Update in Anaesthesia

Recognising the seriously ill child

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SUMMARY

Use the ABC approach to assess and treat the seriously ill child

Normal physiological values vary by age

If the physiological values are normal, this does not always mean the child is well

Children can compensate for serious illness effectively, which may mask how unwell they are

When treating an unwell child, it is important to reassess them after every intervention

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INTRODUCTION

Each year approximately 11 million children die before reaching the age of five, 99% from low- and middle-income countries (LMIC).[1-3] Three-quarters of deaths are from preventable or treatable causes such as pneumonia, diarrhoea, malaria, and measles. Children can become unwell very quickly, and the outcome from cardiac arrest in a child is poor, so early recognition and treatment of the seriously ill child is vital. In the developed world the recognition, assessment and management of the seriously ill child has improved following the introduction of courses such as Advanced Paediatric Life Support[4] (APLS) in the UK and Paediatric Advanced Life Support[5] (PALS) in the US, and these courses are now often mandatory for clinicians working with children.

Studies have shown that that many health workers in emergency facilities in resource-poor countries have no standardised assessment or treatment protocols for severely ill children, but that improved training, assessment and emergency care could improve outcomes.[6,7] In response, the WHO has developed the Emergency Triage Assessment and Treatment (ETAT) system to reduce childhood mortality, particularly within the first 24 hours of admission.[8] This course has been shown to significantly improve care for children presenting with common serious illnesses (e.g. dehydration, pneumonia and severe malnutrition).[9] Approximately 50% of children who die after admission to hospital do so in the first 24 hours.[10] ETAT+ has been developed to include admission care for the first 24 hours.[11]

This article will focus on the assessment, recognition and initial management of the seriously ill child and is based on ETAT and APLS principles; the topics of paediatric life support, trauma and neonatal resuscitation are also included in this edition of *Update in Anaesthesia* (pages 264 and 269).

PRINCIPLES OF MANAGEMENT OF THE SERIOUSLY ILL CHILD

In order to recognise the child who is unwell it is important to know the normal physiological values for different age groups, signs of critical illness, and how children compensate for serious illness. It is important to be prepared to receive a critically ill child to your facility, to understand the principles of triage and the 'ABC' approach to assessment and treatment.

The normal values of heart rate, respiratory rate and systolic blood pressure are shown in Table 1.[12]

Physiological compensation

Children can compensate effectively during the early stages of serious illness, which may mask how unwell they really are. 'Compensation' refers to the ability to maintain perfusion of 'vital' organs such as the brain and heart at the expense of 'non-vital' organs such as skeletal muscle and gut. When compensatory mechanisms fail, decompensation occurs, which if unaddressed, rapidly leads to organ failure and death. Signs of compensation include increased respiratory rate, increased heart rate and peripheral vasoconstriction causing cold extremities. Health workers must be vigilant to signs of compensation so that intervention and treatment can be started promptly. Signs of decompensation include hypotension and bradycardia, and babies may develop apnoeic episodes.

Assessment of end-organ function is important and can also indicate decompensation. For instance, children may appear outwardly well, but they are listless, not interested in their surroundings and tolerate examination and

Table 1. *Normal heart rate, respiratory rate and blood pressure values for children*

	Neonate	Infant	Small child	Adolescent
	< 1 month	< 2 years	2 - 5 years	5 - 12 years
Heart rate (min^{-1})	110-160	100-150	80-120	60-100
Resp rate (min^{-1})	30-40	25-35	25-30	15-20
Systolic BP (lower limit of normal, mmHg)	5-70	70-80	65 + age x2	90-120

interventions without complaint; this can be an early sign of neurological decline or fatigue. Confusion in a child is a very worrying sign and indicates inadequate cerebral perfusion. Conscious level can be assessed quickly using the 'AVPU' score (Alert, responds to Voice, responds to Pain, Unconscious). Unlike adults, reduced urine output due to inadequate renal perfusion is often a late sign in children, and therefore not useful in initial emergency care. However, if a mother reports that the child has not passed urine, this is a serious sign.

PREPARATION

Health facilities caring for sick children must provide not only essential drugs and equipment but also ensure competence and ongoing training of all staff to foster excellent resuscitation team performance.

When preparing to receive a sick child to your facility, individual roles and responsibilities of the resuscitation team members should be clearly understood. The WETFLAG mnemonic (Weight, Energy, Tube, Fluids, Adrenaline, Glucose) is helpful to prepare to receive a sick child to the hospital facility[8] (see Box 1). A worked example of the WETFLAG calculations for a 5-year-old child is given in Box 2, and a table of calculations for children <1 year in Table 2.

Box 1. *'WETFLAG' mnemonic*

Weight*
0-12 months = (0.5 x age (months)) + 4
1-5 years = (2 x age) + 8
6-12 years = (3 x age) + 7
(* Estimation of weight is a guide only)

Energy = 4 x weight (J)
(Energy required for defibrillation)

Tube = age/4 + 4
(Approx. size of uncuffed tracheal tube)

Fluids = 20ml.kg^{-1} of 0.9% saline
(Fluid bolus for shocked child)

Adrenaline = 10mcg.kg^{-1} = 0.1ml.kg^{-1} of 1:10,000
(Dose in cardiac arrest)

Glucose = 2ml.kg^{-1} 10% glucose
(Treatment of hypoglycaemia)

Box 2. *Example of WETFLAG calculations for a 5-year-old child*

5-year-old child

Weight = (2 x 5) +8 = 18kg

Energy = 4 x 18 = 72J

Tube = 5/4 + 4 = 5 - 5.5 - 6

Fluids = 20ml x 18 = 360ml of 0.9% saline

Adrenaline 0.1ml.kg^{-1} = 1.8ml 1:10,000

Glucose = 2ml x18 = 36ml 10% glucose

TRIAGE AND THE ABCDE + DEFG APPROACH

Triage is a system to prioritise who needs to be treated first. Initial triage involves categorizing children who present to the emergency department into three groups of urgency: emergency cases, priority cases and non-urgent cases (see Box 3).

Emergency cases

Signs of a potential emergency case are identified from conducting a rapid primary survey of any child presenting for treatment. The child is assessed using the ABC approach in order to identify those abnormalities that are most rapidly lethal:

Airway. Are there signs of airway obstruction?

Breathing. Is the child having difficulty breathing? (e.g. increased work of breathing, using accessory muscle, cyanosis, abnormal noise such as stridor, wheeze, or silent chest.)

Circulation. Does the child have signs of circulatory failuree.g. cold peripheries, a rapid, weak pulse or capillary refill time > 2 seconds?

Disability or Dehyration. Is the child Awake, or do they have a decreased level of consciousness (assessed quickly using the AVPU score)

Table 2. *WETFLAG calculations for a child less than 1 year. Reproduced with permission. Lorazepam is included as first line treatment for seizures.*

University Hospital Southampton NHS
NHS Foundation Trust

Infant	Weight (KG)	Energy	ET Tube (mm)	Fluid	Lorazepam	Adrenaline (ml)	Glucose (ml)
Months	(0.5 x Age) + 4	4j/KG	Uncuffed (Cuffed)	20ml/kg NaCL 0.9%	0.1mg/kg	0.1ml/kg 1:10'000	2ml/kg 10%
0	4	16	3-3.5 (3)	80	0.4	0.4	8
1	4.5	18	3-3.5 (3)	90	0.45	0.45	9
2	5	20	3-3.5 (3)	100	0.5	0.5	10
3	5.5	22	3-3.5 (3)	110	0.55	0.55	11
4	6	24	3-3.5 (3)	120	0.6	0.6	12
5	6.5	26	3-3.5 (3)	130	0.65	0.65	13
6	7	28	3-3.5 (3)	140	0.7	0.7	14
7	7.5	30	3-3.5 (3)	150	0.75	0.75	15
8	8	32	3-3.5 (3)	160	0.8	0.8	16
9	8.5	34	3-3.5 (3)	170	0.85	0.85	17
10	9	36	3-3.5 (3)	180	0.9	0.9	18
11	9.5	38	3-3.5 (3)	190	0.95	0.95	19
12	10	40	3-3.5 (3)	200	1	1	20

NB - Fluid for trauma = 10ml/kg NaCl 0.9% x 4 then consider blood transfusion

NB - Always escalate Defib Energy to next Joules Up, Remembering 150j is adult dose (Biphasic)

NB - Drugs are maximum drug calculation - use clinical judgement

Box 3. *Triage categories*

5-year-old child

Emergency cases	→	**Immediate emergency treatment**
Priority cases	→	**Assessment and rapid attention**
Non-urgent cases	→	**Can wait their turn in the queue**

Exposure. Are there visible signs of trauma (e.g. fracture) or disease (e.g. rash)? Is the temperature normal? (very hot or very cold)

+ **Don't Ever Forget the Glucose**. Does the child have hypoglycaemia?

These emergency signs must be treated IMMEDIATELY they are discovered, before moving on to the next step.

Priority cases

Once emergency signs are excluded, look for the conditions that need to be treated as a priority. Deciding which children fit in the 'priority' category can be difficult; in the ETAT course this has been developed as the '3TPR-MOB' mnemonic.[8] The mnemonic stands for 3xT (tiny, temperature, trauma), 3xP (pallor, poisoning, pain), 3xR (respiratory, restless, referral), and malnutrition, oedema, burns (see box 4 for an explanation of the 3TPR-MOB priority clinical signs).

If any of the priority signs are identified, the child must be seen quickly, blood taken for emergency investigations including glucose, malaria smear and haemoglobin (Hb), and senior help should be sought.

There are a few conditions such as severe malnutrition, anaemia or cardiac disease that must be identified as part of the initial triage process, as modifications in management will be needed. For example, children with malnutrition who develop diarrhoea are at a higher risk of death than those who are well nourished, and management of children with malnutrition must be modified.[13] These special circumstances are discussed below.

The ABCDE + DEFG approach

The core cycle of assessment, treatment and reassessment using Airway, Breathing, Circulation, Disability, Exposure (ABCDE) is fundamental to the safe and effective care of sick children, and facilitates communication between healthcare workers.

For this approach to be successful, the child must be reassessed regularly, and accurate timed records kept, with results communicated to all team members.

Box 4. *3TPR-MOB – priority signs when assessing the ill child (ETAT)*

3 Ts:
Tiny baby less than 2 months (because difficult to assess, deteriorate quickly)

Temperature: child very hot (high fever)

Trauma (including hidden head and abdominal injuries)

3Ps:

Pain (may indicate a severe condition)

Pallor (severe anaemia)

Poisoning (if history, may need specific urgent treatment)

3 Rs:

Respiratory Distress (if severe, this is an emergency)

Restless: continuously irritable or lethargic (may indicate a severe condition)

Referral: urgent referral to your facility

MOB:
Malnutrition: visible severe wasting (specific treatment protocols are used)

Oedema: both feet (may indicate severe malnutrition)

Burns (may cause urgent airway problem, severe respiratory distress, severe pain, be associated with large fluid losses or other injuries)

Airway

There are some important features to be aware of when assessing and managing the airway in a child (see also page 4)

- Nasal breathing. Infants less than 6 months old breathe predominantly through their nose; nasal obstruction can result in severe respiratory distress, which may be relieved by simple suction to clear the airway.
- Tongue. The tongue in an infant is relatively large and may obstruct the airway when the conscious level is impaired.
- Teeth. These may be loose in children between around 6-13 years of age.
- Adenotonsillar hypertrophy. This is common in 3-8 year olds and may cause upper airway obstruction.
- Soft palate and tonsils. These may be damaged when an oropharyngeal airway is inserted; airways must be inserted with care.
- Trachea. Soft and short, and prone to external compression, including from cricoid pressure. It is very easy to put a tracheal tube down too far.
- Large occiput with short neck in infants tends to force the head into flexion, potentially making airway obstruction worse.
- The airway is narrow in absolute terms. A small amount of airway swelling or obstruction by secretions may result in severe airway obstruction.
- Cricoid ring. This sub-glottic region is the narrowest part of the airway in a small child (compared with the vocal cords in an adult) and is susceptible to oedema. In general, uncuffed tracheal tubes are preferred for children < 8 years old; modern 'microcuff' tracheal tubes with cuff pressure monitoring are a new alternative.

The first question to consider when evaluating the airway is 'is the airway obstructed'?

Observe for:

- Talking or crying – the airway is open
- Noisy breathing. Is this due to stertor or stridor – i.e. partial obstruction above or below the larynx respectively
- 'See-saw' chest and abdominal movements – respiratory effort is present, but potentially with complete airway obstruction.

Common causes of airway obstruction are shown in Box 5.

If there is total airway obstruction, the airway must be opened immediately with simple manoeuvres: head-tilt, chin lift or jaw thrust. Airway adjuncts e.g. oropharyngeal (Guedel) or naso-pharyngeal airway may be required. If total airway obstruction persists despite these simple measures, any subsequent intervention will be determined by the specific history and condition of the child. For example, a child with suspected inhaled foreign body might require specific interventions to clear the airway.

Attempt to provide breaths whilst an assistant maintains airway-opening manoeuvres. If unable, consider direct laryngoscopy and intubation. If unable to intubate or ventilate, proceed urgently to a surgical airway down the 'can't ventilate, can't intubate' emergency airway algorithm (see page 116).

Box 5. *Common causes of airway obstruction in children*

- Reduced level of consciousness
- Inhaled foreign body – sudden onset, often witnessed
- Dental abscess
- Croup – gradual onset, viral illness usually due to parainfluenza virus, with characteristic 'barking' cough
- Epiglottitis – rapid onset, severe, bacterial illness usually due to Haemophilus influenzae. The child is 'toxic', with sore throat, drooling, muffled voice and a high temperature, and often adopts a 'tripod' position to maintain the airway
- Tracheitis – systemically unwell, bacterial illness usually due to Staphylococcus aureus. Bacterial tracheitis usually occurs as a complication of a viral infection.
- Retropharyngeal abscess – usually due to lymphatic spread of infection from sinuses, teeth or middle ear. The child presents with fever, sore throat and neck pain and swelling. Stridor is not often a major feature.

If the child has a traumatic injury, the cervical spine must be immobilised and the airway must be opened using a jaw thrust to keep the head in a neutral position.

Partial airway obstruction

If there is partial airway obstruction, and the child is unconscious, open the airway using the manoeuvres described above (chin lift, jaw thrust).

If there is partial obstruction and the child is conscious, allow the child to adopt a comfortable position – this will often be sitting up or leaning forwards. Leave the child with their parent or carer as this reduces distress; avoid inspecting the oropharynx as this can rapidly worsen partial airway obstruction. Do not attempt intravenous cannulation before the airway can be improved; causing the child added distress may worsen the situation. Strategies to manage a child with stridor are shown in Box 6.

Breathing

Look, listen and feel for effort and efficacy of breathing. There are a number of signs to look for in the rapid assessment of breathing, but increased respiratory rate is one of the key indicators of severe illness. Increased respiratory rate may be due to a variety of causes, such as respiratory disease, sepsis or hypovolaemia. The respiratory rate should be assessed and compared to normal values for age, and the trend followed by repeated assessment. Increasing respiratory rate is a worrying sign and usually indicates a child that is tiring and at risk of imminent collapse; a sudden fall in respiratory rate is a sign of this collapse (it is a pre-terminal sign).

A child with respiratory disease will have to work hard to breath and will tire easily. The airways are relatively narrow and are easily obstructed by oedema or secretions. A small reduction in airway diameter leads to a large increase in resistance, and hence the work of breathing. In infants, respiratory mechanics are not very efficient; the ribs are soft and horizontal and the diaphragm is a major muscle of respiration. Abdominal distension is poorly tolerated. The soft ribs mean that subcostal and intercostal recession is relatively common in infants with respiratory infection, but is an ominous sign in an older child in whom the chest wall is relatively more rigid.

Box 6. *Initial management of stridor in a child with partial airway obstruction.*

- Reassure the child; keep them close to their parents or carer
- Give high flow humidified oxygen via a mask
- Consider adrenaline nebuliser: 5ml of 1:1000 adrenaline with oxygen
- Consider antibiotics (epiglottitis) or steroids (croup)

The signs to look for in assessment of breathing are shown in Table 3.

Increased work of breathing is a compensatory mechanism and may be effective in keeping oxygen delivery normal. The child will still require support and close watching. Carbon dioxide retention is unusual unless there is a reduced conscious level or lower airway obstruction.

Detecting hypoxaemia with pulse oximetry is an important measurement, especially for children with suspected pneumonia. Regular monitoring of oxygen saturation can be used to guide effective use of oxygen, and is associated with improved outcomes. Untreated hypoxaemia in children with pneumonia is associated with increased mortality.[14,15] Note that inability to obtain a pulse oximetry reading may be due to reduced perfusion of the extremities due to shock.

It is important to review other systems to look for signs of respiratory distress, such as an increased heart rate (compensation), bradycardia (a pre-terminal sign), skin colour for cyanosis, and level of consciousness for evidence of cerebral hypoxia. Exhaustion, reduced conscious level and slow breathing or apnoea (stopping breathing) are signs of decompensation and are pre-terminal signs.

If the child has compensated respiratory distress, the management must include the following:

- Sit the child up
- Give oxygen – high flow via mask, humidified if possible. The oxygen mask can be held near to the child's face if they are distressed by it

If the child has decompensated respiratory distress (reduced breathing or apnoeic episodes, cyanosis or desaturation, bradycardia, reduced level of consciousness), intervention to support breathing should be immediate, using 100% oxygen and bag and mask ventilation in the first instance.

Circulation

The next step is to assess circulation, assessing key elements at the same time (this is important to correctly diagnose shock):

- Feel the pulse rate (compare to normal values for age).
- Feel pulse strength (compare the strength of central and peripheral pulses).
- Capillary refill. Ideally the child should be normothermic and should be viewed in good light. Press on a central area such as the chest for 5 seconds; the skin will blanch but normal colour should return within 2 seconds when the pressure is released. Note that vasodilatation in 'warm' shock may mean that capillary refill appears to be normal, even if the child has severe sepsis. On its own, capillary refill time is not a reliable sign of cardiovascular compromise.
- Feel the extremities. Are the hands and feet cold compared with central parts of the body? Where does the zone of warmth extend to?
- Blood pressure. Choose the correct size of cuff (as large as fits comfortably on the arm); a normal BP does not always mean all is well. Remember that hypotension is a late sign that decompensation is occurring. As a guide, the lowest level of normal systolic pressure is 65 + (2 x age in years).
- Look for associated respiratory compensation (tachypnoea).
- Assess end-organ function: level of consciousness (AVPU – see Disability below). Confusion in a child is a worrying sign.

Signs to look out for when assessing the cardiovascular system are shown in Table 4.

The management of cardiovascular insufficiency in children must include:

Table 3. *Assessment of breathing*

Signs of increased effort i.e. increased work of breathing	Signs of efficacy of breathing i.e. is the respiratory effort effective?
• Respiratory rate (compare to normal values)	• Colour - look for central cyanosis
• Body position - sitting forward or adopting 'tripod' position	• Oxygen saturation
• Recession - intercostal, subcostal and or sternal	• Breath sounds (a silent chest is a pre-terminal sign)
• Tracheal tug	• Chest expansion
• Grunting	• Conscious level. Reduction on conscious level is a late sign.
• Wheeze	
• Use of accessory muscles (e.g. sternocleidomastoid in the neck)	
• Nostril flaring	
• Head bobbing	

Table 4. *Indicators of cardiovascular insufficiency or shock*

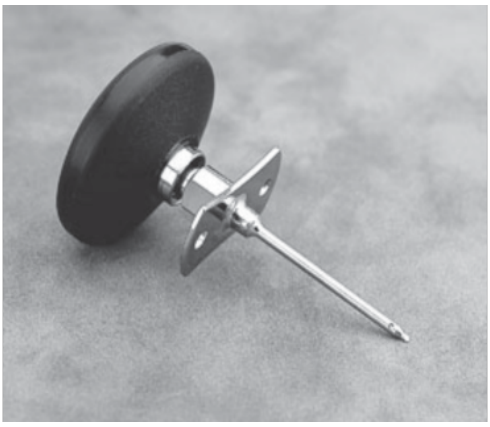
Severe but compensated shock	Decompensated shock – pre-terminal
• Mottled, cold skin	• Hypotension
• Tachycardia	• Bradycardia
• Weak peripheral pulses	• Unconscious
• Cold peripheries – to knees or elbows	
• Prolonged capillary refill (>2 seconds)	
• Increased respiratory rate	

- Oxygen – high flow via face mask
- Stop any bleeding
- IV access – intravenous or intraosseous
- Fluids - oral, nasogastric or intravenous.

Intravenous access can be difficult in children with shock. An intraosseous needle is an effective method of fluid and drug administration and should be considered early if intravenous access is difficult. (See article, page 240)

Traditional fluid management for a child in shock has been to give a fluid bolus of 10-20ml.kg^{-1} 0.9% saline or Ringer's lactate, followed by reassessment. However, intravenous fluid therapy for children in resource-poor settings has been addressed in an important new study, the Fluid Expansion as Supportive Treatment (FEAST) study, published in the New England Journal of Medicine in 2011. This is a randomised controlled study of over 3000 children in six hospitals in Uganda, Kenya and Tanzania, comparing fluid resuscitation starting with a bolus of fluid to just starting maintenance fluids without a bolus, in children with fever and shock. Shock was defined as signs of impaired perfusion plus impaired consciousness or respiratory distress, or both. Children with gastroenteritis, severe malnutrition, burns or surgical conditions were excluded. The main finding was that children given a fluid bolus of 20-40 ml.kg^{-1} 0.9% saline or 5% albumin did worse, with an increased risk of mortality compared to the control group who received maintenance fluids only.[16]

Figure 1. *Intraosseous needle*



This was a well-conducted study and has provoked much debate.[17-21] The children were severely unwell by any measure, but there were no intensive care facilities in the study hospitals. Many children had malaria and were anaemic, but the detrimental effects of fluid bolus were still seen in those without malaria and those without severe anaemia. The children appeared to die from cardiovascular collapse (rather than fluid overload), within 24-48 hours of treatment.[20] Excess mortality associated with fluid bolus was still seen in a smaller group of children who met the more strict WHO criteria for sepsis (i.e. capillary refill time > 3 secs, cold peripheries, a weak pulse, and a fast pulse).[21] The implications of the FEAST study are that children with febrile illness and shock in Africa should receive maintenance fluids only (Ringer's lactate 5% dextrose or 0.9% saline 5% dextrose), and aggressive resuscitation with boluses of 0.9% saline or albumin should be avoided. From a pragmatic point of view, this would appear to be a safer course of action in hospitals with low numbers of nursing staff and without burettes to accurately measure fluid volumes, and no backup intensive care facilities.

Disability: neurological assessment

Make a quick assessment of neurological function. This is essential to assess end-organ function. If the child is alert, this indicates that there is adequate cardio-respiratory compensation; a child with decompensated cardiorespiratory failure will have a depressed conscious level. Depressed conscious level or confusion may also be due to a primary cerebral cause (trauma or cerebral infection).

The three quick assessments are:

- Pupils (size and reactivity to light) – always compare left and right
- Posture

- Conscious level assessed using the AVPU system:
- **A** – Alert
- **V** – responds to Voice
- **P** – only responds to Painful stimuli
- **U** – Unresponsive to painful stimuli.

AVPU is a quick reliable method of assessing conscious level without using an age-specific Glasgow or Blantyre coma scale.[15] In general, a child responding to pain (P) or unresponsive (U) corresponds to a GCS of 8 or below and will likely need airway support.

Exposure

- Check for rashes, burns and bruises or other injuries
- Check temperature.

Glucose

Don't Ever Forget Glucose (DEFG) is the final part of the disability assessment, especially in children with a reduced conscious level. Aim for a blood glucose of >2.5mmol in a well nourished child, >3mmol in a malnourished child.

Treat hypoglycaemia with 10% dextrose 2 ml.kg^{-1} IV, or with oral glucose

Review other systems for signs of neurological failure:

- *Airway.* Reduced conscious level will eventually lead to airway obstruction
- *Breathing.* Increased intracranial pressure may present as hyperventilation, Cheynes Stokes respiration or apnoea
- *Circulation.* Bradycardia + hypertension = Cushing's response, a pre-terminal sign of elevated intracranial pressure

Dehydration

Once shock has been treated (if present), make an assessment of fluid deficit in order to calculate the fluid requirements of the child over the next 24 hours:

Total fluid requirement = degree of dehydration + maintenance fluid + ongoing loss

A guide to assessing dehydration in children is provided in Table 5, and a case example putting everything together is shown in Box 7.

SPECIAL CIRCUMSTANCES

Cardiac disease

It is important, particularly in newborns, to consider cardiac disease as a cause for cardiovascular insufficiency and shock. Signs to look for include:

- Cyanosis – not correcting with oxygen. Ideally all newborn infants should be screened for cyanotic heart disease using pulse oximetry
- Tachycardia
- Raised jugular venous pressure

Table 5. *Clinical assessment of dehydration in children*

Clinical sign	Mild	Moderate	Severe
Weight loss	Less than 5%	5-10%	Greater than 10%
Total fluid deficit	Less than 50 ml.kg^{-1}	50-100 ml.kg^{-1}	>100 ml.kg^{-1}
General appearance	Alert	Irritable, thirsty	Lethargic, drinks poorly
Mucous membranes	Normal	Dry	Dry
Eyes	Normal	Normal	Sunken
Respiration	Normal	Fast	Fast
Pulse	Normal	Fast	Fast, weak
Blood pressure	Normal	Normal	Low
Pinched skin* (Pinch skin between thumb and forefinger on abdomen or thigh)	Springs back	Slow – skin fold present less than 2 seconds	Very slow – skin fold greater than 2 seconds

Box 7. *Putting it all together - case example*

A 5-year-old girl is brought to the emergency department with diarrhoea and a poor appetite. She is lethargic and refusing water. She has a respiratory rate of 40 and a weak femoral pulse with a rate of 140bpm. Her blood pressure is 100mmHg systolic. How would you assess and manage this child?

Preparation. Ensure the team and equipment are prepared to receive the child – remember **WETFLAG**:

5 year-old child...

Weight = (2x5) + 8 =18

Energy = 4x18 = 72J

Tube = 5/4 + 4.5 = 5.5-6.0

Fluids = 20 $ml.kg^{-1}$ = 360ml 0.9% saline*

Adrenaline = 0.1$ml.kg^{-1}$1:10,000 = 1.8ml

Glucose = 2x18 = 18ml 10% dextrose

Triage – look for emergency signs

She has a clear airway but has rapid breathing, fast pulse and has dehydration with lethargy. This child must be treated immediately with:

- Breathing – high flow oxygen via face mask and sit upright
- Circulation and Dehydration – If possible give oral fluids, however with a lethargic child it may be necessary to consider an intravenous fluid bolus 20 $ml.kg^{-1}$ 0.9% saline if there are signs of shock in association with a surgical diagnosis or acute dehydration from gastroenteritis.
- Check blood for glucose, malaria and Hb

Assess and treat ABCD + DEFG

Move on to a full ABC assessment. Her airway is clear and maintained unaided. For assessment of breathing look at effort and efficacy (see Table 2). She has a respiratory rate of 40 breaths per minute, indicating an increased effort of breathing. She is not using accessory muscles. She has good air entry on auscultation with SpO_2 99% in room air, demonstrating good efficacy despite increased effort. We have already started oxygen via facemask and sat her upright as part of our emergency management. This is sufficient treatment for breathing.

As A+B are now stable, move on to circulation. Her pulse rate is fast and thready. She is in the 'compensated' phase of shock - her blood pressure is normal for her age and she remains conscious. She has acute dehydration and is refusing oral fluids. There are no signs of cardiac disease, such as cyanosis or liver enlargement or malnutrition. She should receive an IV fluid bolus 20$ml.kg^{-1}$. After IV fluids her heart rate reduces to 110bpm.

To calculate her ongoing fluid requirement, first calculate her level of dehydration (Table 4). She is lethargic with a raised respiratory rate and tachycardia. She has at least a 10% deficit with clinical signs of hypovolaemia. She is too unwell for oral rehydration. Her fluid requirements for the next 24 hours are: (Total fluid requirement = degree of dehydration + maintenance fluid + ongoing loss)

10% deficit (100$ml.kg^{-1}$) in an 18kg child = 1800ml

- Replace 50% over 8 hours = 900ml
- Replace the remaining volume over the next 16 hours = 900ml

Maintenance = 100$ml.kg^{-1}$ for first 10kg (100x10) + 50$ml.kg^{-1}$ for next 10kg (50x8) = 1400ml

- i.e. IV fluids for first 8 hours = 900ml replacement + 466ml maintenance.
- For next 8-24 hours = 900ml replacement + 933ml maintenance.
- Give as Ringer's lactate 5% dextrose

We can move on to assess Disability. Using the AVPU assessment tool she is responding to voice and is only lethargic. This is still an important sign and must be reassessed during and after treatment. A blood glucose is taken and is within normal limits.

After so many interventions it is important to reassess her and treat any abnormal signs before she is transferred to a paediatric ward for ongoing fluid resuscitation and investigation.

- Gallop rhythm/murmur
- Enlarged liver
- Absent femoral pulses.

Fluids must be given cautiously. This topic is covered in more detail on page 81.

Malnutrition

Malnutrition is a contributing factor in approximately one third of child deaths, making children more susceptible to severe disease.[15] It is vital that malnutrition is identified in seriously ill children as specific management strategies must be adopted.

The child with serious malnutrition undergoes metabolic and physiological changes to conserve energy and preserve essential processes.[22] If these changes are not acknowledged when initiating treatment, the child will be at increased risk of death from heart failure, electrolyte imbalance, hypoglycaemia, hypothermia and they may have untreated infection. Mortality rates of up to 60% are seen in the most severe group.[23]

Signs of malnutrition include:

- Severe wasting
- Oedema in feet
- Underweight for age.

The WHO has produced guidelines for the management of severe malnutrition, which outlines key steps for initial management[24]:

- The child should be fed every 2–3 hours, day and night, to prevent hypoglycaemia and hypothermia
- Keep the child warm
- Rehydrate with low sodium fluids; monitor closely for signs of fluid overload; avoid intravenous fluids, except in shock
- Give 100kcal.kg^{-1}.day^{-1} and 1g protein.kg^{-1}.day^{-1}
- Give potassium and magnesium to correct electrolyte imbalance; restrict sodium
- Give micronutrient supplements; do not give iron
- Give broad spectrum antibiotics even when clinical signs are absent as infections can be silent.

Critically, children with severe malnutrition must not be aggressively resuscitated with IV fluids as this may lead to heart failure. Intravenous fluids should not be given unless the child is lethargic or unconscious and shocked. When restarting feeding malnutrition protocols should be used. A suggested regimen for fluid resuscitation for a child with malnutrition and acute dehydration is shown in box 8.

Box 8. *Fluid resuscitation for a child with malnutrition and shock due to acute dehydration from gastroenteritis*

Slow IV fluid bolus = 15ml.kg^{-1} Ringers lactate with 5% dextrose over 1 hour

Reassess

Oral rehydration with low sodium (ReSoMAL) oral rehydration solution

Measles

Despite an effective vaccine against the virus, more than 20 million people are affected by measles every year, predominantly in parts of Africa and Asia. The majority of deaths occur in low-income countries and in children who are malnourished, particularly with vitamin A deficiency.[25]

Children with measles present with symptoms which usually appear 10–12 days after infection, including a fever, runny nose and white spots on the inside of the mouth. Several days later a rash appears, starting on the face and neck, gradually spreading downwards.

The most serious complications of measles include blindness, encephalitis (an infection that causes brain swelling), severe diarrhoea with dehydration, and severe respiratory infections such as pneumonia.

Measles is caused by a virus for which there is no specific treatment. Children should be assessed using the ETAT triage tool followed by a thorough ABC assessment, with particular attention to assessment of nutritional status and dehydration, and treated symptomatically with supportive therapy.

Malaria

Malaria is one of the five main causes of death in children under 5 years, with symptoms appearing 7-15 days after the infective mosquito bite. It typically presents with non-specific symptoms such as fever, headache and vomiting.[26] It is frequently over-diagnosed and over-treated, yet it is also often treated sub-optimally with incorrect doses of anti-malarial medication prescribed.[27-32] Over-diagnosis of malaria may result in failure to treat other potential causes of febrile illness.[33] Bedside testing is now available in many countries for malaria parasites.

Children with malaria commonly present with:

- High temperature
- Shock
- Severe anaemia
- Hypoglycaemia

- Jaundice.

In severe cases of cerebral malaria they may also present with:

- Convulsions
- Coma.

The assessment and management of malaria should follow ETAT guidelines, with identification and treatment of emergency signs followed by a thorough ABC assessment. Important additional points to remember for suspected malaria are:

- Treat hypoglycaemia
- Assess conscious level and consider lumbar puncture to rule out meningitis
- Do an early blood film to establish diagnosis
- Treat using local anti-malarial guidelines ensuring accurate dosing
- Consider broad spectrum antibiotics if there is some doubt as to the diagnosis
- Give cautious fluids if there is impaired perfusion or shock, especially if there is anaemia or cerebral impairment.

CONCLUSION

In this article we have looked at the initial assessment and management of the seriously ill child. Key points to consider are rapid initial assessment and triage using the ETAT criteria followed by treatment of emergency signs. This must then be followed by a thorough review using the ABCDE + DEFG approach, commencement of appropriate treatment with frequent reassessment of ABCDE +DEFG. This system will ensure effective and accurate initial management for all seriously ill children.

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