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Prehospital trauma management

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1. Introduction

Pre-hospital trauma management has developed quite differently in different countries. The subject is not supported by a wealth of evidence based research but has instead developed on the basis of the intuition and enthusiasm of individuals and organisations responsible for prehospital management. Many of the basic assumptions on which the current systems are based have been questioned. This is due to a genuine desire to improve patient care and the constant pressure to control costs in every area of healthcare. This article will examine some of the issues in pre-hospital trauma care.

2. Pre-hospital trauma deaths: are they preventable?

Two concepts have significantly influenced the development of pre-hospital and early in-hospital trauma care. The first concept is that of the 'Golden Hour' of trauma. This stresses the importance of early medical intervention in the first hour after trauma has occurred. This principle has relevance to pre-hospital trauma care since, in many Emergency Medical Services (EMS) systems, the majority of this first hour is spent outside hospital [1]. Many publications quote or stress the importance of short 'on scene' times. However, when activation time, response time, patient to vehicle time, transport time and vehicle to emergency room time have been added to the scene time, only a small proportion of the first hour is available for interventions in the emergency department. The small proportion of patients who are trapped at the scene are likely to spend the entire first hour after trauma outside hospital.

The purpose of advanced pre-hospital care for trauma patients is to reduce morbidity and mortality. A reduction in pre-hospital deaths can only occur if these deaths are preventable in the first place.

The second concept is that of the 'trimodal distribution of trauma deaths' proposed by Trunkey in 1983 [2]. He suggested that 50% of deaths occur immediately after an accident due to overwhelming injury. The second peak, representing 30% of deaths, occurs in the first 4 h after injury and the last peak (20% of deaths) occurs after 4 h. Pre-hospital services and early comprehensive care in the emergency department have been developed with these second two mortality peaks in mind [3–5]. However, studies in regions where blunt trauma predominates do not seem to confirm the trimodal distribution of death. They suggest a bimodal distribution of deaths where the potential for saving lives by treatment (as opposed to prevention) is much smaller than was previously hoped [6,7]. The proportion of pre-hospital deaths that are preventable is unclear. It has often been assumed that a considerable proportion of deaths might be prevented by improved pre-hospital care and, for example, Hussain and Redmond [8] estimated that death was potentially preventable in at least 39% of those who died from accidental injury before they reached hospital. Another study assessed up to

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47% of pre-hospital fatalities as being 'possibly preventable' [9]. In contrast, other studies emphasise the fact that the majority of deaths occurring prior to arrival in hospital are inevitable. A recent American study looked at 312 pre-hospital deaths where no on site medical care was provided [10]. Sixty percent of deaths occurred at the time of injury and 80% had abbreviated injury scores of 5 or 6. In this study a large proportion of the deaths were firearm related. Other studies have looked at victims of blunt trauma. One found that of 158 pre-hospital deaths only three were likely to have been preventable [11]. Another suggested that in 305 victims of vehicle accidents in the UK the proportion of deaths that might have been avoided in the pre-hospital phase was only 3.1% [12]. In rural Michigan a maximum preventable death rate of 12.9% among 155 trauma deaths was estimated. Of these the majority were in-hospital deaths. [13]. A recent UK study [14] assessed trauma deaths within 3 days of injury. Only 1.4% of the deaths were judged to be preventable by optimal pre-hospital care. Interestingly, in this study while the vast majority of deaths were due to blunt trauma (as expected in the UK), a large proportion of the deaths judged to be possibly preventable were due to the penetrating trauma. This appears to be because the expert panel judged that pre-hospital delay may have contributed to death in patients who died of exsanguination. One potential drawback of most of these studies is that preventable death is often judged by expert panels. Agreement among experts is often poor in the area of pre-hospital care [15].

It appears that the majority of pre-hospital deaths are inevitable. However, prevention of mortality of even a small proportion of pre-hospital deaths may be very worthwhile both medically and economically. The estimated financial benefit to a community of a trauma life saved is said to be very considerable — in UK, for example, the Department of Transport estimated the cost of a trauma life saved in 1993 to be £774 000 [16]. The effect of pre-hospital interventions on in-hospital mortality and morbidity may be more important. However, the effect of pre-hospital interventions are difficult to separate from the effects of the many in-hospital interventions likely to be been carried out on the severely injured patient.

3. International trauma system development

The availability and level of pre-hospital trauma care varies a great deal in different EMS systems. This is partly due to the widely different emphasis placed on the pre-hospital phase of care in different systems, and partly because of variations in funding, personnel and geography.

Trauma care is one small part of pre-hospital EMS. While specific thought and resource has been given to trauma in many systems, in others it is only a minor consideration. It has to be remembered that in some areas major trauma is a rare event. Even in a large European conurbation like London, of approximately 1350 calls received every day by the ambulance service only two or three calls a day involve major trauma [17]. This means that on average, emergency paramedic crews will see only one or two victims of major trauma per year.

Unfortunately, developing countries with poorly developed pre-hospital services, are often those with high rates of trauma [18,19]. A recent study looked at trauma care in a low income area (Ghana), a middle income area (Mexico) and a high income area (USA). Patterns of injury were found to be similar. Mortality decreased with increased income and this was due mainly to a decrease in pre-hospital deaths. Scene time was longer in low income areas. The study concluded that injury prevention was a priority in all the three countries but that decreases in mortality could be achieved by targeting pre-hospital and emergency room care [20]. The type of pre-hospital trauma care systems that developing countries should aim to develop is unclear. Any system should aim to decrease mortality maximally within their resource limitations and in many countries it may be that other healthcare issues take priority. The advanced EMS systems found in the USA are probably not role models for developing countries. One recent study looked at the possible costs and benefits for an EMS system in Kuala Lumpur and concluded that a system based on a North American EMS would be costly and would only be expected to save a very small number of lives per year [21].

Even in Europe, where countries often have a similar, predominantly blunt pattern of trauma, and similar geography and populations, there are different approaches to pre-hospital trauma care. One survey of 22 European countries revealed marked differences in pre-hospital care [22]. While most had 100% ground vehicle coverage of the population, some did not. As expected, air coverage was more variable. In terms of personnel, 59% used predominantly paramedics or nurses in ground ambulances. France, Germany, Eastern European countries, Italy, Belgium and Turkey used physicians outside hospital frequently. Physicians were never used in Holland or Sweden and rarely in most other countries.

Pre-hospital EMS systems develop to some extent according to funding. In some countries the whole system (including aeromedical services) are state funded. This is the situation in France. In some developing countries, privately funded advanced EMS care exists for a small proportion of the population and there is virtually no system for the remaining majority [23]. Many countries have a system of funding somewhere in between.

Differences in personnel are also present in similar systems. Ground vehicles with paramedics and technicians are commonly used. In some systems the fire service rather than the ambulance service are the first responders. Some services employ dual trained personnel (paramedic and fire fighter). For trauma incidents a system like this gives the advantage of large numbers of personnel on scene early. This gives the opportunity to reduce scene times by performing on scene tasks simultaneously rather than consecutively. In-transit care may be limited where a crew of only two is dispatched and one has to drive. Other possibilities are being evaluated. In the UK, motorcycle paramedic services compliment ambulance services to reduce dispatch times and increase personnel numbers at serious incidents.

In conclusion, there is little uniformity in pre-hospital EMS care even in countries with similar resources. Generally accepted models have yet to be established and good evidence for the benefits of particular systems is sparse. Whatever system is developed, it is important that the system is seen as a whole, from the accident scene to rehabilitation. Development of the pre-hospital component of an EMS without consideration of, and effective integration with, the rest of the EMS is likely to produce sub-optimal results.

4. Opportunities for change in the different stages of the pre-hospital phase

The course of the pre-hospital phase is determined by bystander assistance, callout and response time of the emergency services, the nature and skill levels of the rescuers, on scene interventions carried out, and lastly, the method and speed of transport and the chosen hospital destination.

4.1. Bystander interventions

Bystanders may assist a victim by first aid or basic life support (BLS) measures and also by rapidly alerting the emergency services. The BLS skills of the general public will depend upon the availability of training and publicity given to the subject in the country concerned. It is established that in cardiac arrest early BLS is one of the few interventions which improves outcome [24]. In the trauma scenario bystander interventions have not been evaluated. It seems likely that apart from early activation of the emergency services, simple bystander interventions that might be effective at the scene are the maintenance of a patent airway [8], prevention of movement of the injured cervical spine and the application of pressure to external bleeding. Bystander BLS for the trauma patient who has sustained a cardiac arrest outside hospital will not save many lives since such patients virtually never survive [25].

4.2. Emergency service dispatch

Emergency service dispatch may influence the pre-hospital course of trauma patients in several ways. Major trauma is a relatively rare event [17] and has to be separated from a large (and increasing [26]) number of emergency calls. An effective dispatch system may decrease the time to attendance of the emergency services and, where more than one response is available, it may direct appropriate resource to the trauma victim.

In countries with a well developed EMS, activation of the emergency services is usually by a rapid, one number access system. Where this is not the case, dispatch may be significantly delayed. The proliferation of mobile telephones in some countries might be expected to reduce the activation times, particularly in rural areas.

Some countries have developed response time targets for ambulance services. In the UK, for example, the new Department of Health targets are for a response time of 8 min to 90% of potentially life threatening calls, 14 min to 95% of serious incidents and 'as soon as possible' for other calls [27]. To achieve time targets some sort of call triage system has to be used. These systems are in common use in the US and are being introduced into many other countries. They are, however, not without problems. They rely on information from the caller which, if inaccurate can lead to underproritisation of the call and potentially serious delay in response. Most systems allow for this and tend to allocate the highest priority to a large proportion of calls up to 40% has been reported [28] which makes the system safer but much less specific. The two most commonly used systems are criterion based dispatch (CBD) [29] where guidelines help the dispatcher reach a priority decision, and advanced medical priority dispatch (AMPD) [30] where scripted questions and protocols allow little room for interpretation by the dispatcher in reaching the appropriate decision. Both systems have improved efficiency of dispatch and rarely underprioritise calls [26,31]. In some countries, e.g. France and Germany, all the emergency calls are routed to control rooms where a physician is available to advise on an appropriate response. In these countries a number of responses are possible and a multiple trauma victim would be allocated a pre-hospital doctor who would be sent by land or air. In USA, physicians in many States can be contacted by paramedics for advice and 'on line medical control'. In contrast, some EMS systems rely on controllers with no clinical training whatsoever. There may be some justification for this system if only one response is available to a call (as in the majority of UK) but call triage systems may still be required if resources are stretched to meet time targets.

4.3. On scene interventions

4.3.1. Airway interventions

Airway compromise and hypoxia are common at the accident scene [32]. Uncorrected complete obstruction causes irreversible brain damage and death. Lesser insults can profoundly influence outcome, particularly in the presence of head injury [33]. The importance of airway management in trauma patients is, therefore, clear, but exactly how the airway should be managed in the pre-hospital phase is less clear. Trauma patients with airway compromise in hospital are usually intubated after rapid sequence induction. This level of intervention is not available in many pre-hospital systems.

The relief of airway compromise by simple manoeuvres such as the jaw thrust or chin lift is encouraged in virtually all pre-hospital EMS systems. The next step in airway management varies widely in different systems. Some stop at this point and others progress to non-drug assisted intubation. Drug assisted intubation and surgical airways are available in some systems.

The concept that early intubation of the trauma patient with airway compromise is appropriate is not contentious. No one makes a case for delaying intubation of such patients once in hospital. It therefore seems logical to provide the intervention at the accident scene to reduce the exposure time to hypoxia. There are no trials confirming this benefit, though one recent retrospective study did suggest a reduction in early mortality among head injured patients [34]. The potential problems with on scene intubation are (1) providing the necessary skill levels and skill retention for a procedure which may be carried out infrequently [14], (2) providing the best chance of success in a group of patients thought to be relatively difficult to intubate [3] and which may involve the use of drugs to facilitate intubation and (3) Providing an effective 'rescue' plan if intubation fails, particularly when drugs have been used and the patient rendered apnoeic.

In physician led pre-hospital services the rate of failed intubation is reported to be between 0.9 [35] and 3.8% [36]. The grade and speciality of physicians varies between different services but drugs are invariably used to facilitate intubation. The failure rates are considerably higher than commonly quoted in-hospital failed intubation rates for the elective general surgical and obstetric population. However they compare well with 2.6% for failed intubation of injured patients in a hospital emergency department [37]. In non-physician led pre-hospital services, failed intubation rates are more variable. This may be due partly to the practical skills and experience of the personnel involved but is complicated by other factors such as the fact that drugs are often not used to facilitate intubation. This may reduce success rates considerably. In one US study involving 97 pre-hospital intubations without drugs, paramedics had an intubation failure rate of 48% [38]. In another small study, US flight nurses had a failed intubation rate of 20% after the administration of sedative drugs and succinylcholine [39]. Since the administration of drugs potentially can convert a 'cannot intubate' situation into a rapidly fatal 'cannot intubate/cannot ventilate' situation, such high failure rates are of concern. In hospital practice it is a relative contraindication to administer a muscle relaxant to a patient where intubation is likely to be difficult. If muscle relaxants are to be administered in pre-hospital situations the rescuer should be confident of rapidly achieving a definitive airway.

When laryngoscopy is difficult outside hospital, the operator is unlikely to have access to the same range of equipment as in hospital. However, some simple lightweight items have been used successfully outside hospital. They include the gum elastic bougie which has been recommended where only a small part of the glottis can be visualised [40], stylets to direct the tracheal tube into the larynx and the recently introduced McCoy laryngoscope with a hinged blade tip which can improve the view at laryngoscopy when patients are immobilised in a cervical collar [41]. When both intubation and ventilation fail, urgent cricothyroidotomy is indicated. A number of studies reporting surgical cricothyroidotomy performed outside hospital by doctors, nurses and paramedics have been published. It is notable that whoever performs the procedure, success rates are high (between 82 [42] and 100% [36]), perhaps unexpectedly, for a procedure that most operators will perform rarely and in difficult circumstances.

The proportion of patients having attempted cricothyroidotomy is a measure of the failed intubation rate in that system. The lowest rates of surgical airway are seen where doctors administer muscle relaxants [36] (3.8%). Much higher rates can be seen where nurses (18%) [43] or paramedics (15%) [44] attempt to secure the airway (usually without muscle relaxants). Outcome is often not recorded in these studies but what is apparent is that trauma patients who are intubated after cardiac arrest virtually never survive. Another issue is training for a procedure that is rarely performed. It has been estimated that 70% of US paramedics are permitted to perform surgical cricothyroidotomy but that on average each will do only one in every 41 years of practice [44]. Where nurses have performed the procedure with excellent success rates [45], it is notable that they have had regular practical laboratory training.

A number of alternatives to tracheal intubation have been used in trauma patients. Where tracheal intubation fails but ventilation can be achieved, it is likely that transfer to hospital unintubated is the preferred course of action. The laryngeal mask airway (LMA) is established firmly in the European Resuscitation Council guidelines as an alternative to intubation [46] but experience with the device in pre-hospital trauma patients is limited. However, it has been shown that paramedics find insertion of the LMA easier than tracheal intubation [47], and an Australian study showed that paramedics have high success rates for LMA insertion in the pre hospital environment [48]. The Combitube has the advantage of blind insertion and it's use is supported by several encouraging small studies. In the pre-hospital environment, when used as the airway management technique of first choice by paramedics, a success rate of 71% has been reported. More importantly, in the same study, 64% of failed tracheal intubations were successfully managed with the Combitube [49]. In another recent study, where flight nurses failed to intubate 20% of trauma patients to whom muscle relaxants had been administered, all were successfully managed with the Combitube [39]. Although this device was felt by some to be too complicated for use outside hospital, these results challenge this view. It may have a role as an 'airway rescue device' after failed tracheal intubation, particularly where a rescuer cannot perform a surgical airway.

The combined oropharyngeal airway (COPA) is another potential pre-hospital airway device which has yet to be fully evaluated.

4.3.2. Chest drainage procedures

Decompression of tension pneumothorax is a practical procedure which can easily be carried out in the pre-hospital phase. Physician led teams can perform needle or tube thoracocentesis. This is also true of some paramedic and nurse led teams particularly in aeromedical services. Both procedures can be performed with a low complication rate. Tube thoracocentesis takes longer to perform but may need to be performed when needle aspiration fails [50]. Drainage procedures outside hospital have been shown to improve oxygen saturation, blood pressure and reduce pulse rates [51]. The potential problems with drainage procedures are diagnostic uncertainty, placing a needle where no injury exists and causing iatrogenic pneumothorax, and decompressing a massive haemothorax away from surgical and transfusion facilities. Although needle drainage is quick and easy to perform it may only relieve tension pneumothorax transiently. It may also be difficult to reach the pleural cavity with standard length needles [52] particularly in large numbers of patients. In one US study, comprising mainly penetrating trauma, the procedure was performed infrequently by paramedics and only 5% showed objective improvement in vital signs [53]. A German study of pre-hospital tube thoracocentesis showed a low complication rate but a non-therapeutic tube placement rate of 2.4% [54]. An effective, rapid alternative to tube placement is simple thoracostomy on scene with tube placement after arrival in hospital [55].

4.3.3. Bleeding control

Control of external haemorrhage by direct pressure is an appropriate pre-hospital intervention for any level of rescuer. Simple limb splintage is also effective in reducing blood loss and pain. At the other end of the spectrum, physicians in the UK have carried out resuscitative open thoracotomy for penetrating trauma successfully outside hospital [56]. The role of pre-hospital venous cannulation and fluid administration is controversial. Intravenous cannulation increases pre-hospital time but can often be achieved quickly and with high success rates [57]. One recent UK study showed an increase in scene time of 12 min and success rate of 94% when cannulation was attempted [14]. Cannulation can be carried out during transport to reduce scene times [58]. If the induction of anaesthesia is contemplated, venous access is necessary. If cannulation is for fluid administration only then benefits may be less marked. Where transport times are short the amount of fluid administered prior to arrival in hospital is often small. [59]. The aim of fluid administration is to restore intravascular volume and maintain end organ perfusion. Studies in penetrating trauma have suggested that pre-hospital fluid administration may increase bleeding and worsen outcome [60,61]. The shift from fluid resuscitation to surgical haemostasis with simultaneous fluid replacement is now reflected in the teaching of the advanced trauma life support (ATLS) course [3] for in hospital practice. The special situations of entrapment and head injury are different to penetrating trauma. Entrapment often involves lengthy pre-hospital times. End organs can only endure a finite amount of hypoperfusion without damage and this is particularly true of the non-autoregulated injured brain. If only a small volume of fluid is infused prior to arrival in hospital it may be that hypertonic solutions, which cause a disproportionately large expansion in plasma volume, are more appropriate than isotonic fluids. A meta-analysis in 1997 suggested survival improvement with hypertonic solution in a heterogenous group of trauma patients [62].

4.3.4. Does pre hospital advanced life support decrease mortality?

Table 1 summarises some of the studies often quoted for and against pre-hospital ALS care as a whole. All have drawbacks and a recent comprehensive review of the available literature [63] suggested that the studies published both for and against pre-hospital ALS care are scientifically weak and in many cases misleading in their conclusions. Most studies are retrospective, uncontrolled and often only refer to small trauma subgroups. Such studies cannot be reasonably extrapolated to support or condemn the effect of pre-hospital ALS on the whole trauma patient population.

4.4. Transport

Rapid but safe transport to hospital is an objective of every EMS. The most controversial area of transport in trauma care is the use of helicopter services [64–66]. Various studies on the subject have been published but most have shortcomings and are relevant only to the system that they come from. This is not surprising since the studies have emerged from radically different systems serving different populations with different types and severity of injury. The level of medical care on scene varies as do the facilities available at the receiving hospitals. The use of helicopters varies from a fast mode of transport which, unless dis-

Table 1
Studies evaluating pre-hospital advanced life support in trauma patients

Authors	Date/journal	Patients	Outcome measures	Results	Study limitations
Messick et al. North Carolina	J. Trauma 1992 December;33(6):850-5	12 417 trauma deaths in 24 BLS counties vs. 76 ALS countries	County trauma death rates	Statistically significant difference in favour of ALS counties	Not prospective unrandomised
Sampalis et al. Montreal	J. Trauma 1993 February;34(2):252–61	Trauma (mod/severe) given ALS by doctors or not	Death at or before 6 days	ALS did not improve survival	Unrandomised
Aprahamian et al. Milwaukee	J. Trauma 1983 August;23(8):687–90	Major open intra abdominal trauma. 48 paramedic attended patients compared with technician attended historical controls	In hospital deaths	Lower death rate in Paramedic group (relative risk of death 0.8. 95% CI 0.45–1.95)	Not prospective small numbers specific trauma sub group historical controls
Fortner et al. Seattle	J. Trauma 1983 November;23(11):976–81	Multiply injured patients jumping from a bridge 1971 ALS (1970–1981) vs. 36 BLS (1950-1969)	Death until hospital discharge	Decreased mortality in ALS group	Not prospective historical controls all aspects of management changed in period of study not just pre-hospital care
Jacobs et al. Boston	J. Trauma 1984 January;24(1):8–13	Severely injured trauma patients: 80 ALS vs. 98 BLS	Change in trauma score (TS).	Change in trauma score affects outcome but outcome model failed to confirm link between crew status and outcome	Small numbers unrandomised uncontrolled
Cayten et al. New York	J. Trauma 1993 September;35(3):460–6	434 ALS vs. 347 BLS All trauma patients	Death before discharge	BLS = 14.7% death rate ALS = 17.1% death rate Relative risk (RR) = 1.19 (corrected for age, ISS, mechanism RR = 0.98)	Not prospective no controls
Rainer Scotland	Injury 1997 November –December;28(9-10):623 –27	247 ALS vs. 843 BLS patients. MTOS criteria (trapped patients excluded)	Death in hospital	ALS death rate = 4.0% BLS death rate = 3.1% (RR = 1.31)	Unrandomised
Nicholl et al.	Health technol assessment, 1998	MTOS criteria excluding patients attended by doctor ALS 1440 patients vs. 605 BLS patients	Death up to 6 months post incident	ALS death rate = 6% BLS death rate = 4.6% (RR = 1.29)	Not randomised
Potter et al Sydney and Brisbane Australia	Ann. Emerg. Med. 1988 June;17(6):582–88	472 ALS vs. 589 BLS trauma death or admission >24 h	Death, length of hospital stay, Glasgow outcome score	Death rate (crude): ALS = 7.9% BLS = 5.6% (RR = 1.41) Improvement in first 24 h mortality in ALS group but no change in in-hospital mortality After adjustment: no difference in hospital stay, ICU stay, GOS. More respiratory failure in BLS patients	Uncontrolled Small number of fatalities

tances are significant, may not even save time [66], to services which target severe injury and provide a higher level of medical care on scene along with increased triage options. Also, treatments may have changed significantly since the earlier, much quoted studies were performed [67,68]. Mortality is usually the major outcome measure but may be a crude indicator of effectiveness. Morbidity is also not straightforward since survivors may spend months in hospital after their accidents. This means that many variables may effect outcome other than the pre-hospital care received.

Baxt and Moody published three of the largest studies on this issue, all of which concluded that helicopter medical services reduced mortality in trauma patients. The first, published in 1983, compared 150 patients transported by non-physician land crews with 150 patients transported by physician/nurse aeromedical teams to the same trauma centre. The mortality in each group was compared with the mortality of a large reference population. The aeromedical group had a 52% reduction in mortality from that predicted. No reduction in mortality was seen in the land group [68]. In 1985, a second study looked at the predicted and actual mortality of 1273 blunt trauma patients transported by seven aeromedical services (with different crew configurations) to different trauma centres [67]. There was a statistically significant 21% reduction in mortality. A criticism of this study was that the aeromedical patients might have received better in-hospital treatment than the 'control' group consisting of patients from the 45 trauma centres participating in the major trauma outcome study (MTOS). Two years later, the mortality and Glasgow outcome scores of 128 patients with severe brain injury taken by land (non physician) crews were compared to 104 patients taken to the same hospital by physician led helicopter crews [69]. There was a significant reduction in both mortality and outcome scores. In these studies it is difficult to separate the possible beneficial effects of the rapid response and transport that a helicopter provides from the effects of the presence or absence of a doctor on scene. A recent Australian study (unfortunately retrospective) demonstrated a significant reduction in mortality in blunt trauma patients where a doctor is added to a paramedic aeromedical crew [70]. Physicians performed more interventions in the pre-hospital phase. The authors calculated that eight to 19 extra survivors per hundred patients treated would be expected in the physician group.

Supporting the positive effects of aeromedical evacuation found by Baxt and Moody another American group [71] found a reduction in mortality in 93 helicopter transported patients and an increase in mortality among 33 land transported patients compared to the MTOS reference population. In Arizona, Schiller [72] compared the mortality of 259 land transported patients and 347 helicopter transported patients. All patients had Injury Severity Scores of 20–39 and came from an urban area. No difference in mortality was demonstrated. This study was not prospective and the patients in the helicopter group may have been more severely injured. A recent Norwegian study [73] examined 370 cases of helicopter evacuation from a rural area. An expert panel concluded that selected patients derived considerable health benefits from the service. However less than 20% of the patients were trauma victims.

In UK, the Department of Health commissioned three studies into helicopter medical services which were carried out by the Medical Care Research Unit in Sheffield. Two of the studies did not contain enough trauma patients to comment on the benefits, or otherwise, for this group of patients. The third study compared 337 patients carried by Helicopter Emergency Medical Service (HEMS) London with 466 patients carried by land ambulance [74]. The authors concluded that there was no overall survival or outcome advantage in the HEMS group. They did suggest that survival benefit might occur in the HEMS group for very severely injured patients, perhaps 13 patients a year. Other investigators have also suggested that the group of patients deriving most benefit from aeromedical services might be those most severely injured [68,75]. Other criticisms of this study were that it included only a third of the HEMS patients in the study period which might predispose to type two error [76] and that the HEMS group contained more severely injured patients than the land group [77].

In summary, the overall evidence for the benefit of helicopter services for trauma patients is unclear and none of the studies published to date have provided a definitive answer. It may be that studies concentrating on specific aspects of processes of care will be easier to design and carry out than large outcome studies.

5. Conclusions

The treatment priorities for trauma patients outside hospital are the same as in the emergency department. As discussed above, different approaches are used by different EMS systems for the treatment of similar patients. There is no good evidence that one approach is significantly better than another. Most controversy in pre-hospital care can be summarised in the question ‘Does the benefit of on scene intervention outweigh the disadvantage of delayed arrival in hospital?’ The problems of demonstrating the benefits of most interventions have been discussed above. Even interventions which seem mandatory and are clinically second nature, are difficult to quantify scientifically without the great deal of expense and effort which a randomised controlled trial involves. The unrandomised, uncontrolled retrospective studies which make up the majority of pre-hospital studies pre-dispose to positive outcomes and may be misleading. The second part of this question is also surprisingly unsupported. Some EMS systems do not strive for short pre-hospital intervals [35] and there is no objective proof that in trauma patients the time interval from injury to operating theatre is the primary determinant of outcome [63]. The collected studies on this issue are as scientifically weak as those on pre-hospital ALS. A recent editorial on the scientific basis of pre-hospital care [78] demonstrated that despite yearly massive expenditure on pre-hospital services world wide, the total recent scientific database on the subject is less than that of minor medical complaints such as urticaria or constipation. Large outcome studies are ongoing and may help guide future service provision [79,80]. Until then, it seems that the provision of care for severely injured patients, a small but important group of pre-hospital patients, has to be based on the treatment principles of sound hospital clinical practice without undue delay in transport to definitive care.

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