

PRE-HOSPITAL PAEDIATRIC LIFE SUPPORT

A Practical Approach to the
Out-of-Hospital Emergency
Care of Children

Second Edition

Advanced Life Support Group

BMJ
Books



**Blackwell
Publishing**

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|| Preface to the second edition ||

The first edition of PHPLS was written in response to the many in pre-hospital care who realised that children could be saved and morbidity prevented by early, appropriate intervention. Most of those were from the UK Ambulance Service and also General Practice and we are indebted to all those ambassadors for children who helped us put it together and teach it.

They, and others, have now “run with the ball” and the basic principles of the emergency care of children are now being taught (and indeed are mandatory teaching) in ambulance training departments up and down the country. Many of the initial principles that were taught on the first edition course are now second nature in the ambulance service and there is no need for duplication.

Times have moved on as well and the shape of emergency care has changed dramatically since we started writing PHPLS in 1995. Reforming Emergency Care and GPs opting out of “out of hours” have put new pressures on the pre-hospital care of children. We have borne in mind that with the changes to the structure of emergency care we have a new audience and we hope it will be useful to the many triage nurses, emergency care practitioners and others who are currently developing new roles.

The second edition tries to address the new issues as well as reinforcing the old. Whilst still concentrating on the ever requested theme of “how to recognise a seriously ill child” and assess the most appropriate level of transportation, it starts to take emergency paediatric care up a level from the basic to high tech kids, tracheostomies and legal issues to highlight some.

It is also presented in a smaller, we hope, more user friendly format to allow those “at the coal face” to use the text as an aide memoire when it is needed, rather than just as a straight reference text, although we hope you will enjoy reading it as well. There are many algorithms, lists and bullet points and we have tried to cross reference the text widely. There are also spaces for personalising equipment, phone numbers and other things.

We hope you will find it useful. As always, many, many thanks to all those who have helped in the preparation and given us ideas and feedback and thanks in advance to those of you who are still to do so.

Fiona Jewkes, Susan Wieteska (Editorial Board), 2005

▮ Preface to the first edition ▮

Pre-hospital Paediatric Life Support: The Practical Approach was written as a sister publication to *Advanced Paediatric Life Support: The Practical Approach*. It has the same objective of improving the emergency care of children, but concentrates on the first critical minutes prior to arriving at hospital.

It has been developed to fill a void in the training of personnel who have sometimes had to deal with these children with little knowledge or experience of paediatrics. Members of the pre-hospital life support working group, all of whom have extensive experience of working with children in both the pre-hospital and the hospital environments, have developed the manual in conjunction with the Joint Colleges and Ambulance Liaison Committee (JCALC) working party on paediatrics.

This manual also forms the core text of the PHPLS course, which is designed to give both medical and paramedical staff the skills and knowledge to deal with paediatric trauma and medical emergencies. The editors feel that by training together these multidisciplinary groups will both complement each other and reduce potential barriers, thus developing a seamless care approach to these events.

The course is designed to dovetail with the therapies presented in APLS, building upon established and tested interventions that we hope will ultimately provide an improvement in patient outcomes.

The layout of this book begins with background information on the aetiology of illness and disease in children, followed by the assessment and basic life support of children. Specific pre-hospital considerations are then covered followed by practical skills to apply your new-found knowledge.

Emergencies in children can generate a great deal of anxiety in the children, parents and medical personnel who have to deal with them. We hope that this book will enlighten the reader on the subject of pre-hospital paediatric emergency care and provide some support to help all involved. Read it as part of the PHPLS course or as a stand-alone publication, refer to it frequently, and hopefully it will help to achieve its aim of improving the standards of paediatric life support within the pre-hospital setting.

Fiona Jewkes, Paul Lubas, Kevin McCusker (*Editorial Board*),
December 1998

|| Acknowledgements ||

A great many people have put a lot of hard work into the production of this book, and the accompanying pre-hospital paediatric life support course. The editors would like to thank all the contributors for their efforts together with the contributors to the *Advanced Paediatric Life Support: The Practical Approach* text and course to which the pre-hospital text and course is closely aligned. We would also like to thank all the PHPLS instructors and candidates who took the time to send their comments to us.

We are greatly indebted to Helen Carruthers and Mary Harrison MMAA for producing the excellent line drawings that illustrate the text.

Finally, we would like to thank, in advance, those of you who will attend the Prehospital Paediatric Life Support course in the future; no doubt, you will have much constructive criticism to offer.

CONTACT DETAILS AND FURTHER INFORMATION

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UPDATES

The material contained within this book is updated on a 4 yearly cycle. However, practice may change in the interim period. For example, it is anticipated that there will be minor changes made following the publication of the updated ILCOR guidelines at the end of 2005.

We will post any changes on the ALSG Web site, so we advise that you visit the Web site regularly to check for updates ([url: www.alsg.org/updates](http://www.alsg.org/updates)). The Web site will provide you with a new page to download and replace the existing page in your book.

REFERENCES

Throughout the text, you will see one of two logos indicating that evidence/references are available via the Web:



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ON-LINE FEEDBACK

It is important to ALSG that the contact with our providers continues after a course is completed. We now contact everyone six months after their course has taken place asking for on-line feedback on the course. This information is then used whenever the course is updated to ensure that the course provides optimum training to its participants.

PART
I

INTRODUCTION
AND PREPARATION

Introduction

CAUSES OF DEATH IN CHILDHOOD

As can be seen from Table 1.1, the greatest mortality during childhood occurs in the first year of life, with the highest death rate of all happening in the first month.

Table 1.1. Number of deaths by age group

Age group	England and Wales 2001		Australia 2000		Holland 2001	
	Number	Rate per 1000	Number	Rate per 1000	Number	Rate per 1000
0–28 days	2137	3.6	858	3.4		3.9
4–52 weeks	1103	1.9	406	1.6		1.5
1–4 years	588	0.24	260	0.2	210	0.4
5–14 years	832	0.12	432	0.1	280	0.1
1–14 years	1420	0.15	692	0.1	490	

Source: England and Wales, 2003: Office for National Statistics
 Australia, 2003: Australian Bureau of Statistics
 Holland: Centraal Bureau voor de Statistiek

The causes of death vary with age, as shown in Table 1.2. In the newborn period the commonest causes are congenital abnormalities and factors associated with prematurity such as respiratory immaturity, cerebral haemorrhage and infection due to immaturity of the immune response.

From 1 month to 1 year of age, the condition called “cot death” is no longer the most common cause of death. Some victims of this condition have previously unrecognised respiratory or metabolic disease, but some have no specific cause of death found at detailed post-mortem examination. This latter group is described as suffering from the sudden infant death syndrome. There has been a striking reduction in the incidence of cot death over the past few years in the UK, Holland, Australia and New Zealand.

INTRODUCTION

Table 1.2. Common causes of death by age group

Cause	Number (%) of deaths at		
	4–52 weeks	1–4 years	5–14 years
Cot death	164 (13)	0 (0)	0 (0)
Congenital abnormality	205 (20)	97 (18)	64 (8)
Infection	65 (6)	52 (10)	27 (3)
Trauma	53 (5)	90 (16)	197 (24)
Neoplasms	15 (1)	89 (16)	218 (26)

Source: England and Wales, 2003: Office for National Statistics

In England and Wales the decrease has been from 1597 in 1988, 454 in 1994, 328 in 1997 to 164 in 2003. The reduction has followed national campaigns to inform parents of known risk factors such as the prone sleeping position in the infant and parental smoking. The next most common causes of death in this age group are congenital abnormalities and infections.

Between the ages of 1 and 4 years, congenital abnormality and trauma are about equally split and after 4 years of age trauma and neoplasms are the most frequent cause of death, and remain so until well into adult life. Deaths from trauma have been described as falling into three groups. The first group suffers overwhelming damage at the time of the trauma and the injury caused is incompatible with life; children with these massive injuries will die within minutes, whatever is done. The second group dies because of progressive respiratory failure, circulatory insufficiency or raised intracranial pressure secondary to the effects of injury; death occurs within a few hours if no treatment is administered, but can be avoided in some cases if treatment is prompt and effective. The final group consists of late deaths due to raised intracranial pressure, infection or multiple-organ failure. Appropriate management in the first few hours will decrease mortality in this group also.

In developing countries infectious diseases are still major causes of death. Seven out of ten childhood deaths can be attributed to just five main causes: pneumonia, diarrhoea, measles, malaria and malnutrition. Three out of every four children seen by health services are suffering from at least one of these conditions. HIV/AIDS has contributed to this and also been associated with increasing deaths from tuberculosis in countries affected. As these societies become more urbanised the mortality from trauma especially from motor vehicle accidents increases. In South Africa, a country which, although developing rapidly, has large areas of severe poverty, the under 5's mortality rate has recently been shown to include 40% (42 749) deaths from HIV/AIDS, 11% (11 876) from low birth weight, 21% (22 680) from infections and 3% (3506) from trauma. In older South African children trauma, especially road traffic

accidents, homicide and suicide are leading causes of death. In Trinidad children under 1 year accounted for 4% of deaths in 1997 with infant mortality at 17 per 1000 live births. In Trinidadian school children the foremost cause of death was injury, with infections causing one-fifth of deaths.

Only a minority of deaths in childhood, such as those due to unresponsive end stage neoplastic disease, are expected and "managed". Most children with potentially fatal diseases such as complex congenital heart disease, in-born errors of metabolism or cystic fibrosis are treated or "cured" by operation, diet, transplant or, soon, even gene therapy. The approach to these children is to treat vigorously incidental illnesses (such as respiratory infections) to which many are especially prone. Therefore, some children who present to hospital with serious life threatening acute illness also have an underlying chronic disease.

PATHWAYS LEADING TO CARDIORESPIRATORY ARREST

Cardiac arrest in infancy and childhood is rarely due to primary cardiac disease. This is different from the situation in adults where the primary arrest is often cardiac, and cardiorespiratory function may remain near normal until the moment that the arrest occurs. In childhood most cardiac arrests are secondary to hypoxia. Underlying causes include birth asphyxia, epiglottitis, inhalation of foreign body, bronchiolitis, asthma and pneumothorax. Respiratory arrest also occurs secondarily to neurological dysfunction such as that caused by some poisons or during convulsions. Raised intracranial pressure due to head injury or acute encephalopathy eventually leads to respiratory arrest, but severe neuronal damage has already been sustained before the arrest occurs.

Whatever the cause, by the time cardiac arrest occurs the child has had a period of respiratory insufficiency which will have caused hypoxia and respiratory and metabolic acidosis. The combination of hypoxia and acidosis causes cell damage and death (particularly in more sensitive organs such as the brain, liver, and kidney) before myocardial damage is severe enough to cause cardiac arrest.

Most other cardiac arrests are secondary to circulatory failure (shock). This will have resulted either from fluid or blood loss or from fluid maldistribution within the circulatory system. The former may be due to gastroenteritis, burns or trauma while the latter is often caused by sepsis, heart failure or anaphylaxis. As all organs are deprived of essential nutrients and oxygen as shock progresses to cardiac arrest, circulatory failure, like respiratory failure, causes tissue hypoxia and acidosis. In fact, both pathways may occur in the same condition. The pathways leading to cardiac arrest in children are summarised in Figure 1.1.

INTRODUCTION

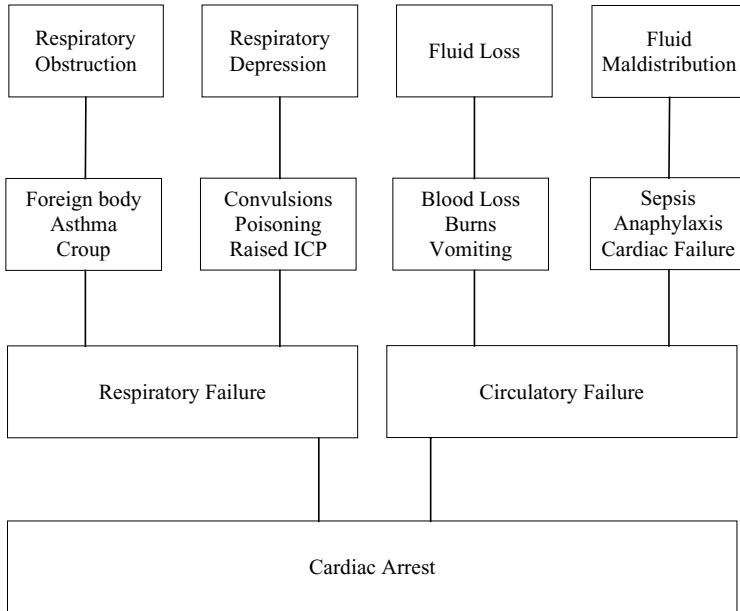


Figure 1.1. Pathways to cardiac arrest in childhood (with examples of underlying causes)

The worst outcome is in children who have had an out-of-hospital arrest and who arrive in hospital apnoeic and pulseless. These children have a poor chance of intact neurological survival. There has often been a prolonged period of hypoxia and ischaemia before the start of adequate cardiopulmonary resuscitation. Earlier recognition of seriously ill children and paediatric cardiopulmonary resuscitation training for the public could improve the outcome for these children.

Why treat children differently?

INTRODUCTION

Children are not little adults. Their anatomy, physiology and psychology change with age. The spectrum of diseases that they suffer from is different from that of adults, and their responses to disease and injury may differ both physically and psychologically. This chapter deals with some specific points of difference that have relevance to their emergency care.

SIZE

The most obvious reason for treating children differently is their size, and its variation with age. The most rapid changes in size occur in the first year of life.

WEIGHT

An average birth weight of 3.5 kg has increased to 10.3 kg by the age of 1 year. From that time weight increases more slowly until the pubertal growth spurt. This is illustrated in the weight chart for boys shown in Figure 1.2.

As most therapies are given as a dose per kilogram, it is important to estimate the weight of a child as soon as possible. In the emergency situation this is especially difficult because it is often impracticable to weigh the child. To overcome this problem a number of methods can be used to derive a weight estimate.

If the age is known the formula:

$$\text{Weight (kg)} = 2 \times (\text{age in years} + 4)$$

can be used if the child is aged between 1 and 10 years. If the child is less than 1 year old, he or she will have doubled the



WHY TREAT CHILDREN DIFFERENTLY?

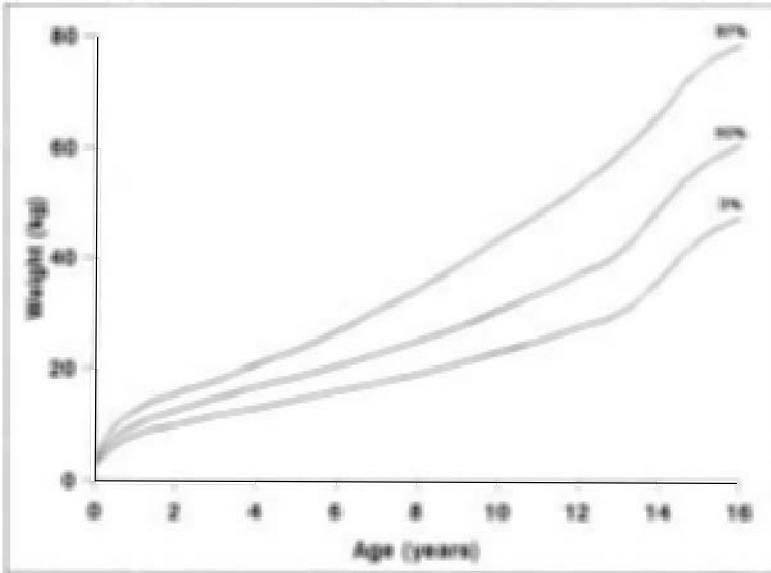


Figure 1.2. Weight chart for boys

birth weight by 6 months and trebled it by 1 year. In addition, various charts (such as the Oakley chart) (Figure 1.3) are available which allow an approximation of weight derived from the age. As an alternative there are various pre-hospital tapes now available (which relate weight to height). Whatever the method, it is essential that the carer is sufficiently familiar with it to be able to use it quickly and accurately.

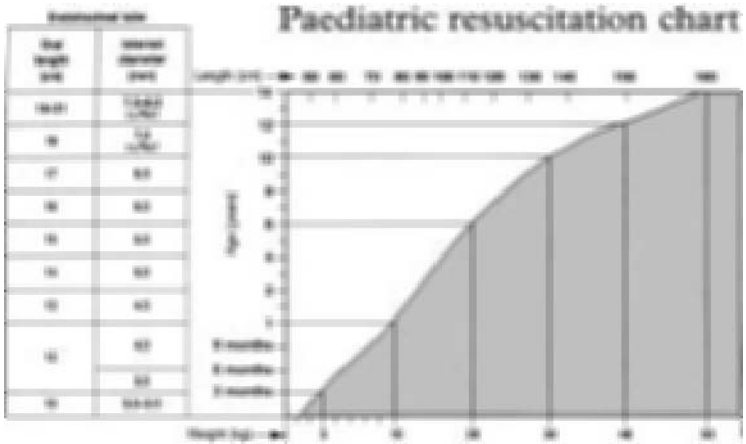
Body proportions

The body proportions change with age. This is most graphically illustrated by considering the body surface area (BSA). At birth the head accounts for 19% of BSA; this falls to 9% by the age of 15 years. Figure 1.4 shows these changes.

The BSA to weight ratio decreases with age. Small children, with a high ratio, lose heat more rapidly and consequently are relatively more prone to hypothermia.

Certain specific changes in body proportions also have a bearing on emergency care. For example, the relatively large head and short neck of the infant tend to cause neck flexion. These proportions and the relatively large tongue make airway care difficult. Specific problems such as this are highlighted in the relevant chapters.

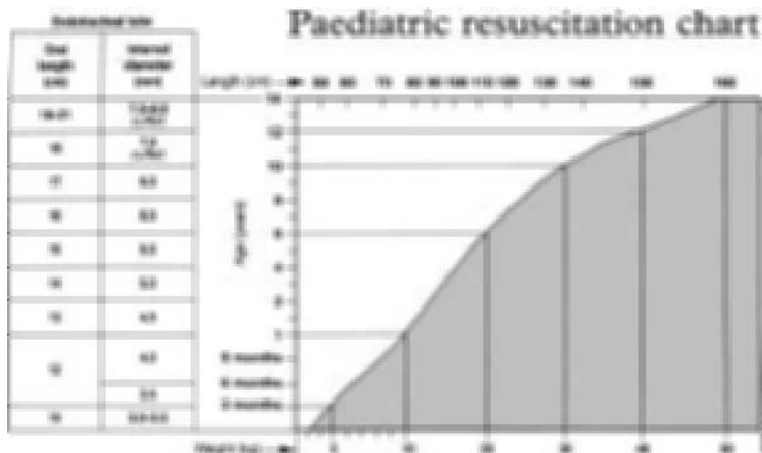
WHY TREAT CHILDREN DIFFERENTLY?



Adrenaline/Epinephrine (ml of 1 in 10 000) intravenous or intraosseous	0.5	1	2	3	4	5
Adrenaline/Epinephrine (ml of 1 in 1000) endotracheal	0.5	1	2	3	4	5
* Atropine (ml of 100 µg/ml) intravenous or intraosseous	1	2	4	6	8	10
Atropine (ml of 600 µg/ml)	-	0.3	0.7	1	1.3	1.7
* Amiodarone (ml of 30 µg/ml pre-filled) (bolus in cardiac arrest, slowly over 3 minutes if not) intravenous or intraosseous	0.8	1.5	3.5	5	6.5	8.5 ml
				<i>dilute appropriately in 5% glucose</i>		
* Amiodarone (ml of 50 µg/ml concentrated solution)	0.5	1	2	3	4	5 ml
				<i>dilute appropriately in 5% glucose</i>		
* Bicarbonate (mmol) intravenous or intraosseous	5	10	20	30	40	50 mmol
* Calcium chloride (ml of 10%) intravenous or intraosseous	0.5	1	2	3	4	5
* Lidocaine/Lignocaine (ml of 1%) intravenous or intraosseous	0.5	1	2	3	4	5
<hr/>						
<i>Initial DC defibrillation (J) for ventricular fibrillation or pulseless ventricular tachycardia</i>	10	20	40	60	80	100 J
<i>Initial DC cardioversion (J) for supraventricular tachycardia with shock (synchronous) or ventricular tachycardia with shock (non-synchronous)</i>	5	5	10	15	20	25 J
<i>Initial fluid bolus in shock (ml) intravenous or intraosseous (crystalloid or colloid)</i>	100	200	400	600	800	1000

Figure 1.3. Oakley chart

WHY TREAT CHILDREN DIFFERENTLY?



Glucose (ml of 10%) intravenous or intraosseous	25	50	100	150	200	250
Lorazepam (ml of 5 mg <i>diluted</i> to 5 ml in 0.9% saline) intravenous or intraosseous	0.5	1	2	3	4	5
Lorazepam (ml of 5 mg/ml <i>neat</i>)	-	-	0.4	0.6	0.8	1
Diazepam (mg rectal tube solution) (if lorazepam or intravenous access not available) rectal	2.5	5	10	10	10	10 mg
Naloxone neonatal (ml of 20 µg/ml) intravenous or intraosseous	2.5	5	-	-	-	-
Naloxone adult (ml of 400 µg/ml)	-	0.25	0.5	0.75	1	1.25
*Salbutamol (mg nebuliser solution) by nebuliser (dilute to 2.5-5 ml in physiological saline)	-	2.5	5	5	5	5 mg

* Caution! Non-standard drug concentrations may be available:

Use **atropine** 100 µg/ml or prepare by diluting 1mg to 10 ml or 600 µg to 6 ml in 0.9% saline

Bicarbonate is available in various concentrations (8.4% has 1 mmol/ml; 4.2% has 0.5 mmol/ml; 1.26% has 0.15 mmol/ml). In infants, avoid 8.4% or dilute to at least 4.2%.

Note that 1 ml of **calcium chloride** 10% is equivalent to 3 ml of **calcium gluconate** 10%

Use **lidocaine/lignocaine** (*without* adrenaline/epinephrine) 1% or give half the volume of 2% (or dilute appropriately)

In the initial nebulised dose of **Salbutamol**, ipratropium may be added to the nebuliser in doses of 250 µg for a 10 kg child and 500 µg for an older child. Salbutamol may also be given by slow intravenous injection (5 µg/kg), but beware of the different concentrations available (eg 50 and 500 µg/ml)

Figure 1.3. (Continued)

WHY TREAT CHILDREN DIFFERENTLY?

ANATOMY AND PHYSIOLOGY

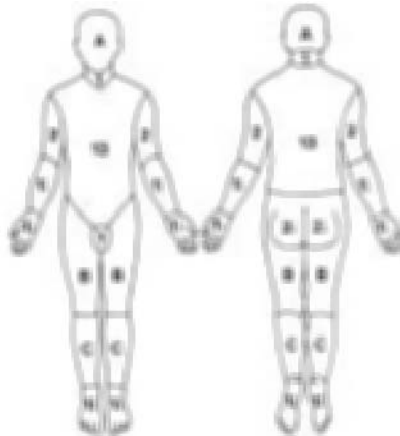
Particular anatomical and physiological features, and the ways they change with age, can have a bearing on emergency care. Although there are changes in all systems, the most important are those that occur in the respiratory and cardiovascular systems affecting the management of airway, breathing and circulation.

Anatomy

Airway

Anatomical features outside the airway have some relevance to its care.

- The head is large and the neck short, tending to cause neck flexion.
- The face and mandible are small and teeth or orthodontic appliances may be loose.
- The relatively large tongue not only tends to obstruct the airway in an unconscious child, but may also impede the view at laryngoscopy.
- The floor of the mouth is easily compressible, requiring care in the positioning of fingers when holding the jaw for airway positioning.



Area indicated	Surface area of				
	0	1 year	2 years	10 years	15 years
A	8.5	8.5	8.5	8.5	8.5
B	2.75	3.25	4.0	4.5	4.5
C	2.5	2.5	2.75	3.0	3.25

Figure 1.4. Body surface area (%). (Reproduced courtesy of Smith & Nephew Pharmaceutical Ltd)