Safer prehospital anaesthesia: updated guidelines from the Association of Anaesthetists

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Guidelines

Safer prehospital anaesthesia: updated guidelines from the Association of Anaesthetists

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Summary

Introduction Prehospital emergency anaesthesia is recognised as a high-risk clinical intervention. These updated guidelines consider changes in prehospital practice and parallel changes in the practice of in-hospital emergency anaesthesia, with the aim of encouraging standardised safe anaesthetic practice in a challenging clinical area.

Method A working group was set up by the Association of Anaesthetists to include experts and resident doctors working in prehospital emergency medicine, anaesthesia, intensive care medicine and emergency medicine. There was also representation from relevant specialist groups and societies. We used a modified Delphi process and conducted targeted literature reviews to inform recommendations.

Results We formulated recommendations in several key areas of prehospital emergency anaesthetic practice including general techniques; sedation before prehospital emergency anaesthesia; personnel and training; equipment and monitoring; prehospital emergency anaesthesia in children; and transport.

Discussion Clinical teams that provide prehospital emergency anaesthesia must be well trained and competent to deliver the procedure to the same standards as their colleagues in the receiving emergency department. Although patients requiring prehospital emergency anaesthesia are often physiologically unstable and have pathology associated with a high mortality, there is good evidence that prehospital emergency anaesthesia can be delivered safely and to high standards.

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This is a consensus document produced by expert members of a Working Party established by the Association of Anaesthetists. It has been seen and approved by the Board of Directors of the Association of Anaesthetists. It is endorsed by the British Association for Immediate Care; Defence Medical Services; Difficult Airway Society; Faculty of Pre-hospital Care, Royal College of Surgeons of Edinburgh; Intercollegiate Board for Training in Pre-hospital Emergency Medicine; Royal College of Anaesthetists; and the Royal College of Emergency Medicine.
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[Correction added on 10 April 2026, after first online publication: The copyright line was changed.]

Key Recommendations

1. Prehospital emergency anaesthesia (PHEA) should only be delivered by services with a robust governance framework which includes regular review of training, practice and case review.
2. Prehospital services should choose anaesthesia techniques with patient safety as the priority.
3. Prehospital anaesthesia should only be conducted after an on-scene rapid assessment of the benefits and potential disadvantages of the procedure, particularly in children and patients with penetrating trauma.
4. An experienced and well-trained team is required to deliver safe PHEA; this should only be conducted by an appropriately trained anaesthesia provider and a trained assistant.
5. Providers of PHEA should have the same level of training and competence that would enable them to perform unsupervised emergency anaesthesia in the emergency department. The number of prehospital anaesthetic episodes performed by individual practitioners is usually limited and continued in-hospital anaesthesia practice is likely to be necessary.
6. The Association of Anaesthetists' recommendations for standards of monitoring are accepted widely as the required standard in UK anaesthetic practice, with most recommendations relevant to PHEA practice.
7. Techniques should be straightforward, reproducible and supported using service standard operating procedures and checklists.
8. Where possible, patients should be extricated rapidly to a suitable environment before PHEA, particularly as genuine entrapment preventing removal is rare.
9. Cricoid force, manual in-line stabilisation and cervical collars may increase tracheal intubation difficulty and have limited evidence for benefit.
10. Videolaryngoscopy should always be available where PHEA is conducted.

Why were these guidelines developed?

Guidelines for PHEA were first developed because, although prehospital anaesthesia is conducted routinely in the UK and recognised as a high-risk intervention, practice had poorly defined standards of care. Achievable standards were set and endorsed by key organisations. This updated version considers contemporary changes in PHEA practice and parallel changes in hospital-based emergency anaesthesia delivery.

What guidelines currently exist?

The last UK guidelines on this subject were published in 2017 [1]. Related guidelines have been published in Scandinavia [2] and the USA [3]. Other relevant guidelines have been produced on specific aspects of emergency anaesthesia and prehospital practice, but there was need to collate these into a single overarching document.

How and why does this statement differ from existing guidelines?

These updated guidelines identify controversies and advances in practice and synthesises recommendations to further encourage safe practice. There are significant differences to guidelines from Scandinavia and the USA, mostly related to differences in emergency medical service infrastructure and prehospital providers. These guidelines are written primarily for UK prehospital practice but are likely to be relevant to services outside the UK where similar service provision is in place.

Introduction

Prehospital emergency anaesthesia is conducted routinely in the UK. The demand for advanced airway management before arrival in hospital has been well documented [4, 5] and UK guidelines from the National Institute for Health and Care Excellence (NICE) recommend that, when a patient requires an anaesthetic, it should be conducted ideally on-scene or as soon as possible after injury [6].

These guidelines are the second update of prehospital anaesthesia guidelines, first published in 2009 by the Association of Anaesthetists. The overarching aim is to provide recommendations to encourage standardised safe anaesthesia in this challenging area of practice. A key principle of these guidelines is that patients requiring airway interventions should have the same level of care in the prehospital phase of care as they do when they arrive in a hospital. This core principle has not changed.

These recommendations are targeted at PHEA practitioners; prehospital organisations; and organisations with responsibility for governance arrangements for patient pathways which include prehospital care (e.g. trauma networks). Current UK PHEA practice has been influenced by the routine use of the doctor–critical care practitioner model to deliver enhanced prehospital care; the establishment of prehospital emergency medicine as a sub-speciality; and the adoption of in-hospital emergency anaesthesia techniques to include advanced monitoring, apnoeic oxygenation and videolaryngoscopy. Since the last

updated guidelines in 2017, multiple guidelines have been published which set out standards of practice in specific aspects of emergency anaesthesia and PHEA [7–14].

Since the first guidelines were produced, there has been increased standardisation of UK PHEA practice. Techniques, equipment and drugs used at induction of anaesthesia are increasingly consistent [15]. Some observational studies of anaesthesia in established prehospital services report excellent results, with some performance metrics equal to (or even better) than those reported in receiving emergency departments [16]. These guidelines aim to consolidate advances in safe PHEA practice and address some of the key controversies in this area of clinical practice.

Methods

We developed these guidelines guided by best practice recommendations, including the principles described in the AGREE-2 reporting checklist [17]. A working group was set up by the Association of Anaesthetists which included experts and resident doctors working in prehospital emergency medicine and the relevant medical specialities of anaesthesia, intensive care medicine and emergency medicine. There was also representation from the Faculty of Pre-hospital Care; Royal College of Surgeons of Edinburgh; Royal College of Emergency Medicine; Royal College of Anaesthesia (RCoA); British Association for Immediate Care; Defence Medical Services; and the Difficult Airway Society.

During an initial meeting, the working group recognised that the guidelines should consider the specific characteristics of PHEA practice. Previous guidelines, initial literature searches and knowledge of the working group indicated that the evidence base for PHEA is limited, mostly based on observational database studies or studies of in-hospital emergency anaesthesia. As a result, the strength of recommendations was expected to be low (grade C or D) based on the modified version of the system developed by the Centre for Evidence-based Medicine and used in previous guidelines from the Association of Anaesthetists [18]. In addition, providers of PHEA vary in experience and seniority and do not necessarily have anaesthesia as their base medical speciality. Finally, patients who receive PHEA are often critically ill, with higher mortality risk than the in-hospital anaesthetic population and are usually unable to participate in consent or decision-making processes for research.

To ensure that key questions in current practice were addressed, the working party conducted a two-round modified Delphi process. In the first round, participants were asked to address the question: `What are the most important clinical questions in the conduct of PHEA?´. The results of round one were recorded and, after removal or consolidation of duplicates, questions were ranked in order of importance for the second round. The six questions with highest rankings were taken forward for focused literature review (conducted by CW and checked by DL). The results were incorporated into the guideline document and recommendations (online Supporting Information, Appendix S1). The six highest ranking questions are shown in Box 1.

Box 1 The six most important clinical questions determined by the working party in the conduct of prehospital emergency anaesthesia (PHEA)

1. What is the role of videolaryngoscopy?
2. What level of competency is required?
3. Should cricoid force be applied routinely?
4. How should manual in-line stabilisation/cervical spine immobilisation be used?
5. What is the role of apnoeic oxygenation?
6. How should checklists be applied?

For guideline revision, authors were asked to consider evidence from the last 10 years in addition to key publications that had been published before this time. The sections of the guidelines were chosen to cover key areas of PHEA practice and included general techniques for PHEA; sedation before PHEA; personnel and training; equipment and monitoring; PHEA in children; and transport. The draft guidelines were agreed by members of the working party (≥ 80% agreement required for consensus) and then sent to the represented bodies for comment and endorsement. Feedback was then considered, with the final draft agreed by the working group.

Results

Conduct of PHEA (general techniques)

The general principles of the practical delivery of PHEA generated most questions in the consensus process. These guidelines do not seek to make recommendations for how every aspect of PHEA should be delivered, although there is evidence that UK services are increasingly standardised [15]. Prehospital services should choose techniques with patient safety as the priority. Key aspects in the delivery of PHEA are shown in Box 2, and prehospital services should have the equipment and expertise to deliver these standards.

Box 2 Key aspects in the delivery of prehospital emergency anaesthesia (PHEA)

- The risks, benefits and alternatives should be considered before proceeding to PHEA and the indication should be documented clearly.
- Prehospital emergency anaesthesia should be delivered to the same standards as emergency anaesthesia provided with the emergency department.
- Techniques should deliver high rates of first-pass tracheal intubation with minimal cardiorespiratory compromise.
- Techniques used in in-hospital anaesthesia are often more complex and adapted to individual patients. Prehospital techniques may need to be simpler with modifications made only for essential factors (e.g. altered patient physiology).
- Techniques should be well practised, reproducible and delivered by a team of at least two prehospital clinicians.

The decision to perform PHEA is straightforward in most cases. The most common indications are impending or established hypoxia; impending or actual ventilatory failure; threatened or actual loss of airway patency; reduced level of consciousness; and severe agitation associated with head injury. In a small proportion of cases, the decision to proceed is more complex, including the management of patients who are post cardiac arrest where tracheal intubation has not been shown to be superior to the use of a well-functioning supraglottic airway device [19]; or patients with head injury who are agitated but have otherwise normal physiology, who may respond to sedation. Furthermore, patients who are hypotensive with suspected ongoing haemorrhage but without significant reduction in conscious level are at high risk of deterioration after induction of anaesthesia and positive pressure ventilation [20, 21]. These patients may have a higher chance of survival when anaesthesia is delayed until arrival in a major trauma centre with rapid access to surgical intervention and readily available blood products [20]. This is particularly important for patients with penetrating trauma, where there is evidence that most prehospital interventions do not improve survival [22]. Senior telephone support should be available to support decision-making in these difficult cases.

The significance of time on scene is controversial but is a factor when considering PHEA. For most of the indications listed above, PHEA should be delivered without delay. Identification of patients with a time-critical injury and rapid transportation for definitive care is a core function of enhanced care teams. However, the delivery of PHEA may only take up a small proportion of the time from injury to arrival in hospital, so decision-making should be balanced, taking into consideration that efficient PHEA followed by direct transfer to definitive care may result in earlier surgical intervention.

Airway management in prehospital care may rarely be required in circumstances where the patient is trapped, in a restricted space or difficult to access. Whenever possible, patients should be extricated rapidly to a suitable environment, particularly as genuine entrapment preventing removal is rare. Where airway obstruction or apnoea is present, simple airway adjuncts or a supraglottic airway device can be used to facilitate patient extrication. Tracheal intubation or scalpel cricothyroidotomy before extrication should only be performed when other options are not possible. In the largest UK series of prehospital cricothyroidotomy, less than one-third of cases were performed on patients who were trapped but, overall, the procedure had a high success rate [23].

Preparation

To reduce the risk of complications and time to tracheal intubation [24], good practice is to carry out standardised preparations before induction of anaesthesia unless the patient is in extremis. This includes consideration of where induction of anaesthesia should be carried out and optimisation of patient position. The decision to move the patient may minimise environmental issues such as bright or low light levels; noise; hostile members of the public; or extreme temperatures. Ideally, induction of anaesthesia should be carried out with 360° patient access, although PHEA can be carried out successfully in vehicles or helicopters if necessary [25, 26]. Patient positioning is usually optimised by placing the patient at a comfortable height on an ambulance trolley.

The tracheal intubation team should be fully briefed. Prehospital anaesthesia should not be attempted unless an appropriately trained anaesthesia provider and a trained assistant are present. To ensure that drugs and the equipment for induction of anaesthesia and management of complications are available immediately, a standardised `kit dump´ is prepared. Prehospital team members should be thoroughly familiar and have undergone training and simulation in equipment preparation and layout. A verbal challenge–response pre-induction checklist is an effective

method of confirming the availability of equipment, doses of drugs to be administered and the management plan in case of failed tracheal intubation. The use of checklists in PHEA is standard practice, but care must be taken to ensure these are well designed and practical to use [27, 28]. Recently revised National Safety Standards for Invasive Procedures (NatSSIPs) emphasise context-specific checklists and standard operating procedures aligned with individual health system governance structures, training, culture and education processes [29].

Pre-oxygenation

Effective pre-oxygenation is an important intervention to reduce the risk of peri-intubation oxygen desaturation [30]. Patient position should be optimised and, where possible, a head-up position achieved to improve ventilation [30]. Hard collars and head blocks should be removed before induction of anaesthesia as these can make laryngoscopy more difficult and are not proven to reduce the risk of neurological damage [31, 32].

In patients with good respiratory effort and adequate spontaneous ventilation, oxygenation can be achieved with at least 3 min of high-flow oxygen delivered via a tight-fitting facemask. A bag-valve-mask can also be used but may increase the work of breathing, and devices may vary in the fraction of inspired oxygen delivered [33]. Where respiratory effort is inadequate, gentle bag-mask ventilation should be carried out to pre-oxygenate. Gentle ventilation can also be carried out in the apnoeic phase and has been shown (in patients who are critically ill) to reduce hypoxic episodes without significantly increasing aspiration risk [34]. In the prehospital setting, patients are less likely to have empty stomachs and have a higher risk of aspiration. The risk of gastric distension and aspiration may be reduced if ventilation pressures are minimised. Where a supraglottic airway device has been inserted as part of early resuscitation interventions, it can be used to oxygenate and ventilate before tracheal intubation.

Apnoeic oxygenation may, where the airway is patent, reduce the incidence of desaturation after tracheal intubation in adults and children [33, 34]. Although the evidence base for the routine use of apnoeic oxygenation in the prehospital setting is limited [35], it is used by many prehospital services and has not been reported to cause practical problems.

Manual in-line stabilisation

The use and value of manual in-line stabilisation during emergency tracheal intubation in trauma patients has been questioned [36]. This is due to conflicting evidence regarding effectiveness in terms of cervical stabilisation; association with worsening of laryngoscopic glottic views; and increased incidence of failed tracheal intubation [31]. Recent multi-society guidelines for in-hospital tracheal intubation in patients with suspect cervical spine injury concluded ``*Manual in-line stabilisation worsens glottic view, and there is very limited evidence suggesting that it reduces the risk of secondary spinal cord injury. If clinicians choose to use MILS, then clinicians should have a low threshold for its removal in the event of difficult tracheal intubation*´´ [31]. However, this working party did note the lack of evidence directly relating to PHEA. Given the lack of definitive data, it would seem reasonable for prehospital care practice to mirror these emergency department recommendations.

Induction of anaesthesia

The combination of ketamine, fentanyl and the neuromuscular blocking drug rocuronium has been used for the induction of PHEA for many years [15, 37] and is associated with good haemodynamic stability [38]. Previously, suxamethonium and etomidate were used commonly but have significant potential disadvantages and have been discontinued by most prehospital services [15].

As part of standard operating procedures, services should provide guidance on drug doses and include adaptation for specific patient groups that are likely to require dose modifications (e.g. children and patients with frailty, hypotension or those who have had pre-induction drug administration).

Although the induction drugs used for PHEA in patients with traumatic injury are relatively consistent in UK practice, PHEA after cardiac arrest and for medical indications may require a different combination of induction and analgesic drugs, although neuromuscular blocking drug use is unlikely to require modification. In these patients, the cardiovascular adverse effects of induction of anaesthesia may be more related to drug doses and patient variables rather than the choice of specific drugs [39].

The dose of fentanyl administered as part of a PHEA induction has been variable but commonly reported to be between 1 and 3 $\mu g.kg^{-1}$ [40]. Modifications to drug doses are made to decrease the frequency of post-induction cardiovascular instability; improve tracheal intubation conditions; and minimise the possibility of awareness. Doses should be based on the clinical state of the patient and any suspected comorbidities present. Doses of fentanyl that are too high can result in potentially harmful hypotension and doses that are too low have been

associated with potentially harmful episodes of post-induction hypertension [41]. Before induction of anaesthesia, drug doses should be calculated and checked with the anaesthetic assistant. Vasopressor drugs should be immediately available to treat any anaesthetic-related hypotension.

Cricoid force

Cricoid force has been used to reduce the risk of aspiration in rapid sequence induction for many years [42]. However, the intervention has a poor evidence base [43] and evidence that is available suggests worsening of laryngoscopic view and more difficult tracheal intubation conditions [44]. The efficacy of cricoid force on the prevention of pulmonary aspiration has also not been established [45]. As a result, cricoid force is not recommended in airway management during cardiopulmonary resuscitation [46] or in emergency anaesthesia guidelines from other European countries [42]. Recommendations by the Difficult Airway Society published in 2025 [47] acknowledge the poor evidence base around the intervention and recommend use in patients ``*at particularly high risk of pulmonary aspiration*´´. Cricoid force is, therefore, not mandated but if it is used, the correct location and amount of force should be applied and it is recommended that it be removed if a poor glottic view is obtained at laryngoscopy [12, 30, 44, 47]. Although external laryngeal manipulation is a separate manoeuvre from cricoid force, it is noted that, once applied, manipulation of cricoid force is used frequently to attempt to improve glottic view. Routine use of an intubating bougie or stylet is recommended [48].

Videolaryngoscopy

Videolaryngoscopy is an established technique in difficult airway management. For in-hospital practice, it is reported to improve tracheal intubation success rates and reduce associated complications [49, 50]. As a result, it has been suggested that all initial in-hospital laryngoscopy attempts should use this technique [51]. Difficult Airway Society guidelines published in 2025 also recommend that ``*A videolaryngoscope should be used for tracheal intubation whenever possible*´´ [47]. However, there are limited data for prehospital use [52, 53]. Improvements in tracheal intubation performance have been shown when videolaryngoscopy is used by very experienced anaesthetists [54] and by less experienced practitioners [55]. Reported improvements in tracheal intubation success and complication rates may also be achieved by `bundles´ of quality improvement which include the use of videolaryngoscopy [56, 57].

It is recommended that videolaryngoscopy is available in all prehospital services that deliver PHEA. There is currently little evidence to guide exactly how videolaryngoscopy should be integrated into standard operating procedures and significant variations may exist (e.g. the technique can be used as a primary or rescue technique and the type of laryngoscope blade used can vary). Services should develop straightforward standard operating procedures to guide the effective use of videolaryngoscopy and ensure that staff are trained to use selected devices.

Failed tracheal intubation

The emergency nature of prehospital airway management increases the risk of difficult tracheal intubation. The opportunity for patient assessment is limited and patients often fall into high-risk categories. Although tracheal intubation difficulties have previously focused on anatomical problems, there is an increasing recognition that many of the problems encountered are due to the `physiologically difficult airway´ [47, 58] and that when standard operating procedures and techniques such as videolaryngoscopy are in place, anatomical difficulties are uncommon and very high first-pass tracheal intubation success has been reported [59].

Services must ensure that the techniques and standard operating procedures used deliver high rates of successful first-pass tracheal intubation and low complication rates. All prehospital services should have well-rehearsed difficult laryngoscopy and failed tracheal intubation plans. Where factors suggestive of difficult tracheal intubation are identified, the practitioner with most anaesthetic experience should be the first to attempt tracheal intubation. With appropriate systems and standard operating procedures in place, tracheal intubation success rates of doctor–paramedic teams are high and, in many services, equivalent to those reported in emergency departments [57, 60, 61].

The Difficult Airway Society has produced guidelines and an algorithm for tracheal intubation in patients who are critically ill [11, 47]. Most of these in-hospital recommendations are relevant to PHEA, including the rapid identification of difficulty followed by adjustment of head position; adjustment of laryngoscope blade position; removal of cricoid force; and laryngeal manipulation to improve the view (`30 second drills´). Simultaneous continued oxygenation with bag-mask ventilation and

apnoeic oxygenation should continue during attempts at tracheal intubation.

In the event of failure to intubate the trachea, attempts at tracheal intubation should be abandoned and rescue oxygenation conducted with two-person facemask ventilation together with simple airway adjuncts or ventilation with a second-generation supraglottic airway device. Where there is continued failure to ventilate, an immediate scalpel cricothyroidotomy should be carried out. Failed tracheal intubation in the prehospital setting differs slightly from in-hospital in that additional expert help is not usually possible, no additional equipment is available and the option to wake up a patient is often impractical. Since waking up is rarely an option, the use of sugammadex to antagonise rocuronium-induced neuromuscular block is used rarely in prehospital practice; this could also delay progression to scalpel cricothyroidotomy where it is required. Rates of scalpel cricothyroidotomy are relatively low in current prehospital practice and often include patients where the procedure is used as a primary, rather than a rescue, intervention [23]. All difficult airway incidents encountered in PHEA should be debriefed formally to promote learning and consider whether existing standard operating procedures are functioning well.

Post-tracheal intubation care

Tracheal tube placement must be confirmed by waveform capnography. Seven consecutive capnography waveforms are recommended to confirm correct tracheal tube placement [50]. Standard clinical assessment methods are insufficiently sensitive to exclude unrecognised oesophageal intubation [50, 62]. The tracheal tube should then be secured. An in-line heat and moisture exchange filter should be used in the ventilation circuit (with a self-inflating bag or portable ventilator). Practical procedures are more difficult to achieve successfully during transfer and should, wherever possible, be carried out before leaving the scene. Preparation for transfer is made by ensuring that the patient, monitoring and other equipment are secure and that there is access to intravenous cannulae and adequate oxygen supply.

A significant benefit of providing enhanced care teams in the prehospital phase of care is the opportunity to start the delivery of critical care before arrival in hospital. This is particularly important when transfer times are prolonged. A key aim of post-tracheal intubation care is to optimise cardiorespiratory physiology and prevent potentially harmful episodes of hypoxia, hypotension and hyper- or hypoventilation. This is particularly important in patients with traumatic brain injury [63, 64]. Although advanced airway management is likely to benefit patients with head injury [65], episodes of potentially harmful physiological disturbance are commonly reported after PHEA [66]. Recent studies have also suggested that, in addition to significant hypotension (systolic blood pressure < 90 mmHg), moderate hypotension (systolic blood pressure 90–130 mmHg) may also be associated with poorer outcomes [67].

Hyperoxia has been associated with adverse outcomes in patients who are critically unwell and is often present on hospital admission in patients receiving PHEA [68]. Following tracheal intubation, patients should have oxygen therapy titrated to a target pulse oximetry level (94–96%), avoiding hyperoxia where possible [69]. Lung-protective ventilation strategies can be delivered with transfer ventilators, although patients who are hypovolaemic may not tolerate higher levels of positive end-expiratory pressure. Ventilation is adjusted to achieve normocapnia, and mechanical ventilation is preferred to better achieve targets. An end-tidal carbon dioxide target of 4.0–4.5 kPa is recommended, although there is often poor correlation between arterial and end-tidal carbon dioxide in patients who are critically ill [70]. Point-of-care blood gas analysis may be available in the prehospital phase of care and can be used to titrate ventilation where necessary.

Maintenance of anaesthesia is achieved with infusions or intermittent boluses of sedative drugs. Infusion pumps are preferred by most services although their weight and bulk are a disadvantage. Midazolam, ketamine and propofol are sedative drugs used commonly. Patients receiving PHEA are at increased risk of awareness due to the use of neuromuscular blocking drugs, particularly in the minority of cases where pre-induction Glasgow Coma Score is high. The 5th RCoA National Audit Project on awareness under anaesthesia identified patients undergoing emergency anaesthesia with neuromuscular blockade as a high-risk group [71]. Propofol target-controlled infusions with processed EEG monitoring are used frequently in in-hospital anaesthetic practice. However, prehospital use of these techniques is not yet practical, and the frequent use of ketamine combined with movement and vibration in patients who are often not conscious before induction may impair interpretation.

Sedation before PHEA

Complications of sedation remain a cause of significant morbidity and mortality, despite the publication of comprehensive clinical guidelines [72, 73]. Patients

requiring PHEA are often critically unwell and susceptible to the complications of sedation. These current guidelines consider sedation practice only in association with PHEA. Standards of prehospital procedural sedation should meet those of in-hospital practice, and this should be straightforward when delivered before induction by a team capable of PHEA and with full monitoring in place.

Patients requiring PHEA may be confused, agitated and/or combative. This may be due to a variety of isolated or combined factors including anxiety; pain; intracranial pathology; acute alcohol intoxication; recreational drug use; hypovolaemic shock; and hypoxia. This can make pre-oxygenation, the application of monitoring and safe induction of anaesthesia difficult, and careful pre-induction sedation may be the safest clinical course. This may avoid the need for physical restraint which can have significant adverse effects on both the patient and healthcare providers. Non-pharmacological methods to reduce anxiety and agitation should be considered before pharmacological sedation. The patient should not be crowded, and a `single face´ point of contact for the patient is preferred.

Patients who are critically unwell have an increased susceptibility to sedative drugs and small incremental doses may be necessary to prevent undesirable adverse effects including respiratory depression with hypoxia and hypercapnia; loss of airway patency; vasodilatation; and hypotension. Patients who are hypovolaemic are at particular risk of respiratory depression and hypotension. The minimum dose of pharmacological sedation should be used to achieve safe induction of anaesthesia. Intravenous sedation is used in preference to intramuscular or other routes. Local guidelines should guide good practice, but common techniques include 1–2 mg incremental doses of midazolam.

Ketamine may also be used for sedation [74] and has a lower risk of respiratory depression and hypotension although apnoea has been reported [75]. This drug is frequently preferred in patients who are hypoxic or hypovolaemic, with the additional benefit of having an analgesic effect [74]. Incremental doses of 10–20 mg in adults (up to 1 $mg.kg^{-1}$) will usually provide adequate sedation and allow pre-oxygenation.

End-tidal carbon dioxide monitoring is recommended for patients who receive intravenous sedation. Where sedation is used to facilitate induction of anaesthesia, preparation for induction should have been completed and full monitoring (ECG, peripheral oxygen saturation and non-invasive blood pressure) attached as soon as possible. In the event of airway compromise, hypoxia or hypoventilation, airway support and induction of anaesthesia can be commenced immediately. In the uncommon situation where agitation is severe and intravenous access is not possible, intramuscular sedation can be considered. In these circumstances, ketamine has been shown to have a more rapid onset than other drugs [76]. Doses of 4 $mg.kg^{-1}$ are recommended but can be modified based on the level of agitation. Once the patient is sedated, intravenous access can be established before proceeding with induction of anaesthesia.

Personnel and training

Prehospital emergency anaesthesia providers should have the same level of training and competence that would enable them to perform unsupervised emergency anaesthesia and tracheal intubation in the emergency department. The evidence base for the level of training and experience required to perform PHEA is relatively poor and subject to many confounding factors. The other sections in these guidelines indicate that an effective service delivers a well-rehearsed and standardised emergency anaesthetic. This requires a more focused range of skills than specialist in-hospital anaesthesia. However, it is also recognised that patients who receive PHEA are a high-risk population with a high mortality and who have not had an equivalent pre-operative assessment or optimisation. Additional challenges arise because PHEA is carried out in relative isolation, with limited equipment and usually without the option of waking the patient up if things go wrong. The available evidence suggests that an experienced and well-trained team is required to deliver safe PHEA, and that services using these providers are effective with low complication rates reported [61, 77, 78].

The metrics used to measure performance in PHEA often include tracheal intubation success rates; measures of physiological stability, and the incidence significant complications. Tracheal intubation success rate is a complex metric and factors which need to be considered include operator background and training; patient population (e.g. cardiac arrest vs. trauma); and whether drugs were used to facilitate tracheal intubation. Physicians generally have better reported tracheal intubation success rates and lower complication rates compared with non-physicians [61, 78, 79]. Critical care paramedics have been reported to have similar tracheal intubation success rated to physicians where both are present and tracheal intubation is carried out by either provider, although the tracheas of higher risk patients may be preferentially intubated by physicians [80]. Some advanced critical care practitioners who have undertaken the extra optional skills framework

[81] have the training and competency to provide anaesthesia in hospital, but only in specific low-risk patient groups. For these providers there is also a requirement for senior supervision to be available on site for `assistance within minutes´. Prehospital patients are in a high-risk group and rapid assistance is not usually available where PHEA is conducted.

An indication of the training and competence required for PHEA is documented in the RCoA guidance on training requirements for provision of anaesthesia with no on-site supervision. Although the RCoA initial assessment of competency is necessary, this is not adequate to deliver unsupervised emergency anaesthesia and further experience or supervision is required [8]. The UK Intercollegiate Board for Training in Pre-hospital Emergency Medicine recommends that, in addition to anaesthetic competency, the provider must also have appropriate prehospital training and experience [82]. Prehospital emergency anaesthetic practitioners require enough in-hospital experience in anaesthesia and other acute specialities to conduct unsupervised anaesthesia to the same standard as expected in the emergency department.

Most current resident doctors will have completed acute care common stem training providing experience in key specialities in emergency care. Setting the absolute numbers of emergency anaesthetics that need to be delivered to achieve or maintain competence is difficult. Previous versions of these guidelines suggested that providers should complete an average of one PHEA per month to maintain competence. The College of Paramedics has recommended 60 tracheal intubations in training and two per month to achieve and maintain competence for the skill of tracheal intubation (unrelated to anaesthesia) [83]. To gain sufficient anaesthetic experience to deliver pre-hospital anaesthesia, an absolute minimum of 6 months in-hospital anaesthesia training or documented equivalent training delivering the same competencies is recommended. Services providing PHEA must provide a period of supervised and assessed prehospital practice which includes PHEA before independent practice, and this is the point where PHEA competence is established. In addition, continued in-hospital anaesthesia practice is likely to be necessary, particularly for those without anaesthesia as part of their standard job plans or those with the minimum training to achieve competence. The number of prehospital anaesthetics performed by individual practitioners even in busier services is limited and unlikely to provide adequate experience to maintain necessary skills [15, 84]. Assessment of competence in PHEA should include direct prehospital observation by experienced senior clinicians.

In recent years, many prehospital services across the UK have moved towards a consultant-delivered model of care. This mirrors practice in major trauma centre consultant-led trauma teams and consultant-delivered emergency department care. Prehospital anaesthesia is a high-risk procedure in a high-risk patient group, and consultant-delivered care may be desirable in the future whenever feasible. The available evidence and guidance for independent in-hospital emergency anaesthesia support the recommendations for training and assessment of competence in PHEA (Box 3).

Safe practice is not only delivered by well-trained individuals but also by the system in which they work. Services should include a governance framework which provides regular review of PHEA practice (as part of routine case discussions) and specific aspects of PHEA care (e.g. tracheal intubation failure, equipment failure and complications). Most prehospital services enter patient data onto an electronic database, which can provide the required data for quality improvement and performance management. Suggested quality indicators for advanced airway management include operator experience, process and outcome measures [85]. For research purposes, data collection tools should be prospectively designed to capture comprehensive clinical information [86].

Equipment and monitoring

Prehospital equipment is designed specifically for transfer and outside hospital use. It should be robust and function effectively in adverse weather conditions, a full range of ambient temperatures and in low or bright light conditions. Most prehospital organisations use disposable equipment or may rely on other service providers for sterilisation of reusable equipment. The quality and capability of portable monitoring equipment have improved significantly in recent years.

In-hospital standards of monitoring are achievable for most physiological variables. The Association of Anaesthetists recommendations for standards of monitoring are accepted widely as the required standard in UK anaesthetic practice [13], and most of the recommendations are also relevant to prehospital anaesthetic practice. The suggested minimum monitoring for transfers is ECG, peripheral oxygen saturation and non-invasive blood pressure measurement. This recommendation is relevant for short intra-hospital transfers but patients in the prehospital setting require more

Box 3 Recommendations for training and assessment of competence in prehospital emergency anaesthesia (PHEA)

1. Prehospital services should have standard operating procedures in place to guide practice. Prehospital emergency anaesthetic practice should be included in regular service reviews and difficult cases should be reviewed and lessons addressed.
2. A named consultant should be responsible for PHEA practice in each service and ensure that operators and assistants meet the required standards.
3. Individual PHEA practice and review should be included in prehospital reviews as part of annual appraisal.
4. Prehospital emergency anaesthesia can only be safely delivered by a team. This requires a minimum of one experienced anaesthesia provider and a trained anaesthesia assistant.
5. The operator should have the equivalent level of training to an in-hospital practitioner conducting independent emergency anaesthesia in the emergency department.
6. The operator and assistant must be well practised and familiar with the equipment and standard operating procedures of the prehospital service.
7. Prehospital services should provide appropriate, easily accessible and ongoing support to practitioners who undertake PHEA. Non-consultants undertaking PHEA without direct supervision should have immediate access to advice from a PHEM consultant fully competent in PHEA and prehospital critical care.
8. In UK practice, prehospital practitioners require in-hospital anaesthesia training and ongoing experience to acquire and maintain adequate skills to carry out safe PHEA.
9. Prehospital emergency anaesthesia is delivered by non-physicians in a small number of services worldwide. There are currently no established training programmes in the UK which prepare non-physicians to deliver safe PHEA to the standards required.

comprehensive monitoring, much closer to in-theatre monitoring standards. The minimum equipment required for PHEA is shown in Box 4.

Box 4 Minimum equipment required for prehospital emergency anaesthesia (PHEA). Adapted from [13]

1. The presence of the anaesthesia providers for the duration of the anaesthetic. In prehospital practice, this will be from induction until handover in hospital.
2. Monitoring equipment with appropriate audible alarm limits: ECG; NIBP; temperature; capnography; and peripheral oxygen saturation. These are mandatory for PHEA and procedural sedation.
3. Oxygen (sufficient for PHEA and transfer to hospital, with reserve)
4. An adequate supply of drugs (ideally pre-prepared and drawn up into labelled syringes) for induction and maintenance of anaesthesia.
5. Tracheal intubation equipment: video- and direct laryngoscopes and bougies.
6. Simple airway adjuncts: oro- and nasopharyngeal airways.
7. Effective suction device.
8. Ventilation equipment: self-inflating bag-mask with an oxygen reservoir.
9. Mechanical ventilators: properly serviced and checked with appropriate pressure relief systems and alarms
10. Rescue airway equipment: second-generation supraglottic airway device and surgical airway equipment.
11. Vascular access equipment: intravenous and intra-osseous.
12. Lighting where appropriate.
13. Procedural checklists.
14. An anaesthetic record; this should be generated and added to the patient record. Most prehospital monitors provide an automated record of physiological variables.

Some recommendations made for in-hospital anaesthesia are not standard practice in prehospital anaesthesia, including monitoring of inspired oxygen concentration; quantitative neuromuscular block monitoring; and processed electroencephalography (pEEG). It is possible that these monitoring techniques will become available increasingly in transfer and prehospital practice in the future. As oxygen or oxygen–air mix are the only gases used commonly during PHEA, anaesthetic gas monitoring is used rarely in the prehospital environment as

the risk of hypoxic gas mixture delivery is minimal. Gas supply failure alarms should be present on mechanical ventilators. The absence of neuromuscular and processed EEG monitoring makes it important to remain vigilant for clinical signs of awareness. The frequency of awareness in prehospital anaesthesia is unknown but may be rare because only a small minority of patients anaesthetised are likely to be fully conscious before induction.

Intra-arterial blood pressure monitoring has long been recognised as feasible in the prehospital working environment [87]. Although non-invasive blood pressure monitoring is rapid, requires little training and is not associated with the complications associated with invasive procedures, it has been shown to be unreliable, particularly in patients with haemodynamic instability [88]. Intra-arterial blood pressure monitoring should be considered in cases where accurate blood pressure monitoring is likely to change management and where the procedure does not delay life-saving interventions. Intravenous and intra-arterial lines should be inserted with an aseptic technique where possible but receiving hospitals will usually change cannulae on the basis that prehospital conditions are often unsterile.

Most prehospital services carry mechanical ventilators. They are often heavy and bulky to transport to and from scene. It is recommended that mechanical ventilation is used after induction of anaesthesia to deliver lung protective ventilation, to improve end-tidal carbon dioxide titration and to increase the availability of prehospital team members for other tasks [10]. Portable ventilators are increasingly sophisticated and can deliver many functions previously only available in hospitals.

Core temperature monitoring should be available in services that conduct prehospital anaesthesia and used when indicated. Continuous monitoring is essential for vulnerable patient groups, colder environments and long transfers. Audio-visual alarms on monitoring equipment should be set up, so that they can be easily detected in noisy or poorly lit environments. Monitoring may need to be suspended temporarily for short periods during difficult extrication.

Children requiring PHEA

Children who are critically ill make up only a small proportion of the case load of enhanced care prehospital services. Individual prehospital providers are only likely to deliver advanced airway management to children infrequently, even in high-throughput services. In addition, younger children make up a minority of the children attended and are encountered even less frequently [89]. Anaesthesia for younger children is often viewed as a sub-specialist area of in-hospital practice and likely to cause most concern to non-specialist prehospital doctors. Despite these challenges, advanced airway management in prehospital practice has very high reported success rates [90] and should be carried out immediately where a non-patent airway or hypoxaemia cannot be addressed with more basic airway techniques. In other circumstances, the choice to proceed to paediatric PHEA should be made on a case-by-case basis and rapid assessment of the risks and benefits will inform this decision. Factors to be considered include the condition and characteristics of the child; the skills of the attending clinical team; and proximity to hospital. On the basis that most children with airway compromise can be managed without tracheal intubation [91], the threshold for PHEA may be higher than that for adult patients.

Most prehospital enhanced care services will not meet the standards recommended for the provision of in-hospital paediatric anaesthesia [8] or paediatric critical care transfer fully [92]. This is because the services are not generally staffed by clinicians working specifically in paediatric practice. To address the challenges posed by paediatric advanced airway management, prehospital services need to have specific arrangements in place to optimise patient safety and prepare clinical teams. The European Resuscitation Council guidelines on paediatric resuscitation acknowledge that paediatric resuscitation is an uncommon event that requires written treatment protocols and a team-based approach to ensure that, when approaching these cases, the team share a mental model of how to proceed [14]. These principles are also very relevant to the conduct of PHEA, particularly in smaller children. The recommendations for paediatric PHEA are summarised in Box 5.

Transport

Patients who have received PHEA should be transferred to hospital safely with minimum delay. Some patients have time-critical injuries and should bypass local hospitals to specialist centres which can provide definitive care. This is an important function of enhanced care teams. Within the UK, interhospital transfer guidelines exist [93] and many recommendations are relevant to transfer of the anaesthetised patient from scene to hospital. Prehospital teams should be experienced in the movement by ground or air of patients who are critically ill. Interhospital standards of monitoring in transport should be applied. Although

Box 5 Recommendations for paediatric prehospital emergency anaesthesia (PHEA)

1. Paediatric guidelines should detail emergency anaesthetic practice and be relevant to the service, case mix and skills of practitioners.
2. Prehospital practitioners should be competent in paediatric resuscitation and emergency anaesthesia. Lead clinicians should ensure that individuals use specific training, courses or continuing professional development in paediatric anaesthesia or resuscitation to gain and maintain competence.
3. Cognitive aids should be available to assist clinical teams in paediatric PHEA. These may include physical or electronic checklists and drug dose calculators.
4. On-scene advice from consultants (remote when not available on scene) should be available to support paediatric cases. Formal links to regional paediatric critical care retrieval services may also provide opportunities for support and education.
5. Clinical teams should be thoroughly practised and familiar with the equipment and drugs used to manage paediatric emergency anaesthesia.

planning and preparation for transport are different on scene, pre-departure checks and communication with the receiving hospital team are mandatory. Safety in transport is vital as accidents during emergency transport are well reported [94]. Patients, equipment and clinical teams should always be secured while mobile.

Guidelines from the Association of Anaesthetists exist to guide safe transfer of patients with brain injury [95]. Recommendations on the indications for tracheal intubation before transfer and physiological targets during transfer are also relevant to patients receiving PHEA on-scene. Invasive arterial blood pressure monitoring should be considered in this patient group where appropriate. Vigilance for signs of awareness and maintenance of sedation is particularly important in the transport phase. The prehospital team leader provides a clear and structured handover to the receiving team. As part of this, details and times of anaesthetic drug administration, airway difficulties and physiological instability are included.

Discussion

Prehospital emergency anaesthesia is required for a small proportion of patients who are critically ill. The widespread availability of prehospital critical care teams means that, in most cases, this can be delivered. The clinical teams that provide PHEA need to be well-trained and competent to deliver to the same standards as their colleagues in the receiving emergency department. Advances in practice and technology have delivered equipment, monitoring and techniques that improve safety in the less predictable prehospital environment. Techniques should be straightforward, reproducible and supported with standard operating procedures and checklists.

Safe practice is only possible with the support of a service with comprehensive clinical governance arrangements in place. Although patients who require PHEA are often physiologically unstable and have pathology associated with a high mortality, there is good evidence that PHEA can be delivered safely to high standards. Where PHEA skills are not available, oxygenation and ventilation should be maintained with the use of second-generation supraglottic airway devices in patients without airway reflexes, or basic airway manoeuvres and basic airway adjuncts in patients with intact airway reflexes.

There are limitations to these guidelines, most notably the lack of evidence relating directly to prehospital practice. This meant that it was not possible to grade the strength of recommendations or undertake quantitative data synthesis, and we have had to rely on consensus of the working party to deliver best practice guidelines. There is a focus on UK practice, but many of the recommendations may be generalisable elsewhere. In summary, we have produced multidisciplinary guidelines that aim to improve the safety of PHEA. We hope that these will be of value to clinicians who work in this challenging environment.

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Supporting Information

Additional supporting information may be found online via the journal website.

Appendix S1. Six highest ranking clinical questions related to prehospital emergency anaesthesia.