A review of emergency equipment carried and procedures performed by UK front line paramedics on paediatric patients

K Roberts, F Jewkes, H Whalley, D Hopkins, K Porter

Objectives: In 1997 a review of paramedic practice upon adult patients in the UK found many inconsistencies and deficiencies in basic care. A follow up review in 2002 identified widespread improvement in provision of equipment and skills to provide basic and advanced life support. Paediatric care was not assessed in either review. The authors conducted this study to identify current standards of care in paediatric paramedic practice and areas of potential improvement.

Method: A questionnaire designed to determine what equipment and skills were available to paramedics for the management of common or serious paediatric emergencies was sent to chief executives of the 32 NHS Ambulance Trusts in England and Wales.

Results: The trend of expanding and standardising practice among adult patients has not extended to paediatric practice despite national guidelines from the Joint Royal Colleges Ambulance Liaison Committee (JRCALC). Furthermore there are some serious failings in the provision of care and skills. Many Trusts have not adopted JRCALC guidelines for the management of life threatening paediatric emergencies such as asthma, meningitis, and fluid replacement in hypovolaemia.

Conclusions: Ambulance Trusts not meeting standards set out in the JRCALC guidelines must address their areas of deficiency. Failure to do so endangers children’s lives and leaves Trusts open to criticism.

METHOD

In July 2003, a year and a half after publication of the second edition of JRCALC guidelines, each chief executive of the 32 NHS Ambulance Trusts in England and Wales was sent a postal questionnaire. No reminders were sent.

The questionnaire was designed to determine what equipment and skills were available to paramedics for the management of common or serious paediatric emergencies including basic and advanced life support. Questions were structured to follow the standard paradigm of the “primary survey”—airway, breathing, and circulation with haemorrhage control. Specific questions relating to extrication equipment, spinal immobilisation, analgesia, and specific paediatric emergencies were included.

RESULTS

Twenty two (69%) Trusts replied to the survey. The results, including comparison with adult practice in 2002 where appropriate (indicated as “adult % of Trusts”), are presented in tables 1 to 5.

In tables and text “Trusts (%)” refers to the percentage of Trusts who responded to the questionnaire and not the total number of UK NHS Ambulance Trusts.

Airway

Table 1 shows the equipment and procedures available to the paramedic for airway control. One Trust cannot provide high flow Oxygen (12–15 l/min) because they do not carry paediatric non re-breather masks with a reservoir bag. All Trusts carry oropharyngeal airways. Only 27% of Trusts permit the cutting of endotracheal tubes for use as nasopharyngeal airways. Intubation is permitted by all trusts.

Abbreviations: JRCALC, Joint Royal Colleges Ambulance Liaison Committee; LMA, laryngeal mask airway; NPA, nasopharyngeal airways; OPA, oropharyngeal airway.
however practice varies widely. 36% of Trusts do not carry straight blades (which are preferred for intubating very young children) and two do not carry uncuffed endotracheal tubes (preferred before puberty as the pressure of the cuff can damage the airway in these children). Six Trusts do not permit intubation of under one year olds, one Trust under five year olds, and one Trust under six year olds. Three Trusts (14%) permit the use of the laryngeal mask airway in children and three have capnography widely available. Needle cricothyroidotomy is permitted by 60% of Trusts.

Breathing

Table 2 shows that 73% of Trusts allow their paramedics to perform needle thoracocentesis in children, comparable to adult practice (68%). Three Trusts do not permit or have the equipment for pulse oximetry. Twenty one (95%) Trusts carry peak flow meters. None carry spacer devices for the inhalation of commonly used asthma medications.

Circulation

Table 3 shows the equipment available for the treatment of shock. All Trusts carry intravenous cannulae and all permit the use of large bore, size 14 gauge cannulae. Eighty two per cent carry intraosseous needles and 23% permit placement of cannulae in the external jugular vein. Twenty one (95%) Trusts employ JRCALC guidelines for the resuscitation of patients suffering haemorrhagic shock with 20 ml/kg being given as a first bolus. Eleven Trusts follow guidelines allowing a second bolus. Practice varies in the remaining Trusts from no further fluid to unlimited boluses. The use of crystalloids in paediatric and adult practice is comparable (Hartmans solution, 64% (this study) and 68% (adult study 2002); normal saline, 77% (this study) and 71% (adult study 2002)) whereas the availability of colloids continues to decrease (Gelofusine, 18% (this study) v 39% (adult study 2002) and 54% (adult study 1997); Haemaccel, 9% (this study) v 29% (adult study 2002) and 72% (adult study 1997)). Eighteen Trusts have a protocol for fluid replacement of paediatric burn victims; however, the protocols vary widely (see table 3). Sixty eight per cent of Trusts carry cling film or Waterjel (Water-Jel Technologies, Carlstadt, New Jersey, USA) for topical application to prevent dehydration of burnt tissue, further fluid loss, and pain relief.

Disability, and spinal and limb immobilisation

The use of AVPU as a tool to assess conscious level is universal. Fourteen Trusts also employ the use of the paediatric Glasgow Coma Scale.

All Trusts returning the questionnaire carry long spinal boards and 9% paediatric scoop stretchers. The use of traction splints (namely Donway, Sagar, or Thomas) is permitted by half of the Trusts (compared with 74% of adult practice). Every Trust uses either box or vacuum splints (or both) for immobilisation of long bone fractures. Extrication devices such as the Telford and Kendrick devices are widely available (87%). These can also be used as a method of paediatric spinal immobilisation.

Medication and analgesia

All Trusts surveyed use entonox. The availability of nalbuphine continues (77%) and no Trust, in accordance with version 2 of the JRCALC guidelines, permits the use of morphine. Simple analgesics (paracetamol or oral non-steroidal anti-inflammatory drugs) are employed by half of
the Trusts. Every Trust permits the use of nebulised salbutamol in the treatment of asthma although none carries salbutamol inhalers. The protocols for the volumes of nebulised salbutamol vary widely (number of Trusts that adopt each protocol is given in parentheses): no maximum unless side effects become a problem (JRCALC guideline) (nine); 5 mg max (two); <1 year old 2.5 mg, >1 year old no max (three); nil to <1 year olds and various other doses for >1 year olds (five); 2.5 mg as required (one); 5 mg <5 year old, 10 mg >5 year old (one); and no protocol (three). Hydrocortisone can be given by four Trusts (18%) for the treatment of asthma.

One Trust does not allow the use of adrenaline (epinephrine) in anaphylaxis whereas two (9%) permit chlorphenamine (not recommended in version 2 but is now in version 3 of the guidelines) and seven (32%) hydrocortisone.

All Trusts carry diazepam for rectal administration and 17 (77%) permit the use of intravenous diazepam. Version 3 of the guidelines permits intravenous or rectal routes for the administration of diazepam.

Benzylpenicillin is carried by 17 (77%) Trusts for the use in cases of suspected meningitis; four of these permit its use when there is no non-blanching purpuric rash.

Four Trusts permit the use of nebulised adrenaline in croup. None carries nebulised budesonide or oral dexamethasone.

One Trust does not routinely check finger tip blood sugar levels but all carry glucagon. Intravenous glucose is carried by 17 Trusts (77%) and oral by 12 (55%).

**DISCUSSION**

This review demonstrates that paediatric care by UK paramedics is limited by resource and skill availability and on occasion accepted standards are seriously lacking, as assessed by comparison with national guidelines. It is not clear why the observed improvement in adult practice has not extended to paediatric practice.

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**Table 5** Medication and analgesia

<table>
<thead>
<tr>
<th>Equipment carried or procedure performed</th>
<th>Trusts (n)</th>
<th>Trusts (%)</th>
<th>Adult % of Trusts</th>
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</thead>
<tbody>
<tr>
<td>Analgesia</td>
<td></td>
<td></td>
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<tr>
<td>Paracetamol/oral NSAID</td>
<td>11</td>
<td>50</td>
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<tr>
<td>Entonox</td>
<td>22</td>
<td>100</td>
<td>100</td>
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<tr>
<td>Nalbuphine</td>
<td>17</td>
<td>77</td>
<td>71</td>
</tr>
<tr>
<td>Morphine</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Asthma</td>
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<td></td>
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<tr>
<td>Salbutamol inhaler</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>Salbutamol nebuliser</td>
<td>22</td>
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<tr>
<td>Ipratropium inh/neb</td>
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<td>0</td>
<td></td>
</tr>
<tr>
<td>Hydrocortisone</td>
<td>4</td>
<td>18</td>
<td></td>
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<td>Anaphylaxis</td>
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<tr>
<td>Adrenaline</td>
<td>21</td>
<td>95</td>
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<tr>
<td>Chlorpheniramine</td>
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<tr>
<td>Hydrocortisone</td>
<td>7</td>
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<tr>
<td>Epilepsy</td>
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<tr>
<td>Diazepam – IV</td>
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<tr>
<td>Diazepam – rectal</td>
<td>22</td>
<td>100</td>
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<tr>
<td>Meningitis</td>
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<tr>
<td>Benzylpenicillin</td>
<td>17</td>
<td>77</td>
<td></td>
</tr>
<tr>
<td>With no rash present</td>
<td>4</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>Croup</td>
<td></td>
<td></td>
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<tr>
<td>Nebulised adrenaline</td>
<td>4</td>
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<tr>
<td>Nebulised budesonide</td>
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<td>Dexamethasone</td>
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<td>Hypoglycaemia</td>
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<td>Routine BM check</td>
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<td>Glucose – oral</td>
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<td>10% Glucose – IV</td>
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</tr>
<tr>
<td>Glucagon</td>
<td>22</td>
<td>100</td>
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</tbody>
</table>

NSAID, non-steroidal anti-inflammatory.

Note: The previous studies reviewing adult practice did not assess treatment of medical conditions.
the ability of the patient to oxygenate their blood and guide
the paramedic as to the effectiveness and need for further
airway or breathing support. It is less widely used in children
than adults (86% vs 95%). The fact that it is less available to
children than adults suggests that Trusts have failed to
purchase paediatric sensors—presumably on grounds of
economy. This is unacceptable, because the main cause of
death in children is hypoxia.

All Trusts appropriately employ wide bore cannulae. Eighty
two per cent carry the intraosseous needle and 23% allow
placement of cannulae in the external jugular vein. In
shocked patients venous access can be difficult and intraoss-
eous needles offer rapid access to the vascular compartment.

All drugs and intravenous fluids can be given by this route. It
is a concern, as with NPAs, cricothyroidotomy, and chest
decompression, that a proportion of Trusts do not permit
their use. Similarly, they are easy to learn how to use,
effective, and there is little skill decay. There are complica-
tions with their use such as extravasation, osteomyelitis, or
growth plate damage and therefore teaching methods of safe
placement in order to avoid complications is essential.

The external jugular vein is a large peripheral vein that is
easily accessible. Cannulating this vein is easy to teach and
again the focus must be how to avoid complications such as
damage to pleura and other deep structures.

Circulatory support is essential in trauma care. There is
much debate and research over volume and type of fluid that
should be used in the resuscitation of adult patients in and
outside of hospital.11-15 However children have very different
physiological and compensatory mechanisms to hypovolae-
mic shock and the authors are not aware of any significant
work investigating fluid resuscitation of children in pre-
hospital care. It is important not to overly extrapolate adult
conclusions to children who have different cardiovascular
physiology.

The increased use of crystalloids and decreased use of
colloids reveal that ambulance Trusts are adapting to the
current trend in medical practice. A recent systematic review
of randomised controlled trials comparing colloid and
 crystalloid resuscitation in critically ill trauma patients found
no difference in outcome.16 A further systematic review of
randomised controlled trials identified an increased relative
risk of death associated with colloid use (2.6, 95% CI 1.1 to
5.9) in a similar group of patients.17 All this, however, is adult
work. If crystalloid is to be given the choice is important. The
use of a lactate containing solution (such as Hartman’s) in
massive haemorrhagic shock decreases acidosis and improves
outcome in adults.12 However children metabolise lactate
poorly, particularly in “medical” shock where lactic acidosis
may become severe (for example, meningococcal sepsis) and
it may be that solutions without lactate, such as 0.9% sodium
chloride, are best.

Although the arguments continue over what fluid type is
best it is accepted that warm fluid must be given to avoid
secondary coagulopathy.17 This is particularly important in
children as their body surface to volume ratio predisposes
them to hypothermia.

A further trend adopted by prehospital practitioners in
adult practice is “hypotensive resuscitation”. This describes
limited fluid replacement to achieve vital organ perfusion
while accepting a lower than normal blood pressure in an
attempt to control further blood loss. A detailed discussion is
beyond the remit of this paper and can be found elsewhere.17
However, during haemorrhage, children maintain their blood
pressure very well before rapid cardiovascular collapse and
death. The hypotensive state that can be identified and then
maintained by limited fluid replacement in adults is not easy
to identify in children. The JRCALC (version 3) guidelines
therefore recommend up to two 20 ml/kg fluid boluses
aiming to normalise pulse and capillary refill time.

Fluid resuscitation outside of hospital can increase on-
scene time and the total volumes of fluid infused are low
because of short scene and transit times.18 19 The temptation
to cannulate on-scene and infuse fluids should be deferred in
non-entraped patients until the ambulance is en route to
definitive care. If the patient is trapped and greater
circulatory support is required prehospital then medical
advice should be sought from prehospital doctors or hospital
based medical personnel.

A minimum standard of care is the ability to splint
fractures and immobilise the spine. This is achieved
universally. Some trusts carry specific paediatric scoop
stretchers or spinal boards; however the majority use adult
long spinal boards—presumably using blankets to stabilise
smaller children on the board.

Lower limb traction splints, such as Donway, Sagar, or
Thomas, can be used by 50% of Trusts on paediatric patients.
This is 24% less than adult practice. Low limb fractures,
especially of the femur, cause moderate blood loss if the
fracture is closed and massive haemorrhage if open. Traction
splintage decreases the volume of blood loss and also the
incidence of fat embolism and pain. The use of the Thomas
splint in the First World War contributed to a decreased
mortality from 80% to 8% in open fractures of the femur.20 It
is appreciated that their application takes several minutes,
but in cases of long on-scene or transport times their use can
be life saving and certainly decreases morbidity and pain.

Four Trusts still use inflatable splints despite concerns over
microvascular compromise.21 22 Now that box or vacuum
splints are available this equipment should be abandoned.

Extraction devices such as the Telford Extrication Device
(TED) and Kendrick Extrication Device (KED) can be very
useful in the extrication of trapped patients from motor
vehicle accidents. In children they have a further use—their
design enables spinal immobilisation and a means of
transport.

A long term criticism of the ambulance service has been
the inadequate provision of analgesia.1 4 In adult practice this
seems to be addressed,2 however the paediatric patient has
until recently been exempt. At the time of the study
paramedics were not permitted to give paediatric patients
morphine. However, in 2003, the Medicines and Health care
products Regulatory Agency (MHRA) approved its use.
Version 3 (March 2004) of the JRCALC guidelines include
advice on the use of morphine in children and this must be
encouraged because of the distress and physiological stress
that pain causes children. When doses are calculated for the
patient’s age the response to intravenous morphine is
predictable and safe.

With the paramedic role continuing to expand and the
introduction of a paramedic degree course, there is scope to
consider the use of other forms of anaesthesia. One suitable
example would be the use of local anaesthetic to anaesthetise
the femoral nerve in fractures of the femur. This aids pain
relief, splintage, and transportation of the patient. Another
would be the use of ketamine to aid extrication of patients
with fractured limbs trapped in road traffic accidents.
Furthermore younger children do not appear to experience
unpleasant emergence phenomena, which can be a problem
with its use in adults.

Every Trust carries salbutamol for nebulised administra-
tion, however the doses given to patients vary greatly and
three Trusts do not allow administration to under one year
olds. Once more discrimination on the basis of age is
unacceptable. At the time of the study ipratroprium was
not permitted, this has been changed in version 3 of the
guidelines. Salbutamol is less effective in under one year olds whereas ipratropium can be particularly effective.

This study has identified many areas of deficiency; however, there are infrequent but encouraging examples of Trusts meeting more advanced practice than basic guidelines recommend. Regarding the treatment of asthma, four Trusts permit the use of hydrocortisone (not discussed in JRCALC guidelines). Another, and more contentious, example is the administration of intravenous benzylpenicillin in cases of suspected meningitis. Currently the majority of Trusts (76%) adopt JRCALC guidelines and permit this when a patient’s history is in keeping with meningitis and the patient has a non-blanching purpuric rash. Antibiotic therapy is more effective given earlier in the disease, before rash formation, and four Trusts permit the administration of benzylpenicillin when there is no rash but the history is suggestive of meningitis. Presumably this is by a locally arranged patient group directive, a legal arrangement permitting non-doctors to prescribe in certain circumstances. This attitude of widening the paramedics scope to improve patient care and to expand practice has to be encouraged, although there are concerns over the diagnostic abilities of paramedics and thus inappropriate administration of benzylpenicillin with potential serious adverse reaction. We would advise Trusts to support their paramedics with additional, specific training when establishing such patient group directives. Audit of this practice is essential along with dissemination of results with other Trusts.

The management of anaphylaxis varies widely. One Trust does not even allow the administration of intramuscular adrenaline whereas two permit chlorpheniramine and seven hydrocortisone. At the time of the study, chlorpheniramine was not endorsed by the JRCALC guidelines but has been in the current version. Although hydrocortisone and chlorpheniramine have a delayed onset of action, their administration is more effective given earlier in the disease, before rash formation, and four Trusts permit the administration of benzylpenicillin when there is no rash but the history is suggestive of meningitis. Presumably this is by a locally arranged patient group directive, a legal arrangement permitting non-doctors to prescribe in certain circumstances. This attitude of widening the paramedics scope to improve patient care and to expand practice has to be encouraged, although there are concerns over the diagnostic abilities of paramedics and thus inappropriate administration of benzylpenicillin with potential serious adverse reaction. We would advise Trusts to support their paramedics with additional, specific training when establishing such patient group directives. Audit of this practice is essential along with dissemination of results with other Trusts.

The management of common medical and traumatic emergencies is not universal and we recommend that Trusts streamline protocols and base them upon the JRCALC guidelines. Such cases include fluid replacement in trauma and burns and the management of asthma, anaphylaxis, and suspected meningitis. We also recommend wider use of the LMA and capnography.

Paramedics are under increasing pressure to perform a wider spectrum of skills and further existing standards of care. In this environment skill decay is a real problem, especially with infrequently performed but potentially life saving procedures. Paramedics must be fully supported to avoid this problem. Methods include Trusts developing regular in-house training sessions and the establishment of external training and review.

CONCLUSION

The trend of expanding and standardising practice among adult patients has largely not extended to paediatric practice, despite national guidelines being in place for over 18 months. Basic standards of care are widely achieved. Such practice includes the use of high flow oxygen combined with suitable oxygen masks, simple airway adjuncts including the ability to modify endotracheal tubes for the use as NPAs, the ability to gain IV access and give fluid, spinal immobilisation, and fracture management. However it is not adequate that such basic care is widely practiced—universal practice must be achieved. Furthermore age discrimination is not acceptable. Ambulance Trusts not meeting standards set out in the JRCALC guidelines must address their areas of deficiency. Failure to do so endangers children’s lives and leaves Trusts open to criticism. We recommend universal ability to provide or perform:

- high flow oxygen
- NPAs for any age of patient
- intubation equipment (including straight blades) for all ages
- cricothyroidotomy
- chest decompression
- pulse oximetry
- intrasosseous access
- low limb traction splints
- morphine administration.

The management of common medical and traumatic emergencies is not universal and we recommend that Trusts streamline protocols and base them upon the JRCALC guidelines. Such cases include fluid replacement in trauma and burns and the management of asthma, anaphylaxis, and suspected meningitis. We also recommend wider use of the LMA and capnography.

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