was present in about three-quarters of the fatalities and in about two-thirds of these, hypotension was associated. In this series, most of the fatal crashes occurred in the daytime. The male gender bias was typical of that found in other studies.[35] Age and gender did not differ between metropolitan and rural fatalities, nor did ISS, survival duration, autopsy performance, or the preventable/potentially preventable death rate. Although PHATLS experience was more frequently available in metropolitan Melbourne PHATLS helicopter crew attendance was similar between metropolitan and rural crashes. In addition, more metropolitan patients were transported to an emergency department within one hour of injury. Longer response times in rural areas for emergency medical services have been frequently reported.[36] The average time-to-crash for the Melbourne metropolitan area of eight minutes was similar to that in most other Australian cities and similar to that reported in Britain.[37] The average metropolitan scene time in the present study of 25 minutes was similar to that reported of 21–25 minutes in British studies,[29] although other studies have reported average times closer to 15 minutes.[38,39] Scene times were longer in rural Victoria which in part was accounted for by the higher frequency of entrapment requiring extrication.

The prehospital combined preventable and potentially preventable death rate was one-third of that occurring in hospital (13% vs. 39%). In addition, the number of deficiencies contributing to death was significantly less than that of any of the various areas of hospital care.[1,2] The frequencies of prehospital deaths between metropolitan Melbourne and rural Victoria were similar. There have been few prehospital preventable death studies reported. In a British study of 152 prehospital deaths from injury, the potentially preventable death rate was estimated to be at least 39%. However, this study included deaths occurring before and after the arrival of ambulance services and all of the potentially preventable deaths occurred prior to arrival of ambulance services. A study of 46 prehospital trauma deaths including road traffic crashes and falls in Greece determined that 11% were definitely preventable and 43% probably preventable.[40]

The Ministerial Task Force on Trauma and Emergency Services has made the following recommendations:[12]

1. Major trauma patients should be identified in the prehospital setting according to specified physiological, anatomical, and mechanistic criteria. Because some mechanistic criteria clearly indicate high risk patients and can be determined by the public (ejection, rollover, etc.), secondary support such as MICA should be dispatched immediately on identification.
2. Crash scenes with multiple patients should be provided with on-scene managers (experienced MICA paramedics who can manage the scene with multi-agency response and coordinate hospital destinations of patients) to allow paramedics to minimize scene time for individual patients.
3. A "load and go" protocol should be implemented for patients not trapped that allows most prehospital interventions to be commenced/completed en route. This should minimize scene times.
4. Major trauma patients should be triaged to one of two adult major trauma devices or the one pediatric service, provided that the transport time to the hospital is <30 minutes.[12] The 30-minute limit was chosen as it should ensure that, for most patients, the interval from injury to a major trauma service would not exceed the "golden hour". Previous experience has shown that prolongation of time beyond one hour to the hospital and definitive management reduces the patient's survival prospects.[41] The preference for triage to a major trauma service is based on previous experience demonstrating significantly better survival prospects and fewer preventable deaths in patients managed at Level-1 Trauma Centers.[4,41] Otherwise, the patient will be triaged to the highest designated trauma service accessible within this time interval. In situations in which a major trauma patient is in an immediately life-threatening situation and considered by the attending paramedics likely to die before arrival at a major trauma service, the patient will be transported to the nearest designated trauma service for stabilization and transferred at the earliest appropriate time to a major trauma service. Instances of an immediate life-threatening situation include failed airway control, rapid exsanguinations, and cardiac arrest.[12]
5. There should be direct radio-communication from the crash scene to the trauma receiving hospital.
6. Investigation of alternative methods of elective intubation. It is recognized that the use of morphine and diazepam prior to intubation is not optimal and can be detrimental to patient outcomes. Alternative methods such as the use of muscle relaxant drugs is currently being evaluated for rapid sequence intubation.
7. Capnography should be made available for all prehospital intubated trauma patients.
8. Ambulance/MICA paramedics should be adequately trained to participate in trauma team management in regional/rural emergency departments. This experience will assist in knowledge and application of infrequently used skills and assessment tools for rural MICA paramedics.
9. Investigation of scene times at rural crashes and improved education of rural paramedics in identifying the need for urgent transport to definitive care.
10. Improvement of extrication services.
11. Earlier hospital notification by paramedics through education concerning the importance of hospital preparation for patient reception (This recommendation was made by the Ministerial Taskforce on Trauma and Emergency Services. The Committee had found hospital notification occurred in 79% of admissions).
12. State Trauma Committee to oversee the monitoring and adequacy of Victoria's new trauma care system.

During the last two years, the majority of the recommendations have been implemented.

Conclusion

Peer-group evaluation of prehospital management of 243 consecutive road crash casualties with fatal outcomes in Victoria, Australia identified errors and inadequacies in 187 (77%) patients which contributed to death in 135 (67%). Of the total 591 deficiencies identified, 394 (67%) related to management, 130 (22%) to system problems, 48 (8%) to technique errors, and 18 (3%) and one (1%) to diagnosis errors and delays, respectively. One of 24 deaths at the crash scene or en route to hospital was considered to be preventable and two potentially preventable. The high prevalence of prehospital deficiencies has been addressed by a Ministerial Task Force on Trauma and Emergency Services and Victoria's new trauma care system progressively is being introduced.

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Appendix—Membership of the Evaluation Committees of the Consultative Committee (CCRTF = Consultative Committee on Road Traffic Fatalities in Victoria; MICA = Mobile Intensive Care Ambulance)

Chris Atkin	General Surgeon	Alfred Hospital
Paul Cashin	General Surgeon	Dandenong Hospital
Narine Efe	General Surgeon	The Royal Melbourne Hospital
Richard Gilhome	General Surgeon	Dandenong Hospital
Afif Hadj	General Surgeon	Maroondah Hospital
Peter Ryan (deceased)	General Surgeon	St Vincent's Hospital
Gordon Trinca	General Surgeon	Royal Australasian College of Surgeons
Jeffrey Rosenfeld	Neurosurgeon	The Royal Children's Hospital
John Laidlaw	Neurosurgeon	Alfred Hospital
Bruce Davis	Cardiothoracic Surgeon	Alfred Hospital
John Goldblatt	Cardiothoracic Surgeon	The Royal Melbourne Hospital
Garry Grossbard	Orthopedic Surgeon	Box Hill Hospital
Mark Smith	Emergency Physician	Alfred Hospital
Richard Harrod	Emergency Physician	The Royal Melbourne Hospital
Johannes Wenzel	Emergency Physician	Dandenong District Hospital
Carolyn Cooper	Emergency Physician	Austin Repat. Hospital
Gerard Stainsby	Anesthetist	The Royal Melbourne Hospital
Bill Shearer	Anesthetist	Dandenong Hospital
Graeme Duke	Intensivist	Northern Hospital
Jamie Cooper	Intensivist	Alfred Hospital
Peter Morle	Intensivist	The Royal Melbourne Hospital
John Reeves	Intensivist	Maroondah Hospital
Philip Hogan	MICA Paramedic	Ambulance Airwing – HEMS 3
Greg Cooper	MICA Paramedic	Metropolitan Ambulance Service
David Ranson	Forensic Pathologist	Victorian Institute of Forensic Medicine
Michael Burke	Forensic Pathologist	Victorian Institute of Forensic Medicine
Ann Tremayne	Project Manager	CCRTF
Stephen Cordner	Co-Chair	CCRTF
Frank McDermott	Co-Chair	CCRTF

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