

## SELF ASSESSMENT EXERCISES

### Self Assessment Questions In The Management Of Paediatric Emergencies

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Paediatric patients make up a surprising, yet predictable, proportion of our operational workload wherever in the world we are deployed. It is important that we have both the equipment and appropriately trained personnel to deal with these children. The following exercises explore some basic principles of paediatric emergency care.

You are deployed in the emergency department of a UK field hospital in the Middle East, providing emergency (life- and limb-saving) care to the local population.

1. You receive prior notice that a 3 year old girl is being brought in by helicopter. She has been struck by a coalition vehicle and appears to have multiple injuries.

- What information would you expect the pre-hospital medical team to provide?
- What preparations would you make prior to her arrival?
- How would you estimate her weight?
- What should be the priorities in management?

2. The same patient arrives in your department. On primary survey she has a clear airway, her breathing is shallow but equal, with a respiratory rate of 45 per minute, and her pulse is 160 bpm. You cannot get a blood pressure reading, as the cuff is too large.

- What are the normal values for vital signs in a 3 year old?
- How are you going to assess the patient for respiratory distress?
- Are there any other parameters you could use to assess circulation?
- How are you going to assess the coma score?

3. Following primary and secondary surveys with appropriate resuscitation, the patient's vital signs normalise. She is taken for a CT scan of her abdomen that reveals a small amount of intraperitoneal blood and a grade II splenic injury.

- What factors should be taken into account when considering whether operative management is appropriate?

4. A 6 year old Iraqi child is brought to the front gate of the hospital in a drowsy state. Her parents state she has been unwell for a

few days, and has had several episodes of diarrhoea. You suspect she may be dehydrated.

- What clinical signs of dehydration would you specifically look for?
- On further assessment you estimate that the child is about 10% dehydrated. How would you calculate this child's fluid requirements over the next 24 hours?
- How would you administer this fluid?
- What fluid would you give?

5. An 8 year old boy who is fitting is brought to the hospital in the back of a pickup truck. On arrival in the resuscitation room he is suffering a generalised tonic-clonic seizure.

- What are the priorities in management of this child?
- What is the first line drug treatment of seizures in children?
- How are you going to subsequently manage him if he does not respond to this?

6. A 3 year old child is brought to the emergency department with a rash. He has not been eating for the last day or so, and is generally listless. Examination reveals a patent airway, equal breath sounds, and a slight tachycardia with a pulse rate of 150bpm. He is groaning, his eyes open to verbal stimuli, and he localises pain. His tympanic temperature is recorded at 39.5°C.

- What are the features of a rash that would suggest that this is meningitis?
- What organism is likely to be responsible?
- What are the priorities in treatment?

### Answers to self assessment exercises

#### Question 1

- The pre-hospital team would be expected to provide information in a **MIST** format concerning the
  - M**echanism of injury.
  - I**njuries sustained.
  - Vital Signs** at the scene and en route (RR, pulse, BP and conscious level on AVPU score).
  - Pre-hospital **T**reatment administered.

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- b. Call the trauma team. Prepare equipment and drugs appropriate to her approximate age and weight.
- c. The child's weight can be estimated using the formula:  
**weight (kg) = 2 x (age in years + 4)**

Her weight is therefore approximately 14kg.

- d. Priorities in management will be:
- Perform an initial primary survey.
  - Initiate appropriate resuscitative procedures dealing with life threatening Airway, Breathing, and Circulation problems.
  - Perform a full secondary survey.
  - Emergency treatment of any injuries revealed during this secondary survey.
  - Facilitate definitive care of the patient.

## Discussion

When you are notified of the imminent transfer of such a patient it is important to mobilise the necessary personnel and equipment to deal with the situation. A multidisciplinary trauma team is an integral part of the management of major trauma and has been shown to improve outcome (1).

Appropriate equipment to deal with life threatening problems pertaining to the airway, breathing and circulation of this patient must be prepared. Appropriate doses of resuscitation drugs should also be prepared prior to arrival. It is useful to have a white board available on which to calculate appropriate equipment sizes and drug doses according to the known age and estimated weight of the incoming paediatric casualty. The mnemonic WETFAG describes some essential pieces of equipment and drugs, as outlined in Table 1.

Table 1. WETFAG.

<p><b>Weight (kg) = 2 x (Age + 4)</b>  <b>Energy (J) = 2J/kg, 2J/kg, 4J/kg</b>  <b>Tracheal tube internal diameter (mm) = 4 + (age/4)</b>  <b>Fluid bolus = 20ml/kg crystalloid</b>  <b>Adrenaline = 0.1ml/kg of 1:10000</b>  <b>Glucose = 5ml/kg of 10% dextrose</b></p>
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With respect to the preparation of other equipment prior to receiving a paediatric casualty, the use of a system such as the Broslow tape (where equipment is grouped by size corresponding to the size of the child, to include basic airway adjuncts, intravenous cannulae, intraosseous needles) enables quick assessment of the child's size and guides appropriate use of equipment (2,3).

When considering priorities in management of a seriously injured child, the structured ABCDE approach should be the framework of the primary survey (4). As with all trauma patients consideration should be given to immobilisation of the cervical spine, although practically speaking this is often difficult in the case of the frightened,

uncooperative child. Resuscitation should occur concurrently with the primary survey, with life threatening problems treated as they are identified.

Other procedures which should routinely be carried out during the resuscitation phase include history taking (gathering as much information about the precise mechanism of injury as possible), blood for group and cross match, radiographs of chest and pelvis, and consideration of the need for a urinary catheter, nasogastric tube and analgesia.

After stabilisation of the patient during resuscitation, a full secondary survey with top to toe examination and relevant further investigations should be commenced. This assessment should include a log roll and examination of the back of the patient.

## Question 2

- a. The normal values for vital signs in a 3 year old are (4):
- Respiratory Rate 25-30 breaths per minute.
  - Heart Rate 95-140 beats per minute.
  - Systolic BP 80-100 mmHg (80 + [age x 2]).
- b. As well as respiratory rate, assess effort, efficacy and effects of breathing (see discussion).
- c. Further assessment of the circulation of this child, in addition to the pulse rate, should include pulse volume, capillary refill time, blood pressure and assessment of inadequate circulation on other organs.
- d. AVPU score then paediatric coma score.

## Discussion

In order to determine whether this patient has respiratory distress, an assessment should be made of the effort of breathing, the efficacy of breathing and the effects of inadequate respiration on other systems.

- Effort: is there recession (sternal, subcostal or intercostal)? Is the respiratory rate abnormally high or low? Hypoventilation in a child with severe breathing difficulties suggests exhaustion. Is there grunting, accessory muscle use or flare of alae nasi?
- Efficacy: are breath sounds audible and are they normal? Does the chest move normally with respirations or is abdominal excursion present?
- Effects: assess heart rate, skin colour, mental status and oxygen saturation.

Assessment of the circulation should include feeling for the pulse volume (weak central pulses are a serious sign of advanced shock). The capillary refill time (CRT) should be measured over the centre of the sternum. It should be less than 2 seconds after 5 seconds of pressure. Beware of the specificity of this sign if the patient has come from a cold environment. Blood pressure,

when measured with an appropriately sized cuff, can support a diagnosis of late and pre-terminal circulatory failure if hypotension is found. Assessment of circulatory inadequacy on other organs will include looking at:

- The respiratory system for a raised respiratory rate
- The skin – pale or cyanosed skin may indicate poor perfusion
- The mental state of the patient – agitation and drowsiness can be caused by poor cerebral perfusion
- Urinary output – less than 1ml/kg/h in children or less than 2ml/kg/h in infants indicates inadequate renal perfusion.

In a child, neurological assessment should be performed after airway; breathing and circulation have been assessed and treated. An initial assessment of conscious level can be made using the AVPU score, by classifying the patient's response as follows:

- **A** - ALERT
- **V** - responds to VOICE
- **P** - responds to PAIN
- **U** - UNRESPONSIVE

A child who is either P or U has a significant degree of coma equivalent to 8 or less on the Glasgow Coma Scale (GCS). Table 2 shows the adult GCS (that can be

used for assessment of the 4-15 year old child) and the paediatric GCS (to be used for children who are less than 4 years old). Assessment of the child's pupil size and reactivity, and whether they can move all four limbs (on gross examination) also form an important part of initial assessment of the neurological function of the traumatised child.

### Question 3

- a. Haemodynamic status, CT contrast blush, facilities for clinical reassessment.

### Discussion

Over recent years there has been an increasing trend towards non-operative management of isolated injuries to the liver and spleen in children. This has resulted in excellent outcomes with decreased blood utilisation and decreased rates of overwhelming post-splenectomy infection (5). However, the most important deciding factors are the clinical and haemodynamic status of the patient. If there is continuing haemodynamic compromise the patient needs surgery to stop the bleeding.

The use of organ injury scaling (6) has

Table 2. Adult and paediatric coma score.

Adult Glasgow Coma Score	Score	Paediatric Coma Score	Score
<i>Eye opening response</i>		<i>Eye opening response</i>	
Spontaneously	4	Spontaneously	4
To verbal stimuli	3	To verbal stimuli	3
To pain	2	To pain	2
No response to pain	1	No response to pain	1
<i>Best motor response</i>		<i>Best motor response</i>	
Obeys verbal command	6	Spontaneous or obeys verbal command	6
Localises to pain	5	Localises to pain or withdraws to touch	5
Withdraws from pain	4	Withdraws from pain	4
Abnormal flexion to pain (decorticate)	3	Abnormal flexion to pain (decorticate)	3
Abnormal extension to pain (decerebrate)	2	Abnormal extension to pain (decerebrate)	2
No response to pain	1	No response to pain	1
<i>Best verbal response</i>		<i>Best verbal response</i>	
Orientated + converses	5	Alert, babbles, coos, words to usual ability	5
Disorientated + converses	4	Less than usual words, spontaneous irritable cry	4
Inappropriate words	3	Cries only to pain	3
Incomprehensible sounds	2	Moans to pain	2
No response to pain	1	No response to pain	1
<i>Maximum score</i>	15	<i>Maximum score</i>	15

allowed anatomical classification of the severity of injuries to the liver, spleen and kidney. Splenic injuries are divided, according to appearance on CT scan, into grades I - V in ascending severity.

Recently, an extra tool for assisting with decisions as to which paediatric patients should progress to splenic intervention (operative or angiographic) has been developed and we can now use the sign of *contrast extravasation* or *blush* on CT scan, in conjunction with the patient's haemodynamic stability, to predict the need for such intervention in blunt solid organ injury (7). In an operational role 3 facility it is unlikely that angio-embolisation techniques will be available, so the patient with a contrast blush will need surgery. Laparotomy is also indicated where injury to the bowel or major pancreatic ductal injuries are suspected, regardless of the severity of injuries to liver, spleen or kidney (8).

If non-operative management is appropriate, the patient needs to be admitted to a ward with intensive monitoring capabilities (a High Dependency Unit) for regular clinical reassessment by an experienced surgeon.

#### Question 4

- The clinical symptoms and signs of a dehydrated child are described in Table 3.
- 3.5 litres.

This child will need replacement of the fluid deficit as well as maintenance fluids. If the child is 10% dehydrated, the fluid deficit can be estimated as 10% of the child's weight [ $2 \times (6+4) = 20\text{kg}$ ] which equals 2kg or 2 litres fluid.

Maintenance fluids can be calculated using Table 4 below.

In this case the child (with an estimated

weight of 20kg) will require  $[(10 \times 100) + (10 \times 50)]$  ml/day for normal maintenance, i.e. 1500ml per day.

In total this 6 year old needs **3.5 litres** of fluid over the forthcoming 24h period.

- This fluid should be administered orally if possible, but if the child is drowsy she will most likely need intravenous fluids as well.
- Start with normal (0.9%) saline and check the electrolytes.

#### Discussion

Fluid is lost from the body and needs replacing on a daily basis. Losses in urine, faeces, sweat and during respiration occur in normal health. However, when abnormal losses such as diarrhoea are added to this, dehydration may result if fluid is not adequately replaced. Electrolytes are also required in order to replace those lost obligatorily in stools, urine and sweat. Any excess ingested or infused will ordinarily be excreted in the urine.

Variable quantities of electrolytes and water are lost from the body depending on the cause of dehydration (gastrointestinal, renal, metabolic). Hypovolaemia is likely to be a problem only when the degree of dehydration is severe, but the speed of fluid loss is also important with slow, prolonged losses giving rise to massive dehydration without hypovolaemia and acute severe losses (particularly bleeding) giving rise to hypovolaemia without apparently obvious dehydration.

Management of dehydration should be by oral rehydration if mild (up to 5% dehydrated) and by the intravenous route if more severe (although oral rehydration should also be encouraged) (4). If intravenous rehydration is necessary, it is

Table 3. Symptoms and signs of dehydration (4).

	Mild (<5%)	Moderate (5-10%)	Severe (>10%)	Notes
Decreased urine output	+	+	+	Watery diarrhoea can make nappies look wet
Dry mouth	+/-	+	+	Mouth breathers are always dry
Decreased skin turgor	-	+/-	+	Examine several sites
Tachypnoea	-	+/-	+	Pyrexia & metabolic acidosis worsen this
Tachycardia	-	+/-	+	Hypovolaemia, pyrexia & irritability cause this

Table 4. Estimation of daily fluid requirements by weight (4).

Body weight	Fluid requirement per day	Fluid requirement per hour
First 10kg	100 ml/kg	4 ml/kg
Second 10kg	50 ml/kg	2 ml/kg
Subsequent kg	20 ml/kg	1 ml/kg

reasonable to start with normal 0.9% saline until the electrolytes have been measured, in which case it might be more appropriate to switch to 0.45% saline with 2.5% dextrose. If dehydration is severe, insertion of a urinary catheter and accurate measurement of urine output will also be necessary.

### Question 5

- ABC, exclude hypoglycaemia, IV access and terminate the convulsion.
- Lorazepam 0.1mg/kg intravenously or rectal diazepam at a dose of 0.5mg/kg if intravenous access has not yet been obtained.
- Repeat lorazepam. If still fitting consider rectal paraldehyde (0.4mls/kg), intravenous phenytoin (18mg/kg over 20 minutes) or rapid sequence induction of anaesthesia with thiopentone (4mg/kg).

### Discussion

Seizures are quite common emergencies in childhood. The vast majority of these events are related to a febrile illness or are idiopathic in nature, although a small number will be associated with other disease or illness, such as meningitis or a head injury.

The priorities in management of this child are to assess and if necessary support airway, breathing and circulation. The aim of this process is to minimise the effects of hypoxia to the brain. Supportive resuscitative procedures may include the insertion of an airway adjunct, provision of high flow

oxygen (via a bag-valve-mask device if hypoventilation is occurring) and gaining intravenous or intraosseous access. After ABC stabilisation and exclusion or treatment of hypoglycaemia, the priority is to terminate the convulsion.

Intravenous access should be established as soon as possible and lorazepam 0.1mg/kg given as a bolus (9), flushed through with saline. If intravenous access cannot be established quickly, rectal diazepam should be administered at 0.5 mg/kg (as a rule of thumb 5 mg for children less than 5 years of age, 10 mg for children over 5 years). Blood glucose should be measured using a bedside testing kit. If there is evidence of hypoglycaemia a bolus of 5ml/kg of 10% dextrose should be administered.

Most seizures respond to one dose of either intravenous lorazepam or rectal diazepam. Intravenous lorazepam may be repeated after 10 minutes if the child is still fitting. If this is unsuccessful further treatment will be necessary using paraldehyde or phenytoin (see Figure 1). Senior medical help should be sought at an early stage, particularly if the first dose of benzodiazepine fails to terminate the seizure.

### Question 6

- The rash of meningococcal septicaemia is classically described as purpuric, although in meningococcal meningitis, skin rashes occur in only 50% of patients, often starting as maculo-papular, and then becoming characteristically petechial.
- The most likely organism to be causing this 3 year old child's meningitis is *Neisseria meningitidis* but we do not know that this child has necessarily been immunised with the Hib vaccination, so consideration of *Haemophilus influenzae* as a causative organism is important.
- Primary survey including high flow oxygen. Gain intravenous access, through which blood should be taken for culture and antibiotics should be given.

### Discussion

After the neonatal period, the commonest cause of bacterial meningitis is *Neisseria meningitidis*. Neonates are additionally exposed to meningitis caused by *Listeria monocytogenes* and *Escherichia coli*. In the developed world, the incidence of *Haemophilus influenzae* has decreased secondary to the widespread introduction of the Hib vaccination, but this is still a major concern in developing countries. *Streptococcus pneumoniae* is an uncommon cause of bacterial meningitis and is found usually in patients who are immunocompromised (particularly asplenic patients).

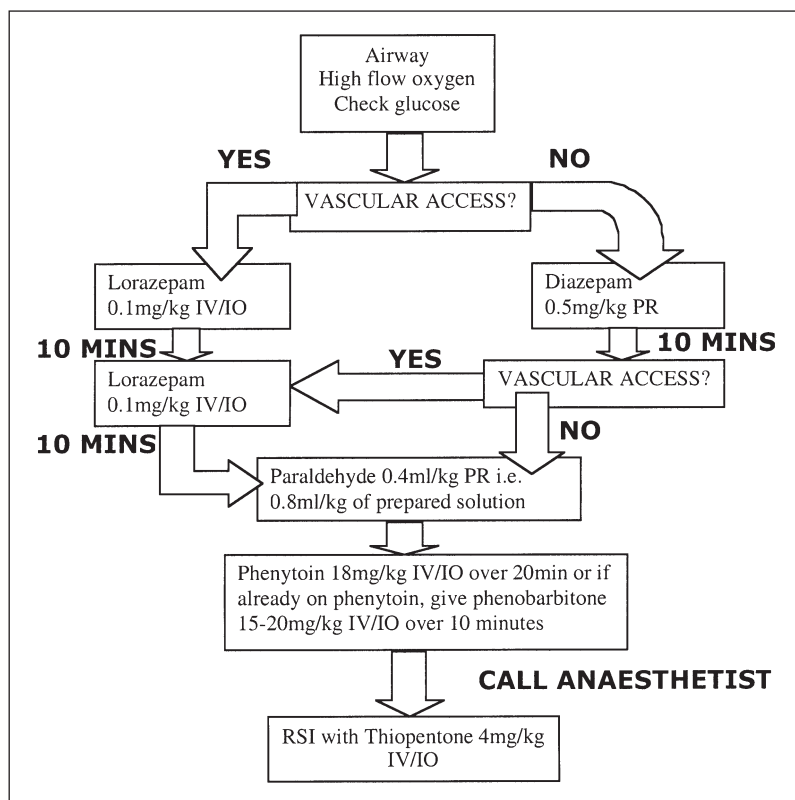


Fig 1. Algorithm for treatment of seizures in children (4).

In any patient presenting with symptoms and signs of meningitis, emergency treatment beyond initial supportive measures should include:

- 100 mg/kg cefotaxime IV (to a maximum of 2g) or 80 mg/kg ceftriaxone IV (to a maximum dose of 4g). Another suitable antibiotic should be used if the patient is cephalosporin allergic.
- Infusion of 20 ml/kg rapid bolus of colloid. This patient is showing signs of shock and has a presumed diagnosis of septicaemia, suggested by his rash. If he did not have a rash, it would be reasonable to use a crystalloid bolus initially.
- Infusion of 5ml/kg of 10% dextrose intravenously if the child's BM is <3mmol/l.
- Consider giving dexamethasone at a dose of 0.15 mg/kg intravenously before or at the same time the initial antibiotic, if *Haemophilus influenzae* is suspected.

A recent Cochrane review (10) looked at the efficacy and safety of adjuvant corticosteroid treatment in children and adults with acute bacterial meningitis and found that their use was associated with decreased case fatalities, decreased severe hearing loss and less long term neurological sequelae. There was a distinct advantage to their use in children with *Haemophilus influenzae* meningitis.

In any patient presenting with symptoms and signs of meningitis, it is important to consider the alternative diagnosis of herpes encephalitis and have a low threshold for giving early anti-viral therapy. Herpes encephalitis has a worse prognosis when treatment is seriously delayed.

Regarding the diagnosis and treatment of bacterial meningitis, the advent of polymerase chain reaction (PCR) testing on blood and CSF has decreased the requirement for lumbar puncture (11). Lumbar puncture is contra-indicated if there are signs of raised intracranial pressure or a reduced conscious level.

Antibiotic choice should be organism dependent with initial treatment based on epidemiological knowledge of the commonest causative organisms for each age

group and on local resistance patterns. Duration of treatment with antibiotics is also dependent upon the organism (11), with *S. pneumoniae* and *H. influenzae* requiring 10 – 14 days of treatment as compared with only 7 days for *N. meningitidis*. *L. monocytogenes* and Group B streptococci require 14 – 21 days and gram negative bacilli require a minimum of 3 weeks of treatment. A broad spectrum cephalosporin, such as cefotaxime or ceftriaxone, is the best empirical choice in children over 3 months of age as this will cover the meningococcus, pneumococcus and *H. influenzae* and has good penetration into the CSF. Ampicillin should be added when treating children less than 3 months old to cover listeria. Once the pathogen and its sensitivities are known, the choice of antibiotic should be modified accordingly.

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