DETERMINING THE COMPOSITION AND BENEFIT OF THE PRE-HOSPITAL MEDICAL RESPONSE TEAM IN THE CONFLICT SETTING

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Abstract

Aim: To determine the optimal composition of the pre-hospital medical response team (MERT) and the value of pre-hospital critical care interventions in a military setting, and specifically to determine both the benefit of including a doctor in the pre-hospital response team and the relevance of the time and distance to definitive care.

Method: A comprehensive review of the literature incorporating a range of electronic search engines and hand searches of key journals.

Results: There was no level 1 evidence on which to base conclusions. The 15 most relevant articles were analysed in detail. There was one randomized controlled trial (level 2 evidence) that supports the inclusion of a doctor on MERT. Several cohort studies were identified that analysed the benefits of specific critical care interventions in the pre-hospital setting.

Conclusions: A doctor with critical care skills deployed on the MERT is associated with improved survival in victims of major trauma. Specific critical care interventions including emergency endotracheal intubation and ventilation, and intercostal drainage are associated with improved survival and functional recovery in certain patients. These benefits appear to be more easily demonstrated for the rural and remote setting than for the urban setting.

Introduction

Pre-hospital critical care is an area under close scrutiny. There is a lack of robust clinical evidence on which to base MERT crew composition and current management protocols. There is discrepancy between the evidence for best pre-hospital management in urban versus rural and remote settings [1,2,3]. During operations the tactical situation will influence best practice because optimal patient care must be balanced against the risk to all personnel involved in the retrieval of a critically ill or injured patient. The distance and time from definitive care, the availability of skilled medical personnel and the time available on-scene for complex medical interventions are factors that may be influenced during operations.

This literature review aims to explore current evidence with regards to three clinical questions.

1. In the pre-hospital management of military trauma patients is the clinical outcome affected by the attendance of an emergency medical technician (EMT), paramedic or nursing officer?
2. In the pre-hospital management of trauma, does the presence of a doctor influence clinical outcome?
3. In the management of time-critical injuries in pre-hospital trauma patients, does evidence exist to support critical care interventions in the following situations:
   a) The urban versus the rural environment?
   b) Where evacuation to definitive care may be delayed?
   c) In cases of penetrating versus blunt trauma?

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Methodology: Search Strategy

A detailed search of MEDLINE, Cinahl, Embase and PubMed was performed in February 2007. Internet searches of Google Scholar, Google and MD Consult (Elsevier) were completed in February 2007. Keywords used: military medicine; pre-hospital; personnel; outcome; nurse; emergency medical technician; paramedic. Relevant articles were selected by the titles and abstracts with a subsequent hand search of key publications.

Results

Twenty-three articles were identified and studied in detail; 15 were most relevant to the clinical questions. The level of evidence ranged from a level 2 randomised clinical trial to level 4 material that included letters, commentaries, event analyses, and literature reviews. Unpublished work analysing the evidence for pre-hospital critical care intervention and the composition of pre-hospital aeromedical teams is included from a paper written by 16 Close Support Medical Regiment (16 CS Med Regt) while deployed in Afghanistan [4].

A summary of the articles highlighted in the literature search and most relevant to the clinical questions is included in Table 1.

Summary of the Evidence

1. The inclusion of a doctor with critical care skills is associated with improved survival in victims of major trauma.
2. Emergency anaesthesia and controlled ventilation pre-hospital is associated with improved survival in victims of severe traumatic brain injury (TBI).
3. Emergency anaesthesia, controlled ventilation and intercostals drainage pre-hospital is associated with improved survival in victims of severe thoracic injury.

Discussion

Crew Composition

The first two clinical questions can be considered under the title of Crew Composition:

Gourley and Gerhardt (5,6) suggest that US military aeromedical Emergency Medical Technician (EMT) crew, operating single-handed, provide a sub-optimal level of care compared with a two person paramedic crew in the civilian trauma setting. This US military experience of employing EMTs as Flight Medics is used as evidence to support the current Royal Air Force (RAF) model of a conjoint Flight Nurse and Flight Paramedic aeromedical team, where the Flight Nurse is drawn from the emergency nurse or intensive care nurse cadres.

Wang's prospective observational study [24] suggests that error rates are high with ALS procedures performed by paramedics.

When considering the value of a doctor in the pre-hospital team only one randomised controlled trial (7) directly compared two different compositions of an aeromedical team. One team comprised a Flight Doctor and Flight Paramedic; the other a Flight Nurse and Flight Paramedic. This study, and the review by Garner [8] support the integration of a critical care doctor within a helicopter emergency medical service (HEMS) aeromedical crew.

Grissom [9], Hetz [10] and the work by 16 CS Med Regt [4] all support the inclusion of a doctor with critical care skills in military primary retrieval (incident site to receiving medical facility) and secondary retrieval (inter-medical facility transfer) operations. These papers describe the essential role of critical care doctors (usually intensivists or emergency doctors) in the aeromedical evacuation of unstable or undifferentiated patients, often requiring anaesthesia and ventilation, over long distances.

The value of the pre-hospital doctor is inherent in his / her ability to perform advanced or critical care interventions such as rapid sequence induction of anaesthesia (RSI), controlled ventilation and tube thoracostomy. This added value also resides in his / her ability to contribute to the command and control of the pre-hospital response, for instance in major incidents where complex triage decisions may be required, and limited resources need to be managed optimally [4,6,7,8,9,10,11,12,13]. Currently in the UK Defence Medical Services (DMS) these skills reside predominantly in the anaesthetic, intensive care and emergency medicine cadres. Clearly these doctors now have a role in the coordinated pre-hospital response to major injury incurred during military operations.

Evidence to support pre-hospital critical care interventions for time-critical injury

Time-critical injury is a term that relates to injuries where there is a predictably poor outcome without early definitive intervention. Some definitive interventions are achievable in the pre-hospital setting (eg endotracheal intubation, decompression of tension pneumothorax) whereas others will require hospital-based skills (eg surgery for non-compressible haemorrhage). The questions considered in this review overlap with those around the benefits of pre-hospital critical care in the urban versus rural setting, and when evacuation time-lines are protracted. It is unrealistic to view these issues independently.

The proximity of the incident site (point of wounding) to the location where definitive resuscitation may take place, is a function of both distance and circumstance. The key consideration is the evacuation time: usually this is fast in the urban environment but invariably prolonged in the rural and remote setting. Operational circumstances – especially the prevailing tactical situation - must be considered when assessing the likely accessibility to definitive medical care for critically ill or injured military patients.

There is conflicting evidence to support pre-hospital critical care in the urban trauma setting [11,14]. By contrast, in the remote and rural environment – the situation most closely analogous to current UK military operations – the evidence overwhelmingly supports pre-hospital critical care [4,6,8,9,10,12,13,15,16,17],

One study specifically compared two trauma systems managing combat injuries in the Battle of Jalalabad during the Soviet occupation of Afghanistan. One limb of the study considered mortality where there was no systematic treatment of battle injury with another system that employed a qualified paramedic [15]. There were significantly improved outcomes from the latter system. In both systems evacuation times were prolonged, frequently 5-7 hours from point of wounding to the receiving medical facility.

The reviews conducted by Garner and Davis et al [4,8] analysed retrospective and prospective cohort studies. They demonstrated that the best evidence to support pre-hospital critical care exists for the use of RSI and controlled ventilation in the pre-hospital management of severe traumatic brain injury (Glasgow Coma Scale score <9) and RSI, ventilation and intrapleural decompression procedures in severe blunt thoracic trauma. These reviews, and internally published data from Ops TELIC and HERRICK, have demonstrated unexpected survivors with these advanced pre-hospital interventions according to TRISS methodology [18]. The expeditionary warfare operations that the UK military are currently conducting in Afghanistan involve such distances between combat zones and medical facilities that the lessons learned from civil rural retrieval operations can be extrapolated to the military setting.

Sebesta identified that of all the deaths at the US 31st Combat Support Hospital, in Iraq between January 2003 and January 2004, 51% were potentially preventable, and 10% were due to pre-hospital airway issues [16]. Uncontrolled haemorrhage from extremity injury has repeatedly been shown to be a prime preventable cause of death in conflict [19]. The lessons learned in Iraq and elsewhere by the US military confirm that the effective management of catastrophic haemorrhage must take priority in the field. Pre-hospital management of catastrophic haemorrhage must therefore take priority over airway management [20], and this is emphasised by current UK DMS clinical doctrine [21,22] and equipment scales in the UK military. This diverges from the traditional civilian doctrine of Airway – Breathing – Circulation [23] but nevertheless this underlying principle supports the change in paradigm by the UK armed forces to <C> ABC, where <C> dictates the control of catastrophic haemorrhage before attending to ABC. Equally, this US data shows that whilst attending to compressible haemorrhage will save many lives, a significant number of casualties will benefit from basic and advanced airway intervention alone. It could be argued that the greatest good for the greatest number of patients during conflict will be achieved by focusing on the management of compressible haemorrhage rather than advanced airway intervention for instance, and that the skills of a critical care physician are not required to manage compressible haemorrhage. However the potential deployment of blood and blood products with aeromedical teams, and the requirement to apply tourniquets to extremity injuries judiciously, are further reasons to support the inclusion of such a physician. Additionally, in complex injuries where non-compressible haemorrhage is present, and surgery offers perhaps the only

Author & Year	Study design	Type of teams	Results	Comments
Garner 2004 (Aust) [8]	Literature review of the role of doctor staffing of HEMS in the pre-hospital trauma response	Helicopter and ground combinations of nurses, paramedics and doctors	Studies from 1983 – 2001 included, including the only Level 1 – RCT – study. Doctors were compared with paramedics and nurse team members empowered to perform doctor – type ALS interventions. Primary (pre-hospital) missions predominantly. TRISS methodology. 10 out of 12 papers demonstrated a survival benefit associated with doctor involvement and therefore support doctor inclusion. No paper demonstrated a higher mortality in doctor treated patients. Both studies looking specifically at head injury demonstrated a survival and residual disability benefit in patients treated by doctors pre-hospital. The majority of systems examined employed specialist (critical care) grade doctors or trainees in critical care.	The most extensive literature review on the subject. Australasian studies unequivocally support doctor inclusion and the rural and remote nature of many missions most parallels the combat situation
Hodgetts et al 2000 (UK) [11]	Review	N/A	A review of the essential role of pre-hospital care in optimal outcome from major trauma. Pre-hospital care is an essential component of the 'trauma system'. Mortality in rural and remote areas is 50% higher than in cities. ALS may be of no benefit in urban trauma scenarios. Key controversies include: *'load and go versus stay and play'*, doctor versus paramedic teams, methods of advanced airway intervention and role of intravenous fluid replacement. No conclusions drawn except that hypotensive fluid resuscitation techniques may be extrapolated to the blunt trauma scenario.	This review highlighted the controversies across international trauma systems, but no conclusions relevant to the military situation can be drawn with the exception of the role of hypotensive fluid resuscitation.
Liberman et al 2003 (USA) [14]	Multicentre Canadian Prospective Cohort Study of Pre-hospital Trauma Care	Montreal: Doctor– ALS Toronto: Paramedic – ALS Quebec City: EMT – BLS	This study compared three separate urban systems where in one trauma calls were predominantly attended by doctors with ALS skills, in another by paramedics with ALS skills and in the third by EMTs with BLS skills. Referral was to a level 1 trauma centres. There was no demonstrable benefit in on-scene ALS for pre-hospital management of trauma patients. The evidence in the urban setting supported the 'scoop and run' philosophy.	Combat rarely mirrors the urban trauma situation in terms of evacuation time-lines and time from point-of-wounding to initiation of hospital-level care.
Husum 1999 (Pakistan) [15]	Retrospective Cohort Study comparing early ALS with simple pre-hospital trauma care in the Battle of Jalalabad, Afghanistan	No systematic treatment (layman help) vs. paramedic staffed car with core ATLS competencies	ALS interventions in the combat zone compared with a system of no structured care. Pre-hospital mortality rate decreased from 26.1% to 13.6%. Evacuation times were protracted: 5-7 hours from POW to a referral hospital. Doctors were not included in pre-hospital medical teams; paramedics performed all interventions.	A situation analogous to that faced by NATO forces currently in Southern Afghanistan
Gourley 2000 (USA) [5]	Retrospective Cohort Study of transport methods, medical records and survival compared with TRISS predictions in El Paso, Texas	All military flight medics trained to a minimum standard of EMT-Basic. Flight teams augmented by RGN or rarely by doctor	Study examined a military aeromedical evacuation system employed as Military Assistance to Safety and Traffic (MAST) analogous to military aid to civil power in the UK. Military flight medical training concentrates on basic airway management, intravenous fluid replacement and non-invasive haemorrhage control. ALS provision is sporadic and inconsistent across the US military aeromedical teams. Overall pre-hospital times were an average of 83.9 minutes for an average distance of 48.1 miles. Ratio 26:1 blunt : penetrating mechanisms of injury. Overall survival was exactly as predicted by TRISS, but there were 6 unexpected deaths and three unexpected survivors within the group.	Six unexpected deaths in a cohort of patients managed over extended timelines by a military aeromedical team in a civilian setting suggest that care may be sub-optimal. The effect of in-flight care versus rapid transportation cannot be assessed accurately due to insufficient data regarding crew composition for specific missions.
Gerhardt et al 2000 (USA) [6]	Descriptive study and review of US Army air medical transport system as a Military Assistance to Safety and Traffic in El Paso, Texas	N/A	EMT-Bs in the US Military should be equivalent to their civilian counterparts but failure rates of pre-hospital procedures and poor patient outcomes compared with MTOS (Major Trauma Outcome Study) data implies that they are unable to provide civil standard emergency care to the critically ill or injured patient alone and that aeromedical teams require augmentation with ALS providers. The current US military model of aeromedical care is one EMT-B (minimum) medic plus a non-medic crew chief compared to the civil standard of two ALS provider aeromedical team members. The perceived failings of the US military aeromedical system may be due to lack of ALS training, a shortage of military emergency doctors, lack of doctor direction, lack of Standard Operating Procedures and Continuing Medical Education. However it is agreed that MAST provides valuable, regular and realistic training for aeromedical crews.	There are important lessons for the UK military here. In particular the UK model of an aeromedical team comprising two ALS providers is supported. UK tactical aeromedical teams could achieve valuable and realistic training if attached either to a civil HEMS service, or to a military SAR service if such a service were to be tasked regularly to civil trauma patients.
Sebesta 2006 (USA) [16]	Commentary: special lessons learned in Iraq by US 31st CSH Jan 2003 – Jan 2004	N/A	51% of deaths were preventable. 10% of all deaths at the CSH were due to pre-hospital airway issues, although it is not known how many pre-hospital deaths were due to airway issues overall. Flight medics may manage airway issues by cricothyroidotomy or by 'Combitube' although cricothyroidotomy was more common. Compressible haemorrhage casualties make up the largest group of potentially salvageable combat trauma patients. The use of tourniquets pre-hospital was validated in compressible extremity haemorrhage. Pre-hospital management of hypothermia is vital.	A small but significant number of potentially salvageable patients require advanced pre-hospital airway interventions
Booz-Allen-Hamilton 2004 (Ire) [12]	Feasibility study on a HEMS for the Island of Ireland	N/A	On balance, HEMS (doctor-inclusive) is justified as a primary response where a severely injured patient in a geographically remote or difficult terrain area is involved.	This draws on Australasian and European experience and the philosophy can be extrapolated to the military setting
Navein 2002 (UK) [17]	Descriptive: CTLS (Combat Trauma Life Support) course design for Special Forces	N/A	Military patients often have delayed evacuation and are more likely to sustain penetrating as opposed to blunt significant trauma. 75% of Killed In Action (KIA) involve non-salvageable injuries. Of the 25% potentially salvageable KIA, the majority require advanced airway, intrapleural drainage procedures or management of exanguinating extremity injury.	Reinforces the role for ALS provision in the forward tactical situation. Critical care rather than surgery in the forward situation is applicable to more cases of potentially salvageable KIA.

Author & Year	Study design	Type of teams	Results	Comments
Grissom et al 2005 (USA) [9]	Descriptive study of US Air Force Critical Care Aeromedical Transport Teams (CCATT)	N/A	Military ICU-level care teams such as the US CCATT may have a role in disaster medicine and in providing critical care in forward settings. Discussion and opinion only of practice in the USA and US military. Traditional teams were critical care nurse + flight paramedic or respiratory technician. Since Op JUST CAUSE (Panama) doctors have been included because of the need to aeromedically evacuate unstable and undifferentiated casualties over long distances. Doctors are typically intensivists (FCCM) or emergency doctors (FACEP).	Highlights the role for critical care doctors in aeromedical evacuation of post-surgical patients (Tactically from a forward based FST, or Strategically from a R3 facility to the UK) and suggests that such teams may have utility in primary missions (i.e. pre-hospital missions) where patients have requirement for ALS procedures such as RSI and controlled ventilation
Wang 2006 (USA) [18]	Prospective Observational Study: Data analysis of paramedic intubation errors	N/A	Suggest that error rates are high with ALS procedures (in particular endotracheal intubation) when performed by paramedics.	When ALS is required, it must be performed to a consistent standard in order to avoid significant avoidable morbidity or mortality.
Hetz 2006 (USA) [10]	Commentary	N/A	Lessons learned by US Military from Somalia and previous conflicts have led to the introduction of CCATT (Critical Care Air Transport Teams) comprising a doctor (with critical care skills), a respiratory therapist and a critical care nurse. These teams have enabled unstable trauma patients to be transported over long intra-theatre and international distances. Prior to the inclusion of a doctor, this was not possible.	This discussion was more applicable to the secondary mission scenario, but highlighted the essential role of critical care transport in the military trauma system.
Rashford & Myers 2004 (Aust) [13]	Commentary on Garner 2004 (Aust) paper	N/A	HEMS crewing remains controversial. The need for ALS pre-hospital needs to be further defined. Pre-hospital endotracheal intubation of trauma patients by paramedics may provide no benefit and may increase morbidity. There is a risk : benefit ratio to the HEMS providers to be observed in the use of aeromedical assets even in the civil setting. HEMS should be reserved for patients known to be severely injured and who are either entrapped, are more than one hour from hospital by road or who are in inaccessible terrain. In order to identify these patients a stratified dispatch policy must be incorporated that includes doctors experienced in pre-hospital care and retrieval medicine. Pre-hospital HEMS teams must adhere to clinical governance. Critical care doctors have a vital role to play in managing major trauma, but other practitioners trained in the appropriate specialist skills may contribute too.	This commentary emphasises the role of the pre-hospital doctor in the management of major trauma; that role may be a clinical one or it may be at the mission activation stage in deciding the crew-mix that is most appropriate to attend a given clinical situation. In the military setting, this paper emphasises the role of the pre-hospital doctor in the planning phase of a tactical aeromedical mission and offers a model that might suit future military doctrine.
Sikka & Margolis 2005 (USA) [1]	Review of pre-hospital care systems around the world	N/A	UK, USA, Canada, Australasia and Hong Kong all predominantly use non-doctors to provide pre-hospital care (with protocols and occasionally access to online or telephone direction from a doctor). Singapore and Dubai use nurses to deliver out-of-hospital care. European nations such as France and Germany utilise critical care doctors. Frequently the paramedic does not exist in near-European nations. This review does not compare like with like as national health care systems and medical doctrine vary between nations.	Reinforces the role for ALS provision in the forward tactical situation. Critical care rather than surgery in the forward situation is applicable to more cases of potentially salvageable KIA.
16 Close Support Medical Regiment (UK) [4]	Strawman Paper based upon experiences from OP HERRICK 4 and a review of the literature for pre-hospital ALS intervention	N/A	Augmentation of RAF tactical aeromedical teams during HERRICK 4 was associated with unexpected survivors according to TRISS and NISS methodology. Evidence for improved outcome in major thoracic trauma and traumatic brain injury following pre-hospital critical care intervention is compelling. Skill sets and competencies rather than the specialty cadre of the doctor are more important, but in current UK military practice these skill sets rest with emergency doctors, anaesthetists and intensivists.	Highlights the role for critical care doctors in aeromedical evacuation of post-surgical patients (Tactically from a forward based FST, or Strategically from a R3 facility to the UK) and suggests that such teams may have utility in primary missions (i.e. pre-hospital missions) where patients have requirement for ALS procedures such as RSI and controlled ventilation

definitive treatment, the fact that this is recognised in the field and that initial resuscitation manouvres have been completed (including perhaps RSI and ventilation), may indeed speed the passage of the patient to the operating room and thus enhance his chances of survival.

When considering the clinical question of blunt versus penetrating trauma requiring critical care intervention pre-hospital, there is a distinct lack of evidence in the literature. The vast majority of civilian trauma considered in the published literature considers blunt trauma. Further research is required to clarify this clinical question, and perhaps the current operational environment will enable research to be completed that compliments the data for blunt trauma.

Summary

The evidence supports the current UK military aim to man the MERT with a doctor when attending the most seriously injured casualties if logistically possible. Critical care interventions pre-hospital are beneficial in situations of prolonged evacuation times or in patients with severe brain or chest injury. Deployment of MERT will always be constrained by tactical and logistical considerations so adherence to the principles of <C> ABC remains paramount for first responders.

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