Pre-hospital anaesthesia: the same but different

D. J. Lockey1,2*, K. Crewdson2 and H. M. Lossius3,4

1 North Bristol NHS Trust, Bristol BS16 1LE, UK
2 London’s Air Ambulance, Barts Health NHS Trust, London E1 1BB, UK
3 Department of Research and Development, The Norwegian Air Ambulance Foundation, Holterveien 24, PO Box 94, N-1441 Drøbak, Norway
4 Field of Pre-hospital Critical Care, Network for Medical Sciences, University of Stavanger, Kjell Arholmsgate 41, Stavanger 4036, Norway

* Corresponding author. E-mail: David.Lockey@nbt.nhs.uk

Advanced airway management is one of the most controversial areas of pre-hospital trauma care and is carried out by different providers using different techniques in different Emergency Medical Services systems. Pre-hospital anaesthesia is the standard of care for trauma patients arriving in the emergency department with airway compromise. A small proportion of severely injured patients who cannot be managed with basic airway management require pre-hospital anaesthesia to avoid death or hypoxic brain injury. The evidence base for advanced airway management is inconsistent, contradictory and rarely reports all key data. There is evidence that poorly performed advanced airway management is harmful and that less-experienced providers have higher intubation failure rates and complication rates. International guidelines carry many common messages about the system requirements for the practice of advanced airway management. Pre-hospital rapid sequence induction (RSI) should be practiced to the same standard as emergency department RSI. Many in-hospital standards such as monitoring, equipment, and provider competence can be achieved. Pre-hospital and emergency in-hospital RSI has been modified from standard RSI techniques to improve patient safety, physiologic disturbance, and practicality. Examples include the use of opioids and long-acting neuromuscular blocking agents, ventilation before intubation, and the early release of cricoid pressure to improve laryngoscopic view. Pre-hospital RSI is indicated in a small proportion of trauma patients. Where pre-hospital anaesthesia cannot be carried out to a high standard by competent providers, excellent quality basic airway management should be the mainstay of management.

Keywords: anaesthesia; emergency care; pre-hospital; management, airway

Accepted for publication: 29 March 2014

Pre-hospital trauma care

The organization of pre-hospital trauma care can have a major influence on outcome. It determines how quickly help is delivered to scene, the type and quality of early care received, how quickly the patient is delivered to hospital and which hospital they are delivered to. The importance of the pre-hospital element of trauma care has been acknowledged in the development of trauma systems1–3 and recently developed UK trauma networks have been encouraged to take responsibility for injured patients from point of injury to rehabilitation.4 In quality terms, a pre-hospital ‘postcode lottery’ exists on a large scale even in countries with similar income and infrastructure.5 The international development of Emergency Medical Services (EMS) and trauma care has produced almost every variation possible. Some countries have put significant effort and resource into advanced pre-hospital services and others are still rudimentary even in 2014.

In the UK, pre- and in-hospital trauma care has been the subject of several adverse reports in the last 20 yr.6,7 Internationally, the UK has been seen to move to an ‘Anglo-American’ paramedic-led model of pre-hospital care in contrast to the ‘Franco-German’ physician-led model of care seen in many other European countries.8 In the UK, paramedic training commenced in the 1970s and the first national training course commenced in 1985. Paramedic training then became more uniform and they have provided the bulk of clinical pre-hospital care in the UK for many years. Their advanced skills have included advanced airway management—up to and including intubation without drugs and the administration of i.v. fluid and drugs. Unfortunately, the benefit of nearly every paramedic extended skill used in trauma has been questioned. The administration of i.v. fluid has been limited to the most severely hypovolemic for many years,9 the value of tracheal intubation without drugs is questionable10,11 and few drugs are...
Pre-hospital airway management

Airway compromise has been identified as a preventable cause of poor outcome and death in trauma and cardiac arrest patients for many years. The influential American College of Surgeons Advanced Trauma Life Support Course (ATLS) has propagated the ‘ABC’ approach to trauma care which makes the airway management the highest priority. As uncorrected airway compromise can lead to preventable death or hypoxic brain injury, this concept is generally accepted. However, the means by which effective airway management should be achieved before arrival in hospital is not straightforward and highly controversial. Where rapid sequence induction (RSI) is required after arrival in the emergency department, it is usually carried out by appropriately trained physicians. In most countries, these physicians are trained anaesthetists or emergency physicians with anaesthesia training. In-hospital RSI allows the administration of drugs to optimize the conditions for tracheal tube insertion and minimize physiological derangement. It is generally accepted as the technique of choice for securing the airway in seriously ill or injured patients and has also become a key component of advanced life support (oxygen administration, chin lift/jaw thrust, bag-valve-mask ventilation, nasal/oral airway). In the pre-hospital setting, the situation is somewhat different. The first Medline- or Embase-indexed reports on pre-hospital intubation were published in the mid-to-late 1960s. In the last 10 yr, the value of pre-hospital intubation has been seriously questioned. Despite many published studies, the benefits of this practice in specific patient groups, the skill levels required by providers, the effect of different techniques, and the alternatives to intubation are less clear now than ever before. The majority of the published papers are based on retrospective trauma database methodologies and are considered to be low-quality evidence. Despite the publication of guidelines from Europe and the USA that recognize the need for appropriately conducted pre-hospital RSI in a limited number of patients, the practice is still widely variable between and within countries. In many European countries in which specially trained physicians have participated in pre-hospital EMS services since the late 1950s, RSI is a core component of pre-hospital advanced life support. In contrast, some pre-hospital EMS systems in developed countries base their advanced life support entirely on paramedics, nurses, or both and their intubation protocols and procedures depend far less on drug administration. A systematic review was carried out in 2011 which attempted to examine the frequency of reporting of 29 key variables, previously determined by an expert panel, in studies reporting on pre-hospital intubation. The majority of the included studies were from North American EMS (59 studies). Of these, 46 (78%) described services in which intubation was conducted by non-physicians. In contrast, physicians performed the pre-hospital intubations in 13 (87%) of the 15 non-North American EMS systems. Of the 46 non-physician-manned systems, 25 (53%) performed drug-assisted intubation. An average of only 10 out of the 29 key variables was reported in the included studies. The under-reporting of key variables and considerable heterogeneity of published studies makes it extremely difficult to generalize findings. This heterogeneity stems from a number of areas. The professional group from which the providers come are usually documented, but there are considerable differences between training and skill levels within professional groups. The term ‘paramedic’ can describe a very different provider in different EMS systems. The term ‘physician’ is even more ill-defined. In some countries, the term relates to a senior doctor with extensive experience and, in European systems, is often a consultant anaesthetist. In other systems, the physician might be a relatively junior trainee or a general practitioner with a lower level of advanced airway management skill. Case mix also varies in different studies. It is often difficult to separate trauma and non-trauma patients, cardiac arrest and non-cardiac arrest, adults and children. The use of drugs is also pivotal to intubation success but in a review of pre-hospital airway management in 2003 which involved 263 publications and 9534 patients it was unclear in 21 studies (involving 2887 patients) whether or not drugs had been administered to facilitate intubation. Similarly, a Cochrane review on the value of pre-hospital tracheal intubation failed to separate paramedic and physician intubation or drug-assisted intubation and intubation without drugs or medical and trauma patients.

In the UK, paramedics have the full range of basic airway management skills (oxygen administration, chin lift/jaw thrust, bag-valve-mask ventilation, nasal/oral airway). In addition, intubation without drugs has been carried out for more
than 20 yr. The benefits of intubation without drugs have not been demonstrated. One study did demonstrate benefit, but authors from the same EMS system have subsequently reported contradictory results. In 2001, a large series of trauma patients who were intubated without drugs was reported in the UK. Mortality was almost 100%, which suggested that the group of trauma patients who could be easily intubated by paramedics were either in cardiac arrest, peri-arrest, or in very severely injured. Other publications have supported the view that this intervention does not confer any benefit and also that success rates are relatively low—between 49 and 63% without drugs. As a result of this and recognition that the development of supraglottic airway devices has provided a less invasive but more effective option, the Joint Royal College Ambulance Liaison Committee in the UK made recommendations in 2008 that tracheal intubation should not be mandatory training for UK paramedics.

Paramedics do not carry out RSI in the UK although there are advocates for this development. Two studies in this area have drawn particular attention. In 2003, Davis and colleagues published a prospective study of 209 patients who were unconscious and could not be intubated without drugs. They were intubated with midazolam and succinylcholine. Mortality and neurological outcome were then compared with 627 historical controls. Outcome in the RSI group was significantly worse. After sub-group analysis, it was suggested that this may have been because of poor training or poor technique resulting in inappropriate ventilation or hypoxaemia. A more recent study was unusual in that a randomized controlled study was achieved in unconsented critically unwell patients. A total of 310 patients with head injury were randomized to paramedic RSI or transport to hospital for RSI in the emergency department. Although no survival benefit was demonstrated, there was an improvement in functional neurological outcome in the pre-hospital RSI group. However, there were a significant number of reported unexpected cardiac arrests after induction in the pre-hospital RSI group, which is of concern. There are other studies that record very high rates of complication after paramedic RSI. A study of 203 trauma patients received in an emergency department in Florida after paramedic RSI reported that 31% had failed intubation. Eighteen percentage could not be intubated after administration of succinylcholine and 12% had unrecognized oesophageal intubation on arrival. On the basis of the available literature, it is unclear whether reported sub-optimal results are because of the fact that the intervention of RSI is performed or because it is being performed badly.

Only a handful of randomized controlled studies have been performed in pre-hospital trauma patients and the barriers to the conduct of studies in unconsented critically unwell patients have been formidable. The most recent attempt to perform a large randomized controlled study in pre-hospital care was the Head Injury Retrieval Trial (HIRT) in Sydney, Australia. The study was designed to measure neurological outcome in head-injured patients who were randomized to treatment by a physician–paramedic aeromedical team or standard ambulance service care. Advanced airway management was likely to be a key factor in any difference demonstrated. The study ran into problems with recruitment and crossover in the two arms of the study because the ambulance service dispatched a physician response to some patients randomized to standard care. This study clearly demonstrates some of the difficulties of carrying out even well-funded high-quality research in the pre-hospital environment.

Is there real need for pre-hospital anaesthesia?

One of the key questions in the provision of pre-hospital anaesthesia for trauma patients is whether there is genuine demand for the intervention. If airway management which stops short of pre-hospital anaesthesia is adequate for victims of major trauma, then the provision of pre-hospital anaesthesia may be unnecessary. Unfortunately, the published literature does not support this concept. The National Confidential Enquiry into patient outcome and death—Trauma Who Cares? Published in 2007 reported a significant number of patients who arrived in the emergency department after suffering traumatic injury with airway compromise after on-scene management by ambulance paramedics. In the USA, an examination of trauma patients arriving in hospital demonstrated that ~10% required intubation in the emergency department. Around half of the patients who required intubation had immediate indications such as airway obstruction, ventilatory failure, or cardiac arrest, which are highly unlikely to have developed on arrival in the emergency department. Similarly in a Norwegian EMS, Sollid and colleagues demonstrated that a substantial number of trauma patients were only intubated on arrival in the emergency department despite having clear indications for RSI before arrival in hospital. The exact demand for pre-hospital anaesthesia in trauma patients is difficult to quantify. Ideally, it would be useful to understand what proportion of major trauma patients meet the criteria for immediate intubation on scene and also to establish what proportion of these can be safely managed with more basic airway management. When poor performance is reported in systems where pre-hospital anaesthesia is not available, it is difficult to establish whether this is because the available, more basic interventions are inadequate or were not carried out properly.

The discussions about the potential advantages and drawbacks of pre-hospital anaesthesia (and other pre-hospital interventions) are often related to time. There is little doubt that pre-hospital interventions increase time on scene. This is often only by a small margin and increased scene time is not necessarily associated with increased mortality. What is clear is that, regardless of the interventions carried out, total pre-hospital times are quite consistent in different EMS systems and the ‘scrap and run’ concept rarely results in trauma patients arriving in the emergency department minutes after injury. In the small proportion of trauma patients who have airway compromise on scene, there may be a considerable interval before in hospital RSI is possible. In addition, the actual time of RSI might well be some time after arrival in the emergency department. In patients who require immediate intubation in the emergency department delay is unacceptable.
and is one of the quality indicators of trauma care measured in the UK Trauma Audit and Research Network.57 The patients outside hospital are the same patients earlier in the patient pathway and the concept of ‘Critical care without walls’ could be applied to the critically ill with airway compromise outside hospital in the same way as the critically unwell patient on the general hospital ward.

Less immediate indications are also used for pre-hospital anaesthesia—humanitarian in severe injury or perhaps severe agitation without airway compromise. In these situations, the risk–benefit ratio is different and, as survival or disability is unlikely to be prevented by immediate RSI, the provider must be confident that the intervention can be delivered with minimal risk. This is likely to require an experienced provider working with established clinical governance processes.

The practical delivery of pre-hospital anaesthesia

RSI of anaesthesia is a technique to provide anaesthesia and intubation in non-starved patients for emergency procedures. It has been widely applied to the management of trauma patients both in and outside hospital. Early descriptions of the technique59 60 describe the administration of an induction agent and succinylcholine followed by rapid intubation. Cricoid pressure and ‘head up’ positioning were used to help prevent regurgitation of stomach contents. Although the aims of RSI—rapid, safe induction of anaesthesia, and securing the airway with a definitive airway—are still as important as they were when the technique was first described, many adaptations have been trialled to improve safety, intubation success, or physiological disturbance. This has also been the case in the pre-hospital environment. Anaesthesia is only one complex intervention carried out in the pre-hospital phase of care. Training and technological advances have, with enough resource, made it possible to perform almost any diagnostic or medical intervention on-scene. Recent examples include diagnostic ultrasound,61 diagnostic computed tomography for stroke thrombolysis,62 and resuscitative thoracotomy63 for traumatic cardiac arrest. The challenge of pre-hospital medicine is to determine which interventions translate to improved outcome. Changes to the delivery of pre-hospital RSI have been inconsistent. In some EMS systems, the simple use of an induction agent and succinylcholine still dominate and may deliver high intubation success rates. Other systems, usually with more experienced providers deliver the option of a more complex anaesthetic altered to meet the requirements of particular patients. It is well established that the experience of the provider influences intubation success. A meta-analysis carried out in 2012 compared paramedic and physician intubation success.64 This crude comparison was followed by analysis of intubation success of both groups after administration of neuromuscular blocking agents and also with paramedics with very high levels of training. Overall intubation success rates in 15 398 patients were 92.7%. The median success rate for physicians was 99.1% and 84.9% for paramedics. Paramedics intubating without drugs had overall median success rates of 67.5%, using sedatives 81%, and with neuromuscular blocking agents 96.7%. Weighted linear regression analysis demonstrated a statistically significant increased success rate with physician providers in all groups. This difference persisted when comparing physicians with highly trained paramedics using neuromuscular blocking agents. Neuromuscular blocking agents increase the success rates of intubation but also increase the magnitude of potential complications in failed intubation.

The training ‘advantage’ is not only seen between paramedics and physicians. It has also been demonstrated between physicians with different levels of experience. Breckwoldt65 defines a model of ‘competent’ and ‘expert’ intubators defined by the number of intubations carried out in routine practice by different physicians. This definition approximates to emergency physicians and anaesthetists in the UK system of pre-hospital practice. Other studies have demonstrated that even experienced physician anaesthetists require regular structured training to maintain their pre-hospital RSI skills66 and that quality control measures are required to ensure non-procedural skills such as equipment familiarity and standard operating procedures.67

The use of portable monitoring systems means that all mandatory in-hospital standards of monitoring can be met in the conduct of pre-hospital anaesthesia. Even new modes of monitoring and near patient testing can be brought to the patient where advantage is anticipated.68 Capnography is also easily transferable to pre-hospital care and mandatory in an environment with high failed and oesophageal intubation rates.30 In 2005, a study from Florida demonstrated the importance of pre-hospital capnography reducing a 9% misplaced tracheal tube rate on arrival in hospital to zero with the introduction of continuous CO₂ monitoring.69

Improving airway management may be achieved by altering process. The development of algorithms and standard operating procedures are as important in pre-hospital anaesthesia70 as in the emergency department71 and have been demonstrated to change practice.72 Where less-experienced anaesthetic practitioners are delivering pre-hospital anaesthesia, the process may be simplified and choices limited to prevent cognitive overload during the procedure.73 Some processes used in elective anaesthesia are impractical in the emergency or pre-hospital situation.

Drugs

The majority of pre-hospital trauma anaesthetics are administered to patients with airway compromise or unconsciousness73 so the option of waking up a patient is rarely used. If waking the patient up is not an option, the importance of using short-acting neuromuscular blocking agents or short-acting opioids is reduced.

In experienced hands, most combinations of induction agents, analgesics, and neuromuscular blocking agents are possible to safely anaesthetize trauma patients in the pre-hospital environment. For less-experienced providers, some EMS systems provide limited options to improve reliability and familiarity with a reproducible technique. Ketamine is an
increasingly popular induction agent for pre-hospital and emergency department induction and analgesia. Reservations about the use of ketamine in head-injured patients because of the risks of increased intracranial pressure have largely declined, but the consequences of failed intubation after rendering patients apnoeic are potentially catastrophic. Succinylcholine has been the main agent used for pre-hospital RSI, but long-acting agents particularly rocuronium have been increasingly introduced into pre-hospital practice. It has been suggested that the use of this agent should be combined with sugammadex for reversal in pre-hospital anaesthesia. With limited numbers of skilled providers on scene and the considerable preparation time for this agent, it is questionable whether the timely use of a reversal agent is practical in the ‘can’t intubate, can’t ventilate’ trauma patient. The common use of pre-induction opioids in emergency anaesthetic practice is another difference between current practice and the original descriptions of RSI. The pre-hospital haemodynamic response to intubation can be impressive and is of potential risk in those with head injury and unstable blood clots. Opioid use is therefore common but risks depression of respiration during induction and recovery from short-acting neuromuscular blocking agents.

**Patient assessment**

Airway assessment is standard practice in elective anaesthesia but of less value in pre-hospital anaesthesia. As emergency anaesthesia should not be contemplated unless absolutely necessary the assessment of the airway and risk stratification for difficult intubation is unlikely to influence management. Also there is evidence that the elements of airway assessment that include, for example, patient co-operation and neck mobility may be impractical in the compromised trauma patient.

**Pre-oxygenation strategies**

Pre-hospital trauma patients may be children or present with obesity, and rarely pregnancy all of which are established risk factors for rapid desaturation after the induction of anaesthesia. They may also have the additional risk factors of hypovolaemia and respiratory compromise. Pre-oxygenation is important in pre-hospital anaesthesia and gentle bag-valve mask ventilation may be indicated after neuromuscular blocking agent administration. Although this is contrary to standard RSI descriptions because of the risk of gastric insufflation and aspiration, it has been demonstrated to reduce oxygen desaturation in children after pre-hospital induction.

**Cricoid pressure**

The use of cricoid pressure is well established in the UK anaesthetic practice and is frequently used in pre-hospital emergency anaesthesia. It has been associated with a poor laryngoscopic view particularly when applied by less-experienced assistants in the pre-hospital environment. The evidence base for benefit has been questioned. A pragmatic approach to pre-hospital cricoid pressure might be to use it routinely for oesophageal compression and for the manipulation of laryngoscopic view but to release early if the view is poor.

**Equipment**

Most devices used in in-hospital emergency airway management have been successfully taken into the pre-hospital environment. Selection of particular devices for pre-hospital use may be influenced by practical factors such as battery life, portability, weight, and robustness. The use of the gum elastic bougie is familiar to all UK anaesthetists and has been demonstrated to be effective in unanticipated difficult intubation in the pre-hospital environment and is used routinely in some services. A number of videolaryngoscopes have been trialled in pre-hospital intubation and although data are limited some devices have performed disappointingly particularly in the presence of blood in the airway. Airway rescue devices should be available wherever pre-hospital anaesthesia is carried out. Most of the features determining the choice of specific supraglottic rescue devices are similar in the pre-hospital environment and hospital environment and therefore a variety of different devices are used in different EMS systems. The performance of a surgical airway is included at the end of every failed intubation algorithm. The technique is more likely to be required in pre-hospital care, either as a primary procedure in trapped patients, severe burns or maxillo-facial trauma, or as a rescue technique after failed intubation. Although many commercial ‘kits’ are available, there is no good evidence in real patients to indicate that any technique is more successful than a standard surgical technique (in or out of hospital).

**Pre-hospital advanced airway guidelines**

In recognition that poorly performed tracheal intubation has been shown to worsen patient outcome in any setting, and that pre-hospital advanced airway management can be particularly challenging, a number of countries have produced guidelines to direct and standardize practice in their pre-hospital services in an effort to improve safety and effectiveness. The guidelines produced do reflect the different infrastructure of the services operating within the various countries but are remarkably consistent in their key messages. In the UK, The Association of Anaesthetists of Great Britain and Ireland (AAGBI) produced a pre-hospital anaesthesia safety guideline in 2009, which was endorsed by all of the key training providers including the Royal College of Anaesthetists, College of Emergency Medicine, and Faculty of Pre-hospital Care of The Royal College of Surgeons of Edinburgh. The guidelines place strong emphasis on performing anaesthesia in the pre-hospital setting to the same standard as in the hospital emergency department. All providers should be competent in emergency anaesthesia, and the equipment and monitoring used should meet AAGBI in-hospital guidelines. In addition, individual pre-hospital services should have a robust structure in place for clinical governance that provides a regular review of clinical practice, guidelines for the management of difficult airways and failed intubations, and a lead clinician...
with overall responsibility for the practice of anaesthesia within the pre-hospital service.

Comprehensive guidelines from Scandinavia\(^\text{31}\) contain similar principles to those from the UK. In Scandinavia, pre-hospital airway management is often performed by anaesthetists with specific pre-hospital training. The guidelines place emphasis on the skill level of the healthcare provider, recommending very different airway techniques for anaesthetists and non-anaesthetists. Tracheal intubation is recommended only for anaesthetists and more basic airway management combined with the lateral trauma position for all other providers. The Scandinavian guidelines also consider end-tidal carbon dioxide (\(E_{CO_2}\)) monitoring to be mandatory in advanced airway management, in recognition that misplaced tracheal tubes are well described and potentially fatal. Both the UK and Scandinavian guidelines make it quite clear that providers of pre-hospital anaesthesia should have the same level of competence as in-hospital anaesthesia providers. The lateral trauma position described in the Scandinavian guidelines and the European Resuscitation guidelines\(^\text{94}\) to reduce the incidence of airway obstruction and contamination is also rarely mentioned in US practice. Routine positioning of trauma patients in the supine position with in-line stabilization provided for potential spinal cord injury, as traditionally taught on Advanced Trauma Life Support and Pre-hospital Trauma Life Support courses appears to be standard US practice.

Conclusions

There is a clear need for immediate RSI in a small proportion of trauma patients. After arrival in the emergency department, the time in which this intervention is achieved is a quality indicator of performance.\(^\text{57}\) Anaesthesia is currently delivered in many EMS systems to the same group of patients earlier in the patient pathway in the pre-hospital phase of care. Although the benefits of early airway control, oxygenation, and controlled ventilation are attractive, there is a great deal of evidence to suggest that poorly performed RSI can be harmful. Straightforward guidelines are available with advice on provider competence, equipment, monitoring, and system governance and the use of these principles may have the potential to improve patient safety and give pre-hospital and emergency department anaesthesia a similar safety profile.

There are many unanswered questions in pre-hospital advanced airway management. They include: which sub-group of trauma patients really benefit from pre-hospital RSI? What are viable alternatives to RSI in systems unable to deliver the intervention? When making the decision to perform pre-hospital anaesthesia, which factors in the risk–benefit analysis should influence the decision? Do less-experienced providers perform the procedure and post-intubation interventions less well and have worse results or do they anaesthetize a different group of patients to more experienced providers?

Unfortunately, there is a lack of data in which to search for answers to these questions. Studies are rarely easily transferable to other EMS systems and key data are frequently missing.\(^\text{38}\) Reporting key data in pre-hospital airway studies are an important step forward in unravelling the complex picture which currently exists.\(^\text{95}\) An international template for pre-hospital airway reporting has been developed and has the potential to achieve this objective.\(^\text{96}\) Pre-hospital anaesthesia is an intervention which has the potential to improve trauma patient outcome. Current evidence suggests that when performed badly or by less-experienced providers it can be detrimental. In systems where it is provided, it should meet the same standards as emergency department anaesthetic management. In systems that cannot provide this level of care, efforts should be made to achieve excellent standards of basic airway management and ventilation.

Declaration of interest

None declared.

References

1. Lendrum RA, Lockey DJ. Trauma system development. Anaesthesia 2013; 68(Suppl. 1): 30–9
15 American College of Surgeons Committee on Trauma. Advanced Trauma Life Support Course for Doctors, 8th Edn. Chicago: American College of Surgeons, 2008
20 Davis DP, Dunford JV, Poste JC, et al. The impact of hypoxia and hyperventilation on outcome after paramedic rapid sequence intubation of severely head-injured patients. *J Trauma* 2004; 57: 1–8
22 Fischer G. [Intubation or tracheotomy at the place of accident (at the same time a contribution to the equipment of the physician’s emergency kit.)] *Z Arztli Fortbild (Jena)* 1965; 59: 1314 –6
38 Lossius HM, Sillid SJM, Rehn M, Lockey DJ. Revisiting the value of pre-hospital tracheal intubation: an all time systematic literature review extracting the Utstein airway core variables. *Crit Care* 2011; 15: R26
40 Cochrane database of systematic reviews. Available from www.cochrane.org (accessed 14 February 2014)
41 Winchell RJ, Hoyt DB. Endotracheal intubation in the field improves survival in patients with severe head injury. *Trauma Research and Education Foundation of San Diego*. *Arch Surg* 1997; 132: 592 –7
60 Snow RG, Nunn JF. Induction of anaesthesia in the foot-down position for penetrating trauma: a pre-hospital physician-performed resuscitation procedure that can yield good results. J Trauma Acute Care Surg 2011; 72: 930–5
75 Davis GE, Lockey DJ. Thirteen survivors of prehospital thoracotomy for penetrating trauma: a pre-hospital physician-performed resuscitation procedure that can yield good results. J Trauma 2011; 70: 745–8
81 Harris T, Ellis DY, Foster L, Lockey D. Cricoid pressure and laryngeal manipulation in 402 pre-hospital emergency anaesthesiologists: essential safety measure or a hindrance to rapid safe intubation? Resuscitation 2010; 81: 810–6


95 Davis DP. The need for standardized data reporting for prehospital airway management. *Crit Care* 2011; 15: 133


Handling editor: S. J. Howell