INNOVATIONS

Paediatric triage tape

T J Hodgetts, J Hall, I Maconochie, C Smart

Abstract

Effective triage is essential in the presence of multiple casualties. The *triage sieve* is a simple, safe, rapid, and reproducible physiological system for triaging adults. There is no simple pre-hospital triage system that respects the different normal physiological values in children.

The *paediatric triage tape* relates the child's length to age related changes in normal physiological values. The information is presented on a waterproof tape and can be used in conjunction with any existing triage label system. The tape is divided into four compartments (50–80 cm, or 3–10 kg; 80–100 cm, or 11–18 kg; 100–140 cm, or 19–32 kg; and >140 cm, or >32 kg). Each compartment has a *triage sieve* algorithm corrected for age.

The *paediatric triage tape* will temper the subjective desire to treat all children as a high priority. Appropriate prioritisation will allow limited paediatric resources to be diverted to the genuinely needy children. Adults requiring immediate intervention will not be ignored at the expense of children who are less severely injured.

(*Pre-hospital Immediate Care* 1998;**2**:155–159)

Keywords: triage; children; tape; major incident; disaster

Consultant and Specialty Adviser, Accident and Emergency Medicine, Frimley Park Hospital, Portsmouth Road, Frimley, Camberley, Surrey GU16 5UJ
T J Hodgetts

General practitioner, Bromsgrove, Worcestershire
J Hall

Senior registrar, Department of Academic Paediatrics, Imperial College School of Medicine at St Mary's Hospital, London
I Maconochie

Adviser in Disaster Management, Leeds
C Smart

Correspondence to:
Major Hodgetts (e-mail: tim@blenheim.softnet.co.uk).

Accepted for publication
18 March 1998

Effective triage is essential in the presence of multiple casualties. Triage systems are classified as *physiological*, *anatomical*, or *mixed*. Physiological systems are simple, safe, rapid to perform, and reproducible between operators.[1] In contrast to anatomical systems they do not require extensive clinical experience to interpret the physical signs, nor do they require the patient to be widely exposed. The limitation of physiological systems are recognised when adult values are applied to children.[2]

Major incidents are perceived to be rare. An analysis of the incidence of major incidents in Great Britain from 1968 to 1996 has shown that they occur three to four times per year (range 0–11).[3] These incidents can be anticipated to involve a proportion of children (see table 1). Following a city centre terrorist bombing in Manchester in 1996, 31 (17.1%) of 181 casualties who received hospital treatment where an age was recorded were 16 years or younger.[4] Occasionally, incidents have involved predominantly children, including the landslide in Aberfan, Wales in October 1966 (147 dead), and the shooting of primary schoolchildren in Dunblane in March 1996 (17 dead and 12 injured). However, the perceived immunity of children from involvement in a major incident cannot excuse a lack of preparation.

The effective triage of children in a major incident has been criticised. In the aftermath of the Avianca plane crash in 1990, van Amerongen *et al* concluded that children had not been adequately triaged at the site. This was partly explained by the limited paediatric

Table 1 Major incidents known to have involved significant numbers of children

Major incident	*Year*	*Total No of casualties*	*No of paediatric casualties*
Martinez coach crash (USA)	1975	51	50
Mass lightning strike (USA)	1977	47	47
Bologna bombing (Italy)	1980	291	27
M5 coach crash (UK)	1983	31	27
Chemical gas leak, Arizona (USA)	1987	>67	67
Zeebrugge ferry disaster (Belgium)	1987	536	NA
Enniskillin bombing (UK)	1987	65	6
Hillsborough stadium crush (UK)	1989	260	NA
Three Rivers regatta accident (USA)	1990	24	16
Avianca plane disaster (USA)	1990	92	22
Newton train crash (UK)	1991	26	7
Dimmocks Cote train crash (UK)	1992	45	12
York coach crash (UK)	1994	41	40
West Street bus crash, Glasgow (UK)	1994	33	33
Abbeyhill junction train crash (UK)	1994	47	10
Tokyo sarin gas attack (Japan)	1995	640	NA
Oklahoma bombing (USA)	1995	759	61
Warrington coach crash (UK)	1996	51	50
Manchester bombing (UK)	1996	217*	31
Dunblane mass shooting (UK)	1996	30	28

* Age recorded at hospital in only 181. NA = information not available (adapted with permission from: Carley SD. The management of children in major incidents. Master of Philosophy thesis. Manchester University, Faculty of Medicine, 1997).

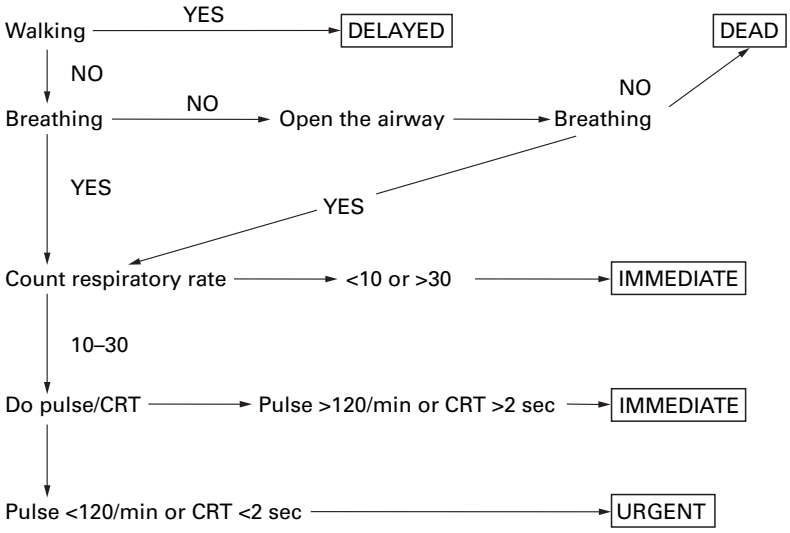

Figure 1 Triage sieve (CRT = capillary refill test).

training of pre-hospital personnel. The recommendation was made to improve emergency medical services' responsiveness to a paediatric major incident by assigning appropriate triage criteria to injured and ill children.[5]

A combination of anxiety, inexperience with sick and injured children, and ignorance of normal physiological values in the young may lead pre-hospital carers to over triage children. The result will be to divert the limited skilled paediatric medical resources from attending to those who are genuinely critical. This paper describes a system that will allow the rapid, objective, and reproducible triage of a number of injured or sick children.

The need

A fundamental principle of major incident medical management is to *"do the most for the most"*. This requires casualties to be sorted into priorities for treatment, so that those with the most immediate clinical need are treated first—a process known as triage. A widely accepted triage method is the *triage sieve*.[2 6–9]

The *triage sieve* starts with an assessment of the patient's mobility, and continues with an assessment of the airway, breathing, and circulation. As soon as a priority is assigned the patient is labelled. The Triage Officer then moves on to the next patient (fig 1). The *modified triage sieve* differs by assigning an "immediate" priority to a patient who starts to breathe when the airway is opened[1] (fig 2).

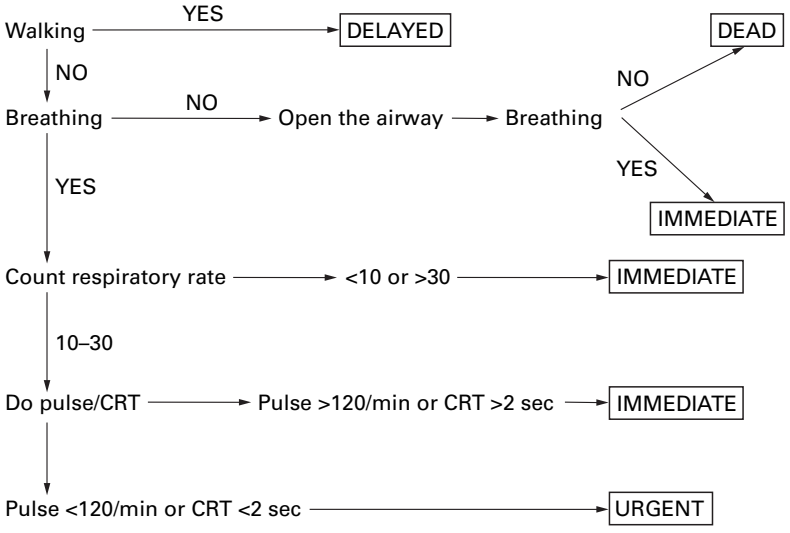

Figure 2 Modified triage sieve (CRT = capillary refill test).

Table 2 Range of respiratory rates in children[10] (breaths/min)

Age (years)	*Minimum*	*Median*	*Maximum*
2–6	14	20	26
7–11	15	18	25
12–16	15	18	22

Table 3 Range of respiratory rates in children[11] (breaths/min)

Age (years)	*Respiratory rate*
< 1	30–40
2–5	25–30
5–12	20–25
> 12	15–20

Table 4 Range of heart rates in children[10] (beats/min)

Age (years)	*Minimum*	*Median*	*Maximum*
2–6	69	86	118
7–11	59	75	93
12–16	58	68	85

Table 5 Range of heart rates in children[11] (beats/min)

Age (years)	*Respiratory rate*
< 1	110–160
2–5	95–140
5–12	80–120
> 12	60–100

Mobility is an unsuitable assessment tool for infants. Children triaged by respiratory rate or pulse rate will receive an inappropriately high priority when the system uses adult normal values. This "over triage" may potentially overwhelm limited paediatric resources, and distract the resources from those children in genuine need. It will also distract care from adults in favour of less needy children.

There is a need to develop a triage system that respects the range of normal values in children.

Paediatric normal physiological values

Values for the range of respiratory rates in children have been estimated on a cohort of 70 patients (table 2).[10] The "minimum" and "maximum" figures represent the 5th and 95th centiles either side of the median.

A similar range of respiratory rates, but with generally higher "minimum" values, is suggested by the *Advanced Paediatric Life Support* course manual (table 3).[11] Other reference ranges of respiratory rates are published, but relate to very small study groups (three to six patients)[12] or fail to identify the number studied.[13] There are data for normal heart rate ranges from the same sources (tables 4 and 5).

The capillary refill test has practical problems in the field. It is unreliable in the dark, which has been confirmed in a classroom model of 309 nurses, emergency medical technicians, and paramedics. Two thirds of this group were unable to assess the capillary refill

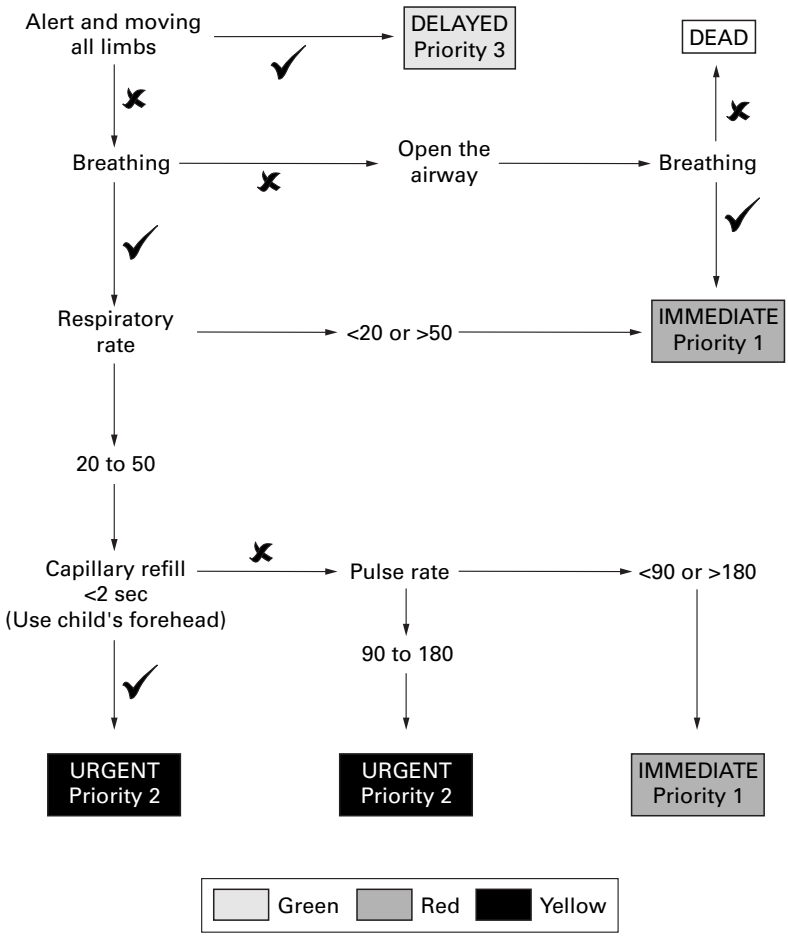

Figure 3A Paediatric triage tape: 50–80 cm (3–10 kg).

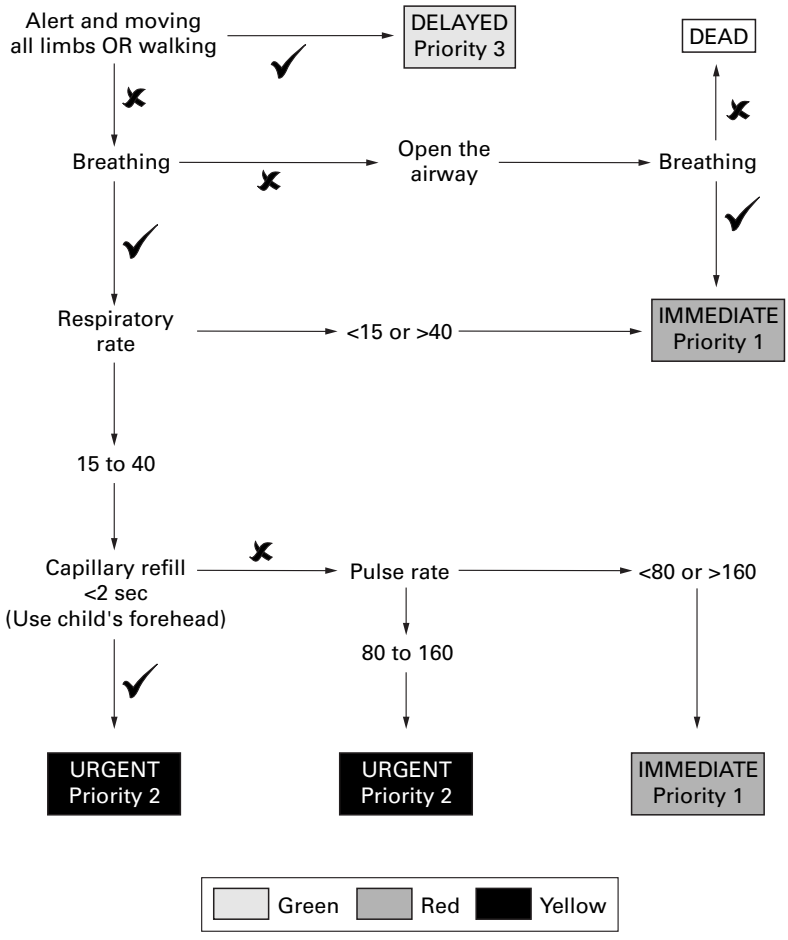

Figure 3B Paediatric triage tape: 80–100 cm (11–18 kg).

in "moonlight or street lamp" (lux metre reading of 4 to 6) conditions.[14] This test was removed from the Trauma Score (a field triage tool reliable for seriously injured patients over 12 years old[15]) by Champion *et al* in 1989,[16] and has been removed from Advanced Trauma Life Support teaching.[17]

Capillary refill also varies greatly with temperature.[18] This variation is age specific, and is significantly prolonged in the elderly. In an ambient temperature of 21 ± 1°C there is a false positive delayed capillary refill in 4% of 100 healthy child volunteers compared with 29% of 100 healthy elderly volunteers.[18] A small study has shown an important effect on capillary refill delay with a fall in ambient temperature in children (32 healthy children). It was noted that heel measurements were significantly longer than fingernail measurements.[19] In fact, the measurement of capillary refill demonstrates a normal distribution only when applied to the forehead or mid-sternum of children.[20] The fingernail and heel are therefore less reliable.

A child's length is proportional to his weight, which is proportional to his age.[11] This is somewhat of a simplification, as the relationship of the 50th centile figures for height and weight will produce a *sigmoidal* curve when plotted against age. However, it is a reliable approximation for children from 1 to 10 years, as a considerable portion of this sigmoid is linear.

The triage tape

The *paediatric triage tape* is a waterproof, non-tear tape that can be used with any existing triage label system (see figs 3A-C and 4). The system is an adaptation of the adult "triage sieve", utilising appropriate physiological variables for four length/weight ranges:

- 50–80 cm (3–10 kg)
- 80–100 cm (11–18 kg)
- 100–140 cm (19–32 kg)
- >140 cm (>32 kg)

The first assessment is of mobility. If the child is walking the tape does not need to be used. A child who is walking is prioritised "delayed" (GREEN). It is appreciated that children may be able to walk after significant injury—but as triage is a dynamic process (and in a major incident this triage process is intended only as a snapshot assessment, not as a predictor of the clinical course) the priority will be changed to reflect any deterioration when it occurs. In infants, mobility cannot be used as a reliable assessment. This system uses "alert and moving all limbs" to indicate an equivalent level of activity to walking, and a "delayed" (GREEN) priority.

If the child is not walking the tape is opened along the length of the child's body. Where the child's heel touches the tape will determine which of the three paediatric triage sieve algorithms is followed. If the heel falls on the boundary between two sections then the section for the *longer* child is used. A child who is trapped and to whom access is limited is assigned an "immediate" (RED) priority until

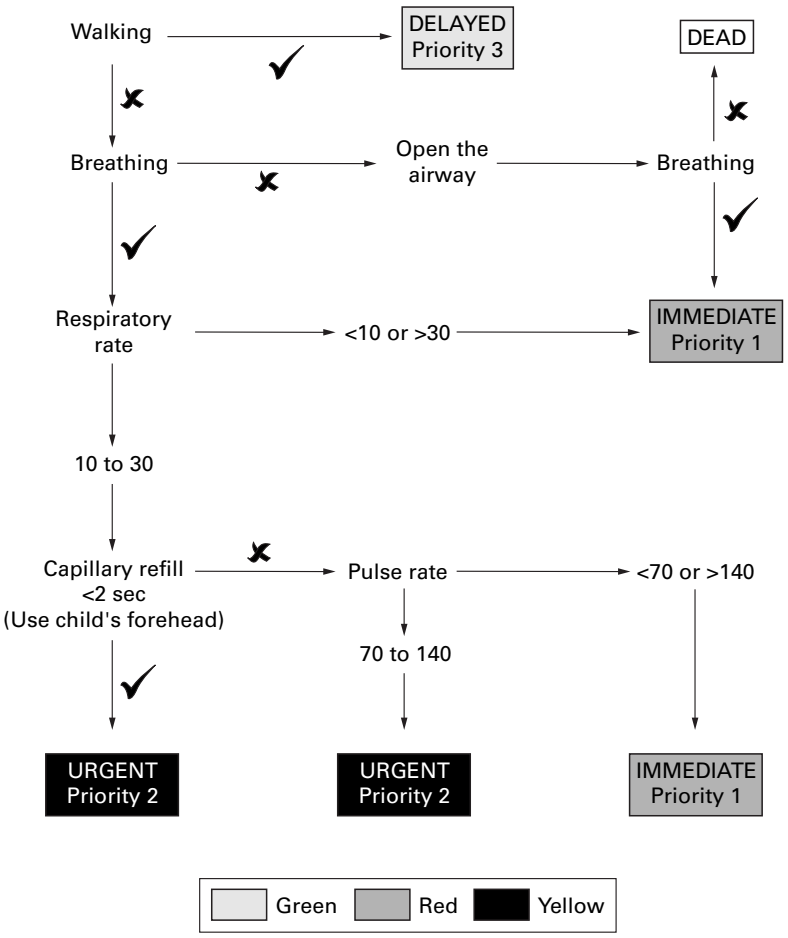

Figure 3C Paediatric triage tape: 100–140 cm (19–32 kg).

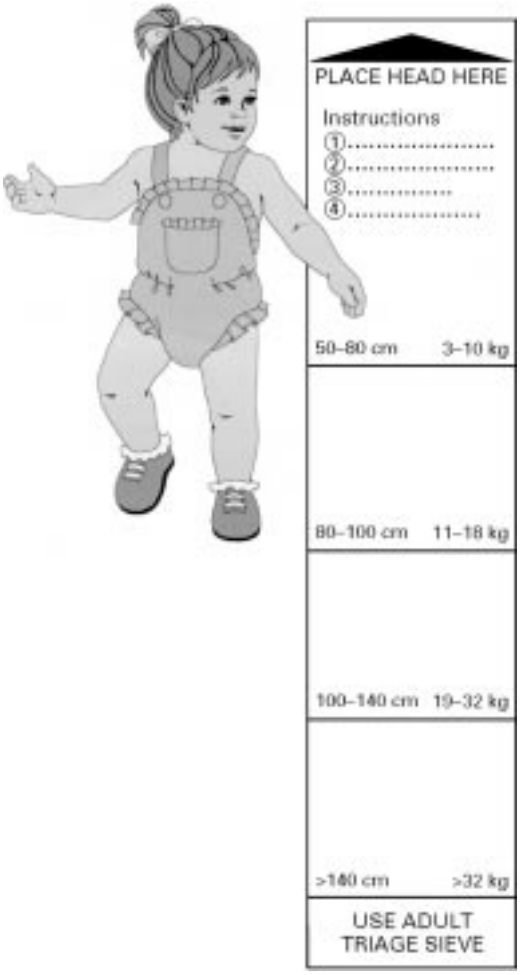

Figure 4 Using the paediatric triage tape.

the child is extricated. The tape is then used to reassess the priority.

If a child's age is known (in years) the correct algorithm can also be selected as follows:

(1) Calculate the weight of the child using the formula[8]:

(age in years + 4) × 2 = weight in kg

(2) Select the algorithm that relates to this weight

Children less than 1 year will fall into the 50–80 cm (3–10 kg) box. Children over 10 years should be triaged as adults.

A child who does not breathe when the airway is opened by jaw thrust is diagnosed dead. This is a reversal of normal priorities, as in isolation such patients would attract extensive resources in an attempt to resuscitate. In a major incident, this will divert resources from salvageable children and is not encouraged. If breathing starts when the airway is opened the child is an "immediate" (RED) priority.

Breathing is assessed by counting the respiratory rate. It is adequate to count this for 15 seconds. An abnormally slow or an abnormally fast rate is assigned an "immediate" (RED) priority. The normal values are dependent upon the child's length/weight/age. If the breathing rate is normal for that child, the circulation is assessed. A capillary refill test is done first. If this is less than two seconds then the peripheral circulation is adequate and the child is prioritised "urgent" (YELLOW). If the capillary refill is prolonged the pulse is taken. This is necessary to ensure that it is not a low ambient temperature that is falsely prolonging the refill. It is still worthwhile starting with the capillary refill as it takes less than half the time of a pulse check to perform, and thereby may reduce the time the Triage Officer spends with a patient. The forehead is the recommended site for the capillary refill test. The sternum would be an alternative, but would require exposure.

The ranges for respiratory and pulse rate have been derived from the best available limited evidence of normal paediatric physiological values, balanced with the combined clinical experience of the authors. Unlike the adult *triage sieve* a lower limit of normal for the pulse rate is also given, as a bradycardia following trauma in a child is a sign of critical blood loss. Serendipitously, the chosen range of values for pulse rate coincides with values that are 15% above and below the limits of the range in table 4, rounded to the nearest 10 beats per minute.

Conclusions

The *paediatric triage tape* relates the child's length to changes in normal physiological values. The information is presented on a waterproof non-tear tape and can be used in conjunction with any existing triage label system.

The *paediatric triage tape* will temper the subjective desire to treat all children as a high priority. Children will be given a triage priority appropriate to their injuries.

The physiological values on the tape have been derived from the best available evidence of observations in small numbers of predominantly healthy children. These have been refined from the combined clinical experience of the authors. An important step to further improve the accuracy of paediatric triage will be to validate the changes in physiology of injured children against a large and reliable database.

Conflict of interest: the paediatric triage tape is made by Smart Memos; one of the authors (CS) is a director of this company.

1 Hodgetts T. Triage. Pre-hospital Immediate Care 1997;1:110–11.
2 Advanced Life Support Group. *Major incident medical management and support: the practical approach*. London: BMJ Publishing Group, 1995.
3 Carley S, Mackway-Jones K, Donnan S. Major incidents in Britain over the past 28 years: the case for the centralised reporting of major incidents. J Epidemiol Community Health 1998;52 (in press).
4 Carley S, Mackway-Jones K. The casualty profile for the Manchester bombing 1996: a proposal for the construction and dissemination of casualty profiles for major incidents. J Accid Emerg Med 1997;14:76–80.
5 van Amerongen R, Fine J, Tunik M, *et al*. The Avianca plane crash: an emergency medical system's response to paediatric survivors of the disaster. Pediatrics 1993;92:105–10.
6 Hodgetts T, Miles S. Major incidents. In: Skinner D, Driscoll P, Earlam R, eds. *ABC of major trauma*. 2nd Ed. London: BMJ Publishing Group, 1996.
7 Hodgetts T, McNeil I, Cooke M. *The pre-hospital emergency management master*. London: BMJ Publishing Group, 1995.
8 Army Medical Directorate. *Battlefield advanced trauma life support*. London: HMSO, 1997 (Army Code No 63726).
9 Greaves I, Hodgetts T, Porter K, eds. *Emergency care: a textbook for paramedics*. London: WB Saunders, 1997.
10 Poets CF, Stebbens VA, Samuels MP, *et al*. Oxygen saturation and breathing patterns in children. Pediatrics 1993;92: 686–90.
11 Advanced Life Support Group. *Advanced paediatric life support: the practical approach*. 2nd Ed. London: BMJ Publishing Group, 1996.
12 Iliff A, Lee V. Pulse rate, respiratory rate and body temperature of children between two months and eighteen years of age. Child Dev 1952;23:237.
13 Nichols D, Yaster M, Lappe D, *et al*, eds. *John Hopkins golden hour: the handbook of advanced paediatric life support*. Mosby, 1991.
14 Brown L, Prasad N, Whitley T. Adverse lighting condition effects on the assessment of capillary refill. Am J Emerg Med 1994;12:46–7.
15 Boyd C, Tolson M, Copes W. Evaluating trauma care: the TRISS method. J Trauma 1987;27:370–8.
16 Champion HR, Sacco WJ, Carnazzo AJ, *et al*. Trauma score. Crit Care Med 1980;9:672–6.
17 American College of Surgeons. *Advanced trauma life support: provider manual*. Chicago: American College of Surgeons, 1993.
18 Schriger D, Baraff L. Defining normal capillary refill: variation with age, sex, and temperature. Ann Emerg Med 1988;17:932–5.
19 Gorelick M, Shaw K, Baker M. Effect of ambient temperature on capillary refill in healthy children. Pediatrics 1993; 92:699–702.
20 Strozik KS, Pieper CH, Roller J. Capillary refilling time in newborn babies: normal values. Arch Dis Child 1997;76: 193–6.