PAEDIATRIC TRAUMA: PRIMARY SURVEY AND RESUSCITATION—II

A R Lloyd-Thomas

Circulation and control of bleeding

Normal values for paediatric vital signs in patients who are not crying

Age	Heart rate (beats/min)	Blood pressure (systolic) (mm Hg)	Respiratory rate (breaths/min)	Blood volume (ml/kg)
<1 year	120-140	70-90	30-40	90
2-5 years	100-120	80-90	20-30	80
5-12 years	80-100	90-110	15-20	80

Advanced trauma life support classification of shock in children

	Class I <15%	Class II 20-25%	Class III 30-35%	Class IV 40%
Cardiovascular system (heart rate in beats/min)	Heart rate ↑ 10-20% Blood pressure normal	Tachycardia (>150) Systolic blood pressure ↓ Pulse pressure ↓	Tachycardia (>150) Systolic blood pressure ↓ ↓ Pulse pressure ↓ ↓	Tachycardia/bradycardia Severe hypotension Peripheral pulses absent
Respiratory rate (breaths/min)	Normal	Tachypnoea (35-40)	Tachypnoea	Respiratory rate falls
Skin	Normal	Cool, peripheries cyanotic	Cold, clammy, cyanotic	Pale, cold
Central nervous system	Normal	Irritable, confused, aggressive	Lethargic	Comatose
Capillary refill time	Normal	Prolonged	Very prolonged	

As in any victim of trauma major external haemorrhage must be controlled by direct pressure. The pulse rate and blood pressure are then recorded, the capillary refill time estimated, and the peripheral skin temperature and colour noted. Normal values for vital signs vary with age.

A child's normal systolic blood pressure may be estimated by using the formula: blood pressure = 80 mm Hg + (2 × age). The increased physiological reserve of the child's circulation compared with that of adults means that vital signs may be only slightly abnormal despite considerable blood loss. Therefore the early diagnosis of impending shock in children is based on the appearance of the skin, the temperature of the extremities, the capillary refill time, and altered sensorium. The degree of shock, and hence blood loss, can be estimated from the classification of shock. Fluid resuscitation should not be withheld until vital signs are abnormal.

Appropriate vessels for intravenous cannulation.

Circulatory access

Venous access in hypovolaemic children with collapsed veins is difficult, especially in those less than 6 years old. Percutaneous cannulation of peripheral veins with an appropriately sized cannula should be attempted. In patients with appreciable abdominal injuries a vein draining to the superior vena cava should be chosen. If after two attempts access is not established the femoral or external jugular vein should be cannulated.

If all attempts at percutaneous cannulation fail a cut down should be undertaken in the median cephalic vein in the elbow or the long saphenous vein in the ankle.

In the interim intraosseous infusion is a useful method of emergency resuscitation in children. Crystalloids, colloids, and drugs can be given by this route, and the circulation time is usually less than 30 seconds. Cellulitis or osteomyelitis are potential complications.

The sites for intraosseous infusion are:

- (1) The anterior tibial plateau 3 cm below the tibial tuberosity.
- (2) The inferior one third of femur 3 cm above the external condyle.

Enter perpendicular to the bone (using a 16 G or 18 G needle). Marrow aspiration indicates correct positioning.

Cannulation of the right internal jugular vein.

Transfix the vessel.

Withdraw the needle then the cannula until blood flows freely.

Advance the cannula into the vessel.

Technique for transfixion and cannulation of a peripheral artery.

Having established venous access take blood samples for determination of group and cross matching, full blood count, and urea and electrolyte concentrations.

Central venous cannulation in children is hazardous, especially if the patient is hypovolaemic, and should *never* be attempted by inexperienced doctors.

As in adults, a central venous pressure line is primarily for monitoring and not for giving fluids. Time must not be wasted inserting a central venous pressure line at the expense of other measures of basic life support during the initial resuscitation. Hypovolaemic children respond well to volume loading, allowing an adequate central venous pressure to be inferred from improvements in vital signs and skin perfusion.

When blood loss is massive (30-40%), however, intravascular volume must be measured with a central venous pressure line.

The series of four pictures shows the procedure for cannulation of the right internal jugular vein. Tilt the patient's head downwards; extend the neck with a sandbag under the shoulder (there must be no suspicion of cervical spin injury); turn the head to the left and identify the triangle formed by the clavicle (the base) and the two heads of sternocleidomastoid muscle (top left). With a strict aseptic technique pierce the skin at the apex of the triangle, aiming for the right nipple (top right). The internal jugular vein is very superficial and should be entered within 1-2 cm of the skin. Having punctured the vein, move the needle to a more horizontal position, then advance the cannula over the needle into the superior vena cava (bottom left). Withdraw the needle and ensure that blood can be aspirated freely (bottom right), then connect to a monitoring set.

Seriously injured patients should also have their intra-arterial pressure monitored. A transfixion technique is easiest in infants, and this should initially be attempted in the peripheral arteries.

Fluid administration

Initial resuscitation should be with colloid (Haemaccel, Gelofusine, hetastarch, or 4-5% albumin (human plasma protein fraction). All fluids must be warmed to body temperature. An initial dose of 20 ml/kg should be given as a bolus, after which the response should be assessed and the decision tree followed. Patients with class III or IV shock require blood. If necessary blood that is not cross matched can be used; there is, however, usually time to get an immediate typed crossmatch that will eliminate serious reactions due to ABO incompatibility.

Whole blood, especially fresh whole blood, is rarely available. Red blood cells with a packed cell volume of 65-75% are often supplied. Administration of blood with a high packed cell volume is difficult through the small (22 G or 24 G) cannulas used in infants. Reconstitution of packed cells to a normal packed cell volume with human plasma protein fraction or fresh frozen plasma overcomes this problem.

Paediatric Glasgow coma score

Eye opening	4	>1 year Spontaneously	<1 year Spontaneously
	3	To verbal command	To shout
	2	To pain	To pain
	1	No response	No response
Best motor response	5	Obeys commands	
	4	Localises pain	Localises pain
	3	Flexion to pain	Flexion to pain
	2	Extension to pain	Extension to pain
Best verbal response	1	No response	No response
	5	>5 years Oriented and converses	2-5 years Appropriate words and phrases
	4	Disoriented and converses	Inappropriate words
	3	Inappropriate words	Cries
	2	Incomprehen- sible sounds	Grunting
	1	No response	No response
		Normal aggregate score:	
		<6 months	12
		6-12 months	12
		1-2 years	13
		2-5 years	14
		>5 years	14

The line drawings depicting the venous system of an infant and transfixion and cannulation of a peripheral artery were prepared by the department of education and medical illustration services, St Bartholomew's Hospital, London.

Dysfunction

If the patient is old enough and well enough to cooperate the brain and spinal cord can be assessed rapidly by standard techniques. In young patients observation of motor function and ability to speak must suffice. An initial Glasgow coma scale score should be established.

Exposure

Removal of clothing is essential to allow adequate physical examination and facilitate practical procedures. Children, especially infants, however, lose heat rapidly as a result of their high ratio of surface area to weight, thin skin, and lack of subcutaneous tissue. Considerable heat loss may have occurred at the site of injury and during transportation. Monitoring temperature is a vital component of initial assessment. A fall in body temperature causes a rise in oxygen consumption as endogenous processes begin to increase heat production, peripheral vasoconstriction, and consequent lactic acidemia. The ambient temperature of the resuscitation room should be raised and overhead heaters and warming blankets used. Plastic sheets can be used to cover exposed body parts.

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MEDICINE AND THE MEDIA

BMA Complete Family Health Encyclopaedia

Self sufficiency

I can remember that as a child we had at home a tome on the shelves called something like "the family health encyclopaedia." It was fairly hefty and dated from before the war. It was laid out alphabetically on a problem and symptom basis and was a ready source of information on what to do in particular medical eventualities. I imagine that before 1948 it must have been an invaluable source of advice to lower middle class and working class families without ready access to a medical practitioner, and my memory of it was that it had been produced in conjunction with one of the large daily newspapers—thereby bringing it within reach of those who might not normally buy books.

All of which brings me to the book in question. The *BMA Complete Family Health Encyclopaedia* (published by Dorling

Kindersley, price £25.00) is beautifully produced, very long (almost 1200 pages), and rather intimidating. I found the initial section on how to use the encyclopaedia fussy and off putting, and I rapidly began to wonder who the potential audience was. I was told it was for a lay audience and had therefore assumed that plain English, simplicity, and accessibility would be the main emphasis. What I found was a mixture. Some of the general sections on lifestyle, personal behaviour, prevention, and diagnosis were straightforward, clearly written, and understandable. The difficulties really began with the A to Z section on symptoms and health. Are Joe or Jane Public really going to look up achalasia, dacryocystitis, or Esmarch's bandage out of the blue? Or are they more likely to look up something for which there is a common English expression and then perhaps find some medical terms demystified? I don't know, but I am uneasy; I think that most people would be looking for Valium rather than diazepam, but maybe generic prescribing will change that.

This encyclopaedia has clearly been a formidable undertaking, and as a doctor I

find it beautiful and comprehensive. I just don't know who is going to use it. I think that preclinical medical students and various paramedical students might find it valuable, and that it would be really useful for some self help groups that are already familiar with some of the jargon. Whether it will ever find a place on the living room shelves of millions of lower middle class and working class Britons I somehow doubt. Yet faced with the NHS after the white paper (back to the pre-1948 days), with more self sufficiency on the one hand and more aware and critical consumers on the other, ready access to this breadth of information is going to be essential.

Perhaps this volume was not intended to achieve this, though it could be the first step if it was made accessible through the pages of Ceefax, for example, and translated into a plain English index. I hope that I haven't done an injustice to all the work that has gone in to producing a fine product—my anxiety is about the market.—JOHN ASHTON, senior lecturer, Liverpool