SECTION 12: Management of Paediatric Emergencies (IMEESC 3.2)

Recognition of the seriously ill child

The outcome following cardiac arrest is poor for children. Early recognition and treatment of children presenting with problems affecting respiratory, cardiovascular and CNS function will reduce mortality and morbidity.

This section will focus on recognition and management of the child developing a potentially life threatening condition. It will link with the next section on management of some important conditions. The child with trauma will be covered in a separate section.

The primary assessment ensures that problems with the greatest threat to well being are treated first. The priority is assessment and management of

A – airway
B – breathing
C – circulation
D – disability – which covers conditions affecting the CNS

To be able to evaluate the child, you must be aware of the normal respiratory and heart rates of children at different ages

Age (years)	Heart Rate (bpm)	Systolic BP (mmHg)	Resp rate (/ min)
≤ 1	**110 - 160**	**70 – 90**	**30 - 40**
1 - 2	**100 - 150**	**80 – 95**	**25 - 35**
2 - 5	**95 - 145**	**80 – 100**	**25 - 30**
5 - 12	**80 - 120**	**90 – 110**	**20 - 25**
≥ 12	**60 - 100**	**100 – 120**	**15 - 20**

WHO definitions for tachycardia are: > 160 bpm aged under 1 year and >120 bpm aged 1 to 5 years.

WHO definitions for raised respiratory rates in the child are:

< 2 months fast breathing is > or = 60/minute

2months to 11 months fast breathing is > or = 50/minute

1 to 5 years fast breathing is > or = 40/minute.

Primary Assessment of the Airway (IMEESC 14.3)

If the child is crying or able to talk, then they have a patent airway. The degree of patency can be assessed by

Look

- obvious obstruction to upper airway
- chest and abdominal movements
- drooling of saliva
- posture adopted – e.g. is the neck extended to maximise the airway opening.

Listen

- Noises - coughing or choking sounds
  - Stridor which suggests an upper airway obstruction
  - Air entry

Feel – air movement

If any concerns regarding patency of the airway, use the opening airway techniques and re-assess. Proceed along the lines of basic life support and airway maintenance.

Primary Assessment of Breathing

It is important to check

- Effort of breathing – how hard is the child having to work to breathe; and is the child becoming exhausted
- Efficacy of breathing – is the effort being put in resulting in good air entry and oxygenation
- Effects of inadequate breathing – looking for signs that in spite of the effort being put in, the child is not being adequately oxygenated

Effort of breathing

Be aware of the exhausted child who may show signs of little respiratory effort, but be seriously unwell. Apparent reduction in effort should be accompanied by improvement in the child's condition. If it is not, the child is getting worse, and getting tired. Children with CNS depression and those with neuromuscular problems may not have increased effort of breathing – this does not mean they are recovering.

Respiratory rate

- Too fast suggests either lung / airway disease, or a metabolic acidosis
- Too slow suggests fatigue or respiratory depression usually from a sedative drug like diazepam
- Irregular breathing in an unconscious child suggests raised intracranial pressure

Recession

- More common in younger children, and suggests a serious problem if noted in a child over the age of 6-7 years
- Look for intercostal, subcostal and sternal recession
- The degree of recession is a useful indicator of the severity of the problem

Inspiratory / expiratory noises

- Stridor is usually inspiratory and suggests upper airway narrowing
- Severe obstruction might cause expiratory stridor as well
- Wheeze is usually expiratory and associated with lower airway disease
- In neither stridor nor wheeze is the volume of noise an indicator of the severity of the condition

Grunting

- This means the child is trying to breathe out against a partially closed larynx, to prevent collapse of small airways at the end of expiration
- It is usually heard in infants with stiff lungs and is a sign of severe respiratory distress

Use of accessory muscles

- Head bobbing in infants is an attempt to use the sternomastoid muscles to increase air entry. It is generally ineffective although might be useful in older children when the head bobbing does not occur
- flaring of the nostrils increases the calibre of the nasal airway in infants
- neck extension helps keep the airway straight as to allow ease of air entry
- splinting of the pectoral girdle assists when there is increased stiffness of the lungs

Efficacy of breathing

look chest movements

listen bilateral air entry

a silent chest is a very serious sign

pulse oximetry

useful in almost all cases

unreliable in severe anaemia, shock or carboxyhaemoglobinaemia

Effects of inadequate respiration on other organ systems

Heart rate

- hypoxia leads to tachycardia, as the heart works to increase cardiac output and the amount of oxygen being carried to the organs
- fever, pain and anxiety also cause tachycardia, so this is a non-specific sign. Measuring trends in heart rate is useful
- severe hypoxia leads to an ischaemic heart and brain stem resulting in slowing of the heart rate – this is a very serious sign and can rapidly progress to cardio-respiratory arrest if the hypoxaemia is not effectively treated.

Skin colour

- Hypoxia causes vasoconstriction as the body diverts blood from non-essential areas of the body. This causes pallor.
- Cyanosis is a late sign of hypoxia, and may not be detectable in an anaemic child. Unless chronic and associated with congenital heart disease, it represents a serious life threatening problem that needs urgent treatment.

Central nervous system

- Hypoxia and/or hypercapnia cause agitation and drowsiness
- The change in mental status is difficult to detect in infants
- Failure to interact or recognise parents is a serious sign
- Check AVPU

If there are problems with breathing, provide a high flow of oxygen. It may be necessary to help with ventilation.

Primary Assessment of Circulation

It is important to check

- Cardiovascular status
- Effects of circulatory inadequacy on other organs

Cardiovascular status

Heart rate

- Initially increases in shock as the body tries to maintain cardiac output with a falling stroke volume
- Be sure to be familiar with normal heart rates (above)

Pulse volume

- The quality of the pulse may be helpful; the absence of peripheral pulses and weak central pulses is a sign of serious cardiovascular problems

Capillary refill

- This is measured by pressing over the sternum, or non-dependant periphery (the nail bed is useful in pigmented skin: press on a finger nail), for 5 seconds and then releasing. Normal capillary refill is ≤ 3 seconds
- It is less reliable when the child is cold
- Although not a sensitive or specific sign of shock, it is a useful measure which, taken with other signs, may help in evaluating the response to resuscitation

Blood pressure

- **Systolic BP = 80 + (age in years x 2)**
- Always use the correct sized cuff – the length should be 2/3 the length of the upper arm, and the bladder should go round at least 40% of the arm – but not overlap.
- BP may be maintained despite a loss of up to 50% of the circulating blood volume so is a **late sign which if not treated urgently may progress to cardio-respiratory arrest.**
- Monitoring trends in BP and changes in pulse pressure are useful aides

Effects of circulatory inadequacy on other organ systems

Respiratory system

Tachypnoea and hyperventilation occur in response to metabolic acidosis when the child tries to increase the rate of oxygenation of the blood being circulated.

Skin

Pale, mottled skin indicates under perfusion

Central nervous system

Altered mental status indicate an under-perfused brain

Urine output

< 2ml/kg/hr in infants and <1ml/kg/hr in the older child indicates under perfusion of the kidneys.

If there are signs of circulatory failure, consider giving a fluid bolus of 20ml/kg of 0.9% saline

Primary assessment of disability

Once a respiratory or cardiac cause of altered level of consciousness has been ruled out, it is important to consider the CNS causes. In order to function properly the brain needs

- adequate perfusion with adequately oxygenated blood and this may be compromised by respiratory or cardiovascular inadequacy (as above) or by raised intracranial pressure, causing reduced cerebral perfusion pressure
- intracranial pressure may be raised by
    - increased brain volume e.g. infection, oedema, trauma or tumour

- increased CSF e.g. outflow obstruction
- increased volume of blood e.g. trauma, hypercapnia

- glucose- hypoglycaemia **(less than 2.5 mmol/litre (45mg/dl)** is an important cause of impaired consciousness in children.

CNS function may be compromised by convulsions, drugs, and CNS infections
CNS compromise presents with neurological deficit, and effects the respiratory and cardiovascular systems

Neurological assessment

Conscious level

- A rapid assessment of conscious level can be made by using the AVPU scoring system

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

- Pain should be elicited by sternal pressure or by pulling the frontal hair. A child who **only** responds to pain has a Glasgow Coma score of ≤ 8

Posture

- Many children who are seriously unwell have a degree of hypotonia – particularly infants
- Decerebrate or decorticate postures are ominous signs and may need to be elicited by use of a painful stimulus

Pupils

- Note pupil size, equality and reactivity
- The most important signs are inequality, dilation and unreactivity to light which indicate serious brain disorder
- Many drugs have an impact on the pupils and their effects are symmetrical

Respiratory effects of CNS failure

- Raised intracranial pressure or drugs may cause
  - Hyperventilation
  - Irregular respiratory patterns (Cheynes Stokes) – suggestive of a mid or hind brain problem
  - Slow, sighing respiration
  - Apnoea

Cardiovascular effects

- Hypertension and bradycardia (Cushing's response) are indicative of a life-threatening rise in intracranial pressure and represent the brains efforts to increase cerebral perfusion pressure
- The same signs appear with pressure on the medulla oblongata caused by herniation of the brain through the foramen magnum. This is associated with altered pupillary signs and is **a late sign which if not treated will lead to cardio-respiratory arrest.**

If there is a problem with the CNS, make sure the airway, breathing and circulation problems have been corrected. Always check blood glucose and correct if it is low.

Summary : The Rapid Clinical Assessment of an infant or child

AIRWAY

Look, listen and feel

BREATHING

Effort of breathing
Respiratory rate and pattern
Added noises – stridor / wheeze
Listen to the chest – bilateral air entry
Saturation monitoring
Skin colour

CIRCULATION

Heart rate
Pulse volume
Capillary refill
Skin temperature
BP

DISABILITY

Mental status –
A – ALERT
V – responds to **VOICE**
P – responds to **PAIN**
U – UNRESPONSIVE

Posture
Pupils

On completion of this primary survey, and stabilisation of A, B and C, the next step is to identify the most likely underlying cause of the problem (if you have not already done so) and initiate definitive treatment

The next sections look at some common conditions affecting airway, breathing, circulation and central nervous system

Section 12 Quiz 1

With regard to the interpretation of clinical signs, which of the following statements are true?

a) a heart rate of 90 bpm in a 7 year old would be considered normal
b) a breathing rate of 60 per minute in a 6 month old would be considered normal
c) a breathing rate of 45 per minute in a 3 year old would be considered normal
d) a heart rate of 100 per minute in a 2 year old would be considered normal
e) a breathing rate of 16 per minute in a 14 year old would be considered normal

Section 12 Quiz 2

During the primary assessment of airway and/or breathing which of the following statements are correct?

a) a slow respiratory rate is always reassuring
b) intercostal recession is a particularly serious sign if seen in a 7 year old child
c) the severity of stridor is directly related to the volume of the noise produced
d) pulse oximetry is of little use because of its limitations
e) cyanosis may not be detected in an anaemic child
f) a high flow of oxygen should be provided as soon as a problem with breathing is recognised

Section 12 Quiz 3

During the primary assessment of circulation, which of the following statements are correct?

a) capillary refill can be measured by pressing on the sternum for 2 seconds and then releasing
b) the quality of the peripheral pulse may be a helpful sign
c) blood pressure may be maintained at normal levels when 40% of blood volume has been lost
d) a fast breathing rate may be noticed when the main problem is with circulation
e) a more reliable assessment of circulation can be obtained when all the parameters are considered together rather than in isolation
f) a fluid bolus of 20 ml/kg of 0.9% saline should be given if there are signs of shock

Section 12 Quiz 4

During the primary assessment of disability, which of the following statements are correct?

a) the Glasgow coma score is the fastest way of assessing conscious level
b) it is important to check blood glucose level
c) if the pupils are unequal and unreactive, drugs are likely to be the cause

ANSWERS

1. a,d,e 2. b,e,f 3. b,c,d,e,f 4. b

The Infant or Child with Serious Breathing Difficulties

Once the initial assessment has been completed, attention must be focused on managing the most likely cause of the breathing difficulty.

When dealing with a child with respiratory problems, always perform the primary assessment and manage problems as they arise.

A – always support and protect the airway

B --provide high flow oxygen; assist ventilation if needed

C – give IV fluids if signs of circulatory failure

Whatever the cause of the breathing difficulty, it is important to act when there are signs that the child is getting worse. Some important signs to look for are below

- Increasing recession
- Increasing respiratory rate
- Decreasing respiratory rate in a child who is not improving
- Apnoeic episodes
- Increasing pulse rate or bradycardia
- Fatigue or exhaustion
- Altered mental state
- Cyanosis

There are many causes of breathing difficulties – not all of them are due to a respiratory condition – see table below

Not all of these conditions are discussed in this section of the manual. More detail is in the Basic Life Support section. Only those subjects in **bold type** are discussed here.

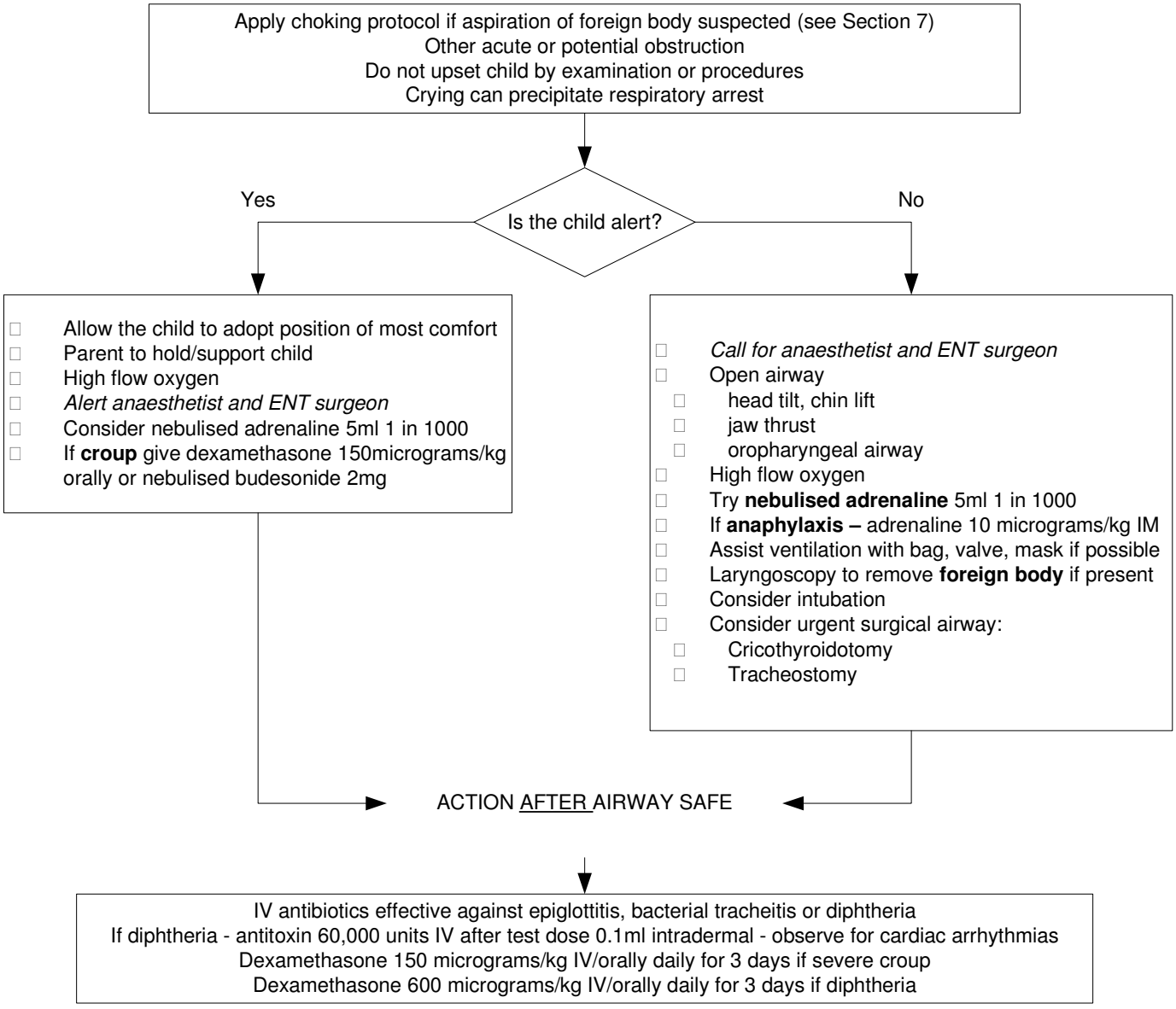
Table – Range of problems that cause breathing difficulties

Breathing difficulties	Causes
Upper airway obstruction	❑ Diphtheria ❑ **Anaphylaxis** ❑ **Croup** ❑ Foreign body (see BLS section) ❑ **Epiglottitis** ❑ Retro-phargyngeal abscess ❑ Anatomical causes
Lower airway obstruction	❑ Tracheitis ❑ **Asthma** ❑ **Bronchiolitis**
Disorders affecting lungs	❑ **Pneumonia** ❑ Pulmonary oedema
Disorders around the lungs	❑ Pneumothorax ❑ Empyema ❑ Rib fractures
Disorders of the respiratory muscles	❑ Neuromuscular
Disorders below the diaphragm	❑ Peritonitis ❑ Abdominal distension
Increased respiratory drive	❑ Diabetic ketoacidosis ❑ Shock ❑ Poisoning (eg salicylates) ❑ Anxiety attack ❑ Hyperventilation
Increased respiratory drive	❑ Diabetic ketoacidosis ❑ Shock ❑ Poisoning (eg salicylates) ❑ Anxiety attack ❑ Hyperventilation
Decreased respiratory drive	❑ Coma ❑ Convulsions ❑ Raised intracranial pressure ❑ Poisoning

Upper airway obstruction

This is potentially life threatening and may be caused by swelling, secretions or foreign material. The smaller the child the more at risk they are because of the small cross sectional area of the airways.

Pathway of Care: Acute Upper Airway Obstruction in Children



Specific topics

Croup

Croup is usually caused by a virus. As with any condition which affects the airway, the patient and family will be frightened. Do not do anything to make this worse. Do not put anything in the child's mouth, or cause pain by repeated attempts at cannulation.

Clinical Features

- Child age 6months – 5 years
- 1 – 3 days coryza
- mild fever < 38.5
- barking cough or hoarseness, worse at night
- inspiratory stridor
- variable respiratory distress
- usually resolve without need for admission

Treatment

- Oxygen if SaO2 < 95%
- In severe cases nebulised adrenaline 5ml 1:1000
- Dexamethasone 0.6 mg/kg PO or IM or equivalent dose of other steroid**

Or

- Budesonide 2mg nebulised
- If concerned re bacterial tracheitis treat with antibiotics (e.g. cefuroxime)
- Intubation may be needed in severe cases

** 1mg prednisilone = 5mg hydrocortisone = 0.15mg dexamethasone

Epiglotittis This is almost always caused by *Haemophilius Influenzae type B* and is very rare in children who have been immunized. Some of the features are similar to croup, but the child is more unwell; the onset is more rapid and cough is not a feature

Comparison of Croup and Epiglotittis		
Feature	**Croup**	**Epiglotittis**
Onset	Over a few days	Over a few hours
Preceding coryza	Yes	No
Cough	Severe, barking	Absent or slight
Able to drink	Yes	No
Drooling saliva	No	Yes
Appearance	Unwell	Toxic, very unwell
Fever	< 38.5	> 38.5
Stridor	Harsh, rasping	Soft
Voice	Hoarse	Muffled, soft voice
Need for intubation	≈ 1%	> 80%

Treatment of Epiglotittis

Calm, reassurance. Do not distress the child
Elective intubation is the best treatment but may be very difficult – consider the need for surgical airway
IV antibiotics only when airway is safe– ceftriaxone or cefotaxime 30mg/kg

Measles

Measles is a highly contagious viral disease with serious complications (such as blindness in children with pre-existing vitamin A deficiency) and high mortality. It is rare in infants under 3 months of age.

Diagnosis

Fever plus a generalized maculopapular rash and one of the following—cough, runny nose, or red eyes. In children with HIV infection, these signs may not be present and the diagnosis of measles may be difficult.

Severe complicated measles

The above plus:

- inability to drink or breastfeed
- vomits everything
- convulsions

On examination, look for signs of late complications after the rash has disappeared, such as:

- lethargy or unconsciousness
- corneal clouding
- deep or extensive mouth ulcers.
- pneumonia
- dehydration from diarrhea
- stridor due to measles croup
- severe malnutrition.

Treatment of severe measles

Children with severe complicated measles require treatment in hospital

Vitamin A therapy. Give oral vitamin A **to all** children with measles unless the child has already had adequate vitamin A treatment for this illness as an outpatient. Give oral vitamin A 50 000 IU (for a child aged <6 months), 100 000 IU (6–11 months) or 200 000 IU (12 months up to 5 years). If the child shows any eye signs of vitamin A deficiency or is severely malnourished, a third dose must be given 2–4 weeks after the second dose.

If the temperature is ≥39 °C (≥102.2 °F) and this is causing the child distress, give paracetamol.

Nutritional support
Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year

Life threatening complications

- Pneumonia
- Diarrhea: treat dehydration, bloody diarrhea or persistent diarrhea
- Measles croup: WHO say do not give steroids: EMCH as with other causes of croup give one dose of steroids
- Eye problems. Conjunctivitis and corneal and retinal damage may occur due to infection, vitamin A deficiency, or harmful local remedies. In addition to giving vitamin A (as above), treat any infection that is present. If there is a clear watery discharge, no treatment is needed. If there is pus discharge, clean the eyes using cotton wool boiled in water, or a clean cloth dipped in clean water. Apply tetracycline eye ointment,

3 times a day for 7 days. Never use steroid ointment. Use a protective eye pad to prevent other infections. If there is no improvement, refer to an eye specialist.

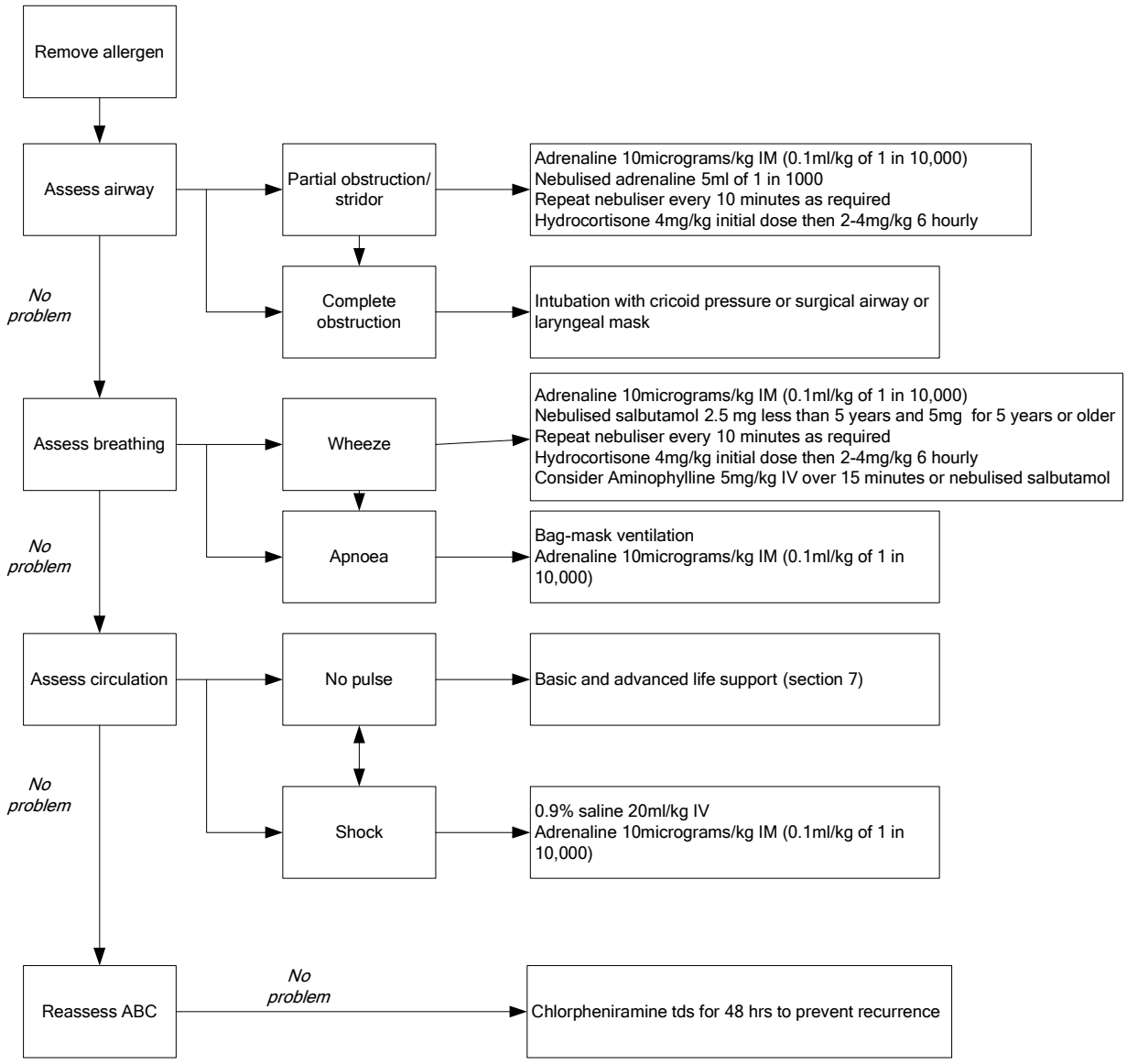
- Mouth ulcers. If the child is able to drink and eat, clean the mouth with clean, salted water (a pinch of salt in a cup of water) at least 4 times a day.
  - — Apply 0.25% gentian violet to the sores in the mouth after cleaning.
  - — If the mouth ulcers are severe and/or smelly, give IM/IV benzylpenicillin (50,000 units/kg every 6 hours (50mg/kg) and oral metronidazole (7.5 mg/kg 3 times a day) for 5 days.
  - — If the mouth sores result in decreased intake of food or fluids, the child may require feeding via a nasogastric tube.
- Neurological complications. Convulsions, excessive sleepiness, drowsiness or coma may be a symptom of encephalitis or severe dehydration.

Anaphylaxis

This is a severe allergic reaction, which may cause respiratory or circulatory problems – or both. The main treatments are IM adrenaline 10micrograms/kg (only given IV / IO if severe shock or cardiac arrest) steroids and IV fluids

Diagnosis
Allergic reaction with respiratory difficulty and / or shock

Pathway of care for Anaphylaxis in a child



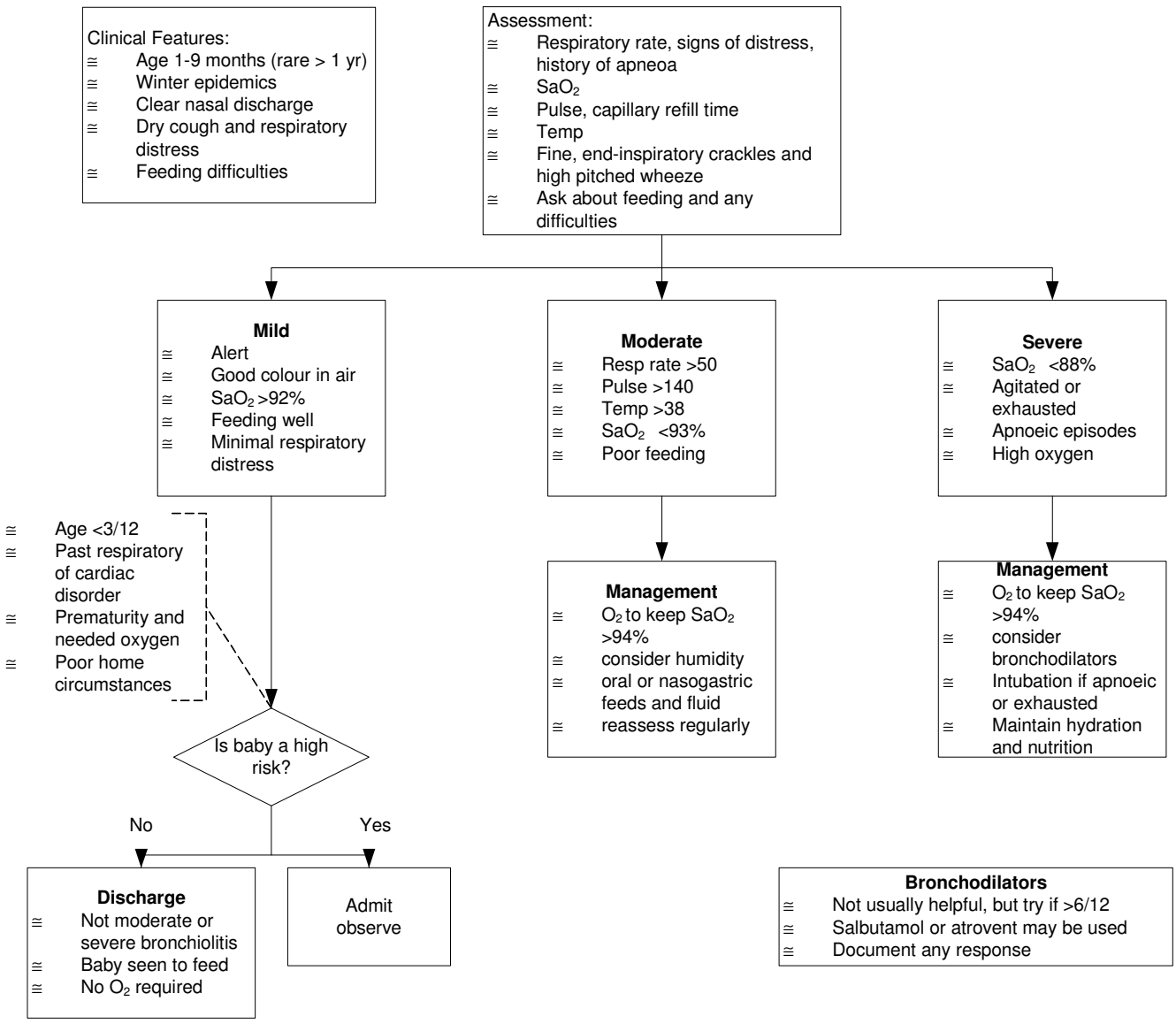
Lower Respiratory Tract infections

Wheeze – The commonest diagnosis is either

- **Bronchiolitis –** in children under 1 year old
- **Asthma** – in older children

Bronchiolitis

Pathway of care for Bronchiolitis



WHO recommends antibiotics for severe cases of bronchiolitis

Severe Asthma

The classic features of acute asthma are cough, wheeze and breathlessness. Any increase in these symptoms, difficulty walking, talking or sleeping, suggests the asthma is getting worse. Worsening asthma is often caused by a viral infection in young children, and by exercise in older children.

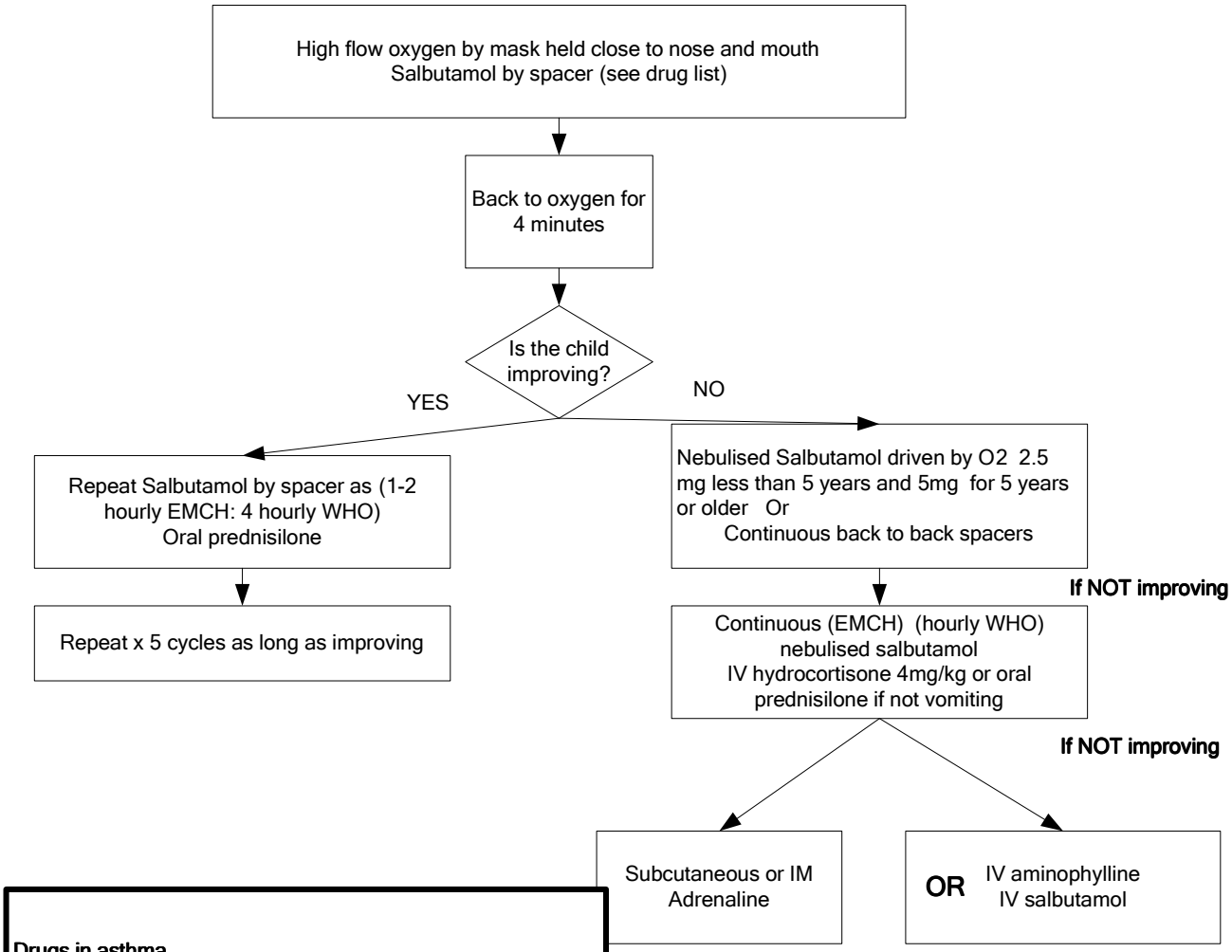
Assessment of severity

When trying to decide how severe an attack is, it is helpful to know how often the child has attacks; how severe they are (e.g. has the child ever been intubated); and what treatment is usually given. The clinical examination helps to decide if the child has moderate or severe/life threatening asthma

Features of severe or life-threatening asthma

- Too breathless to feed or talk
- Marked recession / use of accessory muscles
- Respiratory rate > 50/min
- Pulse rate > 140 / min
- Poor chest movement / silent chest
- SaO2 < 85% or cyanosis
- Depressed level of consciousness / agitation / exhaustion

Pathway of Care for Severe Asthma



Drugs in asthma

Salbutamol
- Spacer 10 x 100 mcg puffs initially then 10 breaths from spacer in 2 minutes (WHO 3 -5 breaths)
- Nebulisers
  - Ø 2.5mg if <5 years old
  - Ø 5mg for ≥ 5 years old
- IV loading 1 month to 2 years 5mcg/kg, 2-18 years 15mcg/kg .
- IV infusion 36-300mcg/kg/hr according to need

Aminophylline
- Loading 5-6mg/kg over 20-60 mins (max dose = 300mg)
- Infusion 1mg/kg/hr

Adrenaline
- 10microgram/kg IM or SC

Steroids
- Hydrocortisone 4 to 8 mg/kg IV (max. 300mg)
- Prednisolone 1mg/kg PO

Omit loading dose of aminophylline if any given in preceding 24 hours
Stop infusion if vomits, HR .180, convulses or headache

Severe Asthma - Indications for intubation and ventilation (if available):

- Increasing exhaustion
- Progressive deterioration in
  - clinical condition
  - oxygenation decreasing and/or oxygen requirement increasing
  - pCO2 increasing (if measurable from arterial/capillary gas)
- Sudden deterioration – and always think about a pneumothorax

Acute lower respiratory tract infection

Always consider that the child might be suffering from TB or HIV infection.
A high fever in a child with breathing difficulties is likely to be due to epiglotittis, bacterial tracheitis or pneumonia. If the airway is clear, the most likely diagnosis is pneumonia. Although high fever and respiratory signs are the usual way for pneumonia to present, it should always be considered in the list of causes of abdominal pain and neck stiffness

Clinical examination (and CXR) cannot reliably tell the difference between a viral and a bacterial pneumonia, so all cases are treated with antibiotics

Features of Pneumonia

- Fever, cough, breathlessness and lethargy following an upper respiratory infection
- Pleuritic chest pain, abdominal pain and neck stiffness indicate pleural involvement
- Signs of consolidation
  - Dull percussion
  - Reduced breath sounds
  - Bronchial breathing

  May be absent in an infant
- CXR may show pleural effusion or empyema as well as consolidation

Treatment

- Oxygen to maintain SaO_2 > 94%
- IV antibiotics
  - Cefotaxime plus either
    - Flucloxacillin

      OR
    - Erythromycin
  - WHO benzyl penicillin and amoxicillin (see below)
- Maintain hydration and replace losses due to high fever
- Do not overload
- CXR is helpful, but not essential

The following section is modified from the WHO Pocket Book of Hospital Care for Children.

CLASSIFICATION OF THE SEVERITY OF PNEUMONIA (WHO)

Sign or symptom	Classification	Treatment
• Central cyanosis • Severe respiratory distress e.g. head nodding, • Not able to drink	Very severe pneumonia	Admit to hospital Give recommended antibiotic Give oxygen Manage the airway Treat high fever if present
Chest in-drawing	Severe pneumonia	Admit to hospital Give recommended antibiotic Manage the airway Treat high fever if present
Fast breathing ≥60 breaths/minute in a child aged <2 months ≥50 breaths/minute in a child aged 2 – 11 months ≥40 breaths/minute in a child aged 1 – 5 years Definite crackles on auscultation	Pneumonia	Home care Give appropriate antibiotic for 5 days Soothe the throat and relieve cough with a safe remedy Advise the mother when to return immediately Follow up in 2 days
No signs of pneumonia or severe or very severe pneumonia	No pneumonia Cough or cold	Home care Soothe the throat and relieve cough with safe remedy Advise the mother to return Follow up in 5 days if not improving If coughing for more than 30 days follow chronic cough instructions

Very severe pneumonia: Diagnosis

Cough or difficult breathing plus at least one of the following:

- central cyanosis
- inability to breastfeed or drink, or vomiting everything
- convulsions, lethargy or unconsciousness
- severe respiratory distress.

In addition, some or all of the other signs of pneumonia or severe pneumonia may be present, such as:

— fast breathing: age <2 months: ≥60/minute
age 2–11 months: ≥50/minute
age 1–5 years: ≥40/minute
— nasal flaring
— grunting (in young infants)
— lower chest wall indrawing
— chest auscultation signs of pneumonia:
— decreased breath sounds
— bronchial breath sounds
— crackles
— abnormal vocal resonance (decreased over a pleural effusion, increased over lobar consolidation)
— pleural rub

If possible, obtain a chest X-ray and SaO2.

Emergency Treatment

Admit the child to hospital

Antibiotic therapy

- Give ampicillin (50 mg/kg IM every 6 hours) and gentamicin (7.5 mg/kg IM once a day) for 5 days; then, if child responds well, complete treatment at home or in hospital with oral amoxicillin (15 mg/kg three times a day (max 500mg, 1g in severe)) plus IM gentamicin once daily for a further 5 days.
- Alternatively, give chloramphenicol (25 mg/kg IM or IV every 8 hours) until the child has improved. Then continue orally 4 times a day for a total course of 10 days. Or use ceftriaxone (80 mg/kg IM or IV once daily).
- If the child does not improve within 48 hours, switch to gentamicin (7.5 mg/kg IM once a day) and cloxacillin (50 mg/kg IM or IV every 6 hours), as described below for staphylococcal pneumonia. When the child improves, continue cloxacillin (or dicloxacillin) orally 4 times a day for a total course of 3 weeks.

Oxygen therapy

Give oxygen to all children with very severe pneumonia
Oxygen if SaO2 < 90% (WHO) or < 94% ESSEMCH until the signs of hypoxia (such as severe lower chest wall in-drawing or breathing rate of ≥70/minute) are no longer present.
Nurses should check every 3 hours that the catheter or prongs are not blocked with mucus and are in the correct place and that all connections are secure.

Supportive care

- If the child has fever (≥39 °C or ≥102.2 °F) which appears to be causing distress, give paracetamol.
- If wheeze is present, give a rapid-acting bronchodilator
- Remove by gentle suction any thick secretions in the throat, which the child cannot clear.
- Ensure daily maintenance fluids appropriate for age but avoid over-hydration.
— Encourage breastfeeding and oral fluids.

— If the child cannot drink, insert a nasogastric tube and give maintenance fluids in frequent small amounts. If the child is taking fluids adequately by mouth, do not use a nasogastric tube as it increases the risk of aspiration pneumonia. If oxygen is given at the same time as nasogastric fluids, pass both tubes through the same nostril.

- Encourage eating as soon as food can be taken.
- Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year

Complications
If not improved after two days, or if condition has worsened, if possible, obtain a chest X-ray.

Staphylococcal pneumonia. This is suggested if there is rapid clinical deterioration despite treatment, by a pneumatocoele or pneumothorax with effusion on chest X-ray, numerous Gram-positive cocci in a smear of sputum, or heavy growth of S. aureus in cultured sputum or empyema fluid. The presence of septic skin pustules supports the diagnosis.

- Treat with cloxacillin (50 mg/kg IM or IV every 6 hours) and gentamicin (7.5 mg/kg IM or IV once a day). When the child improves, continue cloxacillin orally 4 times a day for a total course of 3 weeks. Note that cloxacillin can be substituted by another anti-staphylococcal antibiotic such as oxacillin, flucloxacillin, or dicloxacillin.

Pleural effusion and empyema

Diagnosis
On examination, the chest is dull to percussion and breath sounds are reduced or absent over the affected area.
A pleural rub may be heard at an early stage before the effusion is fully developed.
A chest X-ray shows fluid on one or both sides of the chest.
(An ultrasound examination may be helpful in identifying the size of the effusion and helping to guide drainage ESS-EMCH)
When empyema is present, fever persists despite antibiotic therapy and the pleural fluid is cloudy or frankly purulent.

Treatment

Drainage
Pleural effusions should be drained, unless they are small. If effusions are present on both sides of the chest, drain both. It may be necessary to repeat drainage 2–3 times if fluid returns.

Subsequent management depends on the character of the fluid obtained. Where possible, pleural fluid should be analysed for protein and glucose content, cell count and differential count, and examined after Gram and Ziehl- Neelsen staining, and bacterial and Mycobacterium tuberculosis culture.

Failure to improve
If fever and other signs of illness continue, despite adequate chest drainage and antimicrobial therapy, assess for possible tuberculosis. A trial of antituberculosis therapy may be required

Heart failure

Heart failure causes fast breathing and respiratory distress.

Underlying causes include congenital heart disease (usually in the first months of life), acute rheumatic fever, myocarditis, suppurative pericarditis with constriction, infective endocarditis, acute glomerulonephritis, severe anaemia, very severe pneumonia and severe malnutrition.

Heart failure can be precipitated or worsened by fluid overload, especially when giving salt-containing IV fluids.

Diagnosis

The most common signs of heart failure, on examination, are:

- Tachycardia (heart rate >160/minute in a child under 12 months old; >120/minute in a child aged 12 months to 5 years).
- Gallop rhythm
- Basal crackles on auscultation.
- Enlarged, tender liver.

In infants—fast breathing (or sweating), especially when feeding
In older children oedema of the feet, hands or face, or distended neck veins (raised JVP).

Severe palmar pallor may be present if severe anaemia is the cause of the heart failure.
If the diagnosis is in doubt, a chest X-ray can be taken and will show an enlarged heart.
Measure blood pressure if possible. If raised consider acute glomerulonephritis: microscope urine

Treatment

The main measures for treatment of heart failure in none-severely malnourished children are:
Diuretics. Give frusemide a dose of 1 mg/kg should cause increased urine flow within 2 hours. For faster action, give the drug IV. If the initial dose is not effective, give 2 mg/kg and repeat in 12 hours, if necessary. Thereafter, a single daily dose of 1–2 mg/kg orally is usually sufficient. Maximum is around 40mg per dose, but can give more.
Digoxin.
Supplemental potassium. Supplemental potassium is not required when frusemide is given alone for treatment lasting only a few days. When digoxin and frusemide are given, or if frusemide is given for more than 5 days, give oral potassium (3–5 mmol/kg/day).
Oxygen. Give oxygen if the child has a respiratory rate of ≥70/min, shows signs of respiratory distress, or has central cyanosis or an oxygen saturation of < 94% (EMCH).

Supportive care

• Avoid the use of IV fluids, where possible.
• Support the child in a semi-seated position with head and shoulders elevated and lower limbs dependent.
• Relieve any fever with paracetamol to reduce the cardiac workload.

Section 12 Quiz 5

Which of the following statements are true when considering acute upper airway obstruction in children?

a) upsetting the child can make obstruction much worse
b) expert advice from ENT surgeon and/or anaesthetist should be sought only after diagnosis has been made and specific treatment started
c) nebulised adrenaline may improve symptoms
d) oral or nebulised steroids are indicated for treatment of epiglottis
e) if anaphylaxis is the cause, breathing and circulation problems should be anticipated

Section 12 Quiz 6

When assessing breathing problems in children in their 1st year of life, which of the following statements are true?

a) bronchiolitis is the commonest cause of wheeze
b) management of bronchiolitis includes oxygen to keep SaO_2 > 94%
c) bronchodilators are usually helpful in babies less then 3 months old
d) if the baby has difficulty feeding, naso or orogastric tube nutrition may be needed

ANSWERS

5. a,c,e 6. a, b, d

Section 12 Quiz 7

Features of severe asthma include which of the following?

a) agitation and/or decreased conscious level
b) decreased chest movement and decreased breath sounds
c) cyanosis
d) respiratory rate greater than 50/minute

Section 12 Quiz 8

Which of the following statements about the management of severe asthma are true?

a) salbutamol by spacer or nebuliser
b) oral prednisolone 0.5 mg/kg
c) 5 mg nebulised salbutamol for children aged 1 – 4 years old
d) consideration of pneumothorax if there is a sudden deterioration during treatment

ANSWERS

7. a,b,c,d 8. a, d

Management of the Infant or Child in Shock

Shock is defined as inadequate perfusion of vital organs with adequately oxygenated blood.
Management of shock is focused in two areas

- Resuscitation and support for the circulation, after making sure the airway and breathing are stable and supported
- Treatment of the underlying cause

There are many causes of shock

- Loss of fluid e.g. gastroenteritis; trauma
- Redistribution of fluid e.g. septicaemia; anaphylaxis
- Failure of circulation e.g. cardiac disease; tension pneumothorax

It is often possible to identify the cause of shock with a good history and a careful examination.

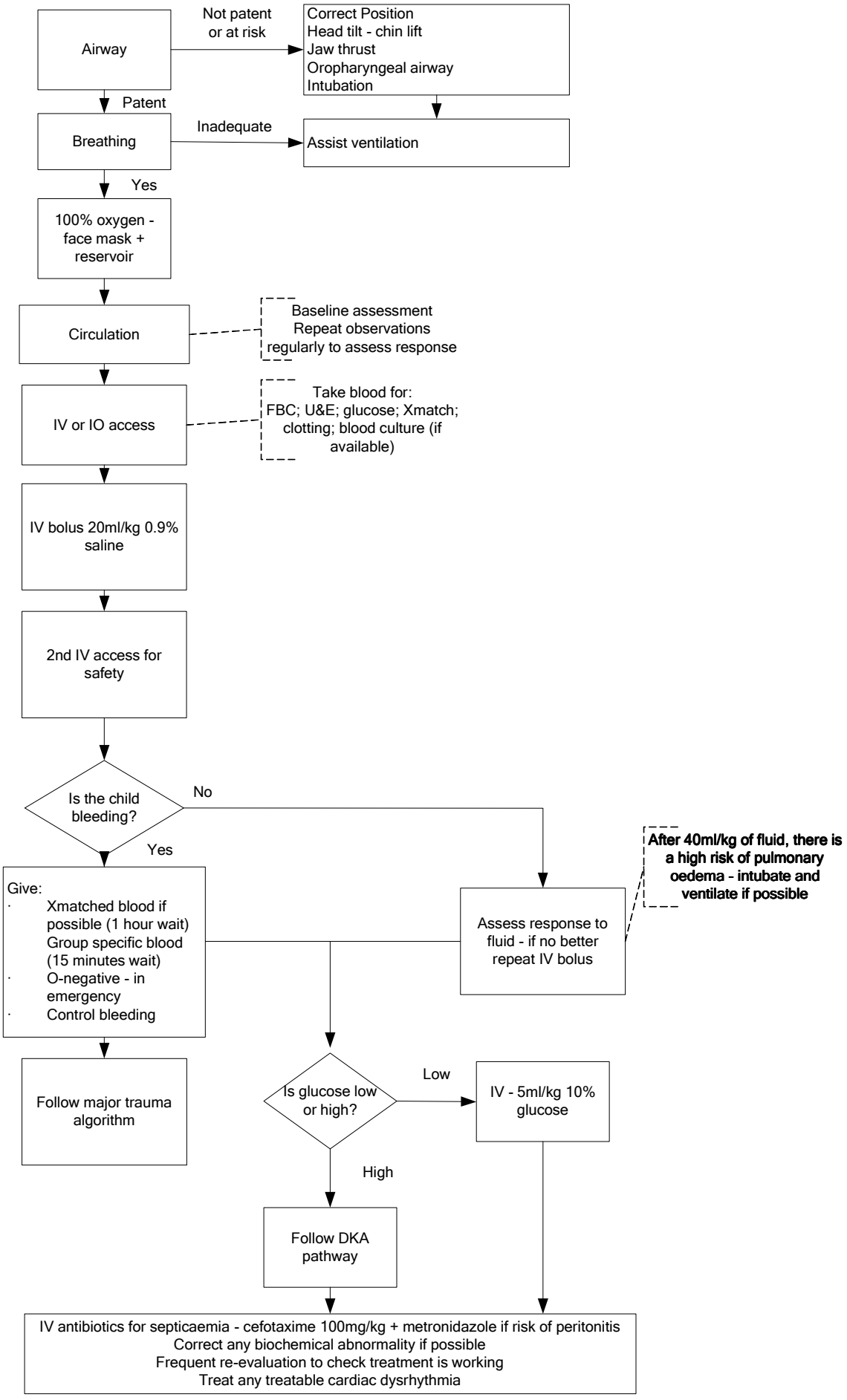
Diagnostic pointers to the cause of shock (those in **bold** will be discussed in detail	
Diarrhoea and / or vomiting	**Gastroenteritis;** volvulus; intussusception
Fever; non-blanching (purpuric) rash	**Septicaemia, Dengue Haemorrhagic Fever**
Urticaria; wheeze; oedema; exposure to allergen	Anaphylaxis
Trauma	Blood loss; tension pneumothorax; internal bleeding
Burns	Fluid loss; blood loss
Baby < 4 weeks old; cyanosis, with no response to oxygen	Congenital heart disease
Very fast pulse; heart failure	**Arrhythmia;** cardiomyopathy
Dehydration, polyuria, polydipsia, high glucose	**Diabetic keto-acidosis**
History of sickle cell disease or diarrhoeal illness and low haemoglobin	Haemolysis with severe anaemia
Pallor, tachycardia, malnutrition	Severe anaemia

The diagnosis and management of shock is complicated by malnutrition, and this will be discussed in a separate section.

Initial Management of Shock

Even though it may be clear on initial inspection that the child is in shock, the first priority will still be the airway, followed by breathing and then management of the circulation.
Intravenous access with short, wide venous cannula, or placement of an intraosseous line (see procedures) is important. It is best to try and get more than one line in case rapid fluid resuscitation is needed. Always take blood for investigations (if available)
FBC; glucose; renal and liver function; blood culture and cross matching

Pathway of Care for the Child in Hypovolaemic/Septic Shock



Specific topics causing shock

The most important thing to do is to stabilise the circulation and maintain perfusion of vital organs. Once this is underway, the cause of the problem needs to be treated.

Dehydration

- Dehydration is loss of water, sodium and other essential electrolytes
- Children are at greater risk because of their higher percentage of total body water
- The most common causes are gastroenteritis and diabetic ketoacidosis
- It is important to also consider surgical causes of dehydration, such as intussusception and volvulus
- Most cases can be managed by simple clinical assessment and treatment
- Most can be treated with oral rehydration solution (ORS) by mouth or NG tube
- In children with severe malnutrition, use a solution with a lower sodium content such as ReSoMal. Care for patients with malnutrition is discussed later.

Dehydration is classified by the percentage of body water lost and is usually only an estimate.

Classification of Dehydration (IMEESC 13.4)

Dehydration is classified according to clinical criteria. This may not apply in severe malnutrition where CARE IS NEEDED

No dehydration <3% wt loss = NO SIGNS!

Some dehydration 3-9% wt loss

Increased thirst, drinks eagerly: dry mucous membranes: loss of skin turgor, tenting when pinched : sunken eyes: sunken fontanel in infants: restless or irritable behavior

Severe dehydration ≥10% wt loss

- More pronounced effects of signs seen in moderate dehydration
- Lack of urine output
- Lack of tears when crying
- Not able to drink or drinks poorly
- Hypovolaemic shock, including:
    - rapid and feeble pulse (radial pulse may be undetectable)
    - low or undetectable BP
    - cool and poorly perfused extremities
    - over sternum decreased capillary refill (> 3s)
    - peripheral cyanosis
- Rapid, deep breathing (from acidosis)
- Altered consciousness or coma
- Lethargy

Emergency treatment of severe dehydration: Principles of treatment

- Recognise and treat shock
  - Give a fluid bolus 20ml/kg 0.9% N/saline IV
  - A second bolus may be needed if the child does not respond well (see the "shock" pathway)
  - It is unusual to need more than this in cases of dehydration due to gastroenteritis – think of other causes. If sepsis is suspected, treat with IV antibiotics
- Decide on the most likely cause of dehydration
- Decide what level of dehydration you are treating (see above)

Calculate the fluid deficit, maintenance needs and on-going losses (see below) When shock has resolved and the patients level of consciousness returns to normal, the remaining estimated deficit MUST BE TAKEN by mouth or by gastric tube especially if severe malnutrition and/or anaemia (danger of large IV fluid volume IV)

- In severe cases, intubation, ventilation, CVP monitoring and inotrope support might be indicated, if these are available
- Check the serum sodium, and if >155mmol/l, reduce it slowly over 48 hrs. Too rapid a reduction in sodium leads to cerebral oedema
- Further tests might include abdominal X-ray or ultrasound, if there is concern regarding a distended abdomen.
- A surgical opinion is needed if bile stained vomiting or abdominal guarding

Calculating Fluid Requirements

WHO Plans A-C for gastroenteritis in children (see Pathway of care) include estimates of total fluid requirements and assume that most children will be drinking by 4 hours into treatment and thus able to "self-regulate". For patients where this is not the case, Fluid Management can be conducted using the following guidelines.

Estimating Fluid requirements

The amount of fluid that the child needs over a 24 hour period needs to be calculated. It is the sum of:

Estimated fluid deficit + maintenance requirements + on-going losses

Deficit

If an accurate recent pre-illness weight is available, subtract current weight to estimate lost fluid (1 kg = 1 litre of fluid)

eg a child who weighed 9.2 kg is seen with diarrhea and weight 8.3kg: estimated fluid loss is [9.2 - 8.3]kg = 0.9kg = 900ml deficit, that is 10% dehydrated

If no recent weight or considered to be unreliable:

decide degree of dehydration

weigh child (or estimate from age as follows: wt(kg) = 2x[age(yrs)+4])

use formula: **% dehydration x weight (kg) x 10 = deficit (in mls)**

eg a child whose weight is estimated as 10 kg is 10% dehydrated:
estimated fluid loss is 10 x 10 x 10 = 1000 mls (40 ml/hour if replaced over 24 hours)

Maintenance

Estimated maintenance fluid requirements based on body weight for a child are:

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

Ongoing losses

for each diarrhea stool	<2 yrs old, give 50-100 ml > 2 yrs old give 100-200 ml
for each vomit	2ml / kg ORS: give small frequent volumes (eg 5ml every minute in a child) via spoon or syringe or cup
For naso-gastric tube aspirates	Replace volume for volume with either ORS or Normal saline with 5 or 10% glucose and 5mmol/litre of potassium chloride OR Hartmanns with 5 or 10% glucose.

Over-hydration

- oedematous (puffy) eyelids may be a sign of over hydration, cardiac failure (as in severe malnutrition) chronic malnutrition or protein losing enteropathy
- cardiac failure (especially in severe malnutrition) chronic malnutrition or protein losing enteropathy
- crepitations at lung bases
- A CXR may be helpful in showing pulmonary plethora or oedema
- stop giving ORS solution, but give breast milk or plain water, and food
- do not give a diuretic unless pulmonary oedema, then give frusemide 1 mg/kg/IV

Pathway for management of gastroenteritis in children

Estimate % loss

None <3%

- Manage at home
- Continue breast feed (frequently or longer at each feed) or diet suitable for their age, even if vomiting
- Frequent sips from cup: if vomits, wait 10 mins then give slowly
- Give extra fluid (as much as will take to prevent dehydration) ORS, food based fluids (soup, rice water, yoghurt) or clean water after each stool (50-100ml up to 2 yrs and 100-200ml after 2 yrs)
- Give extra fluid until diarrhea stops
- Make sure the mother knows to return if the child **becomes sicker, is unable to drink or has blood in the stools**
- Follow up check in 5 days

WHO PLAN A

Moderate 3-9%

- Start ORS straight away (at triage even in queue etc.) MUST be in first 4 HOURS
- Give ORS 75ml/Kg over 4 hours or:

Wt	Age	ORS in first 4 hrs
<6Kg	<4mth	200-400ml
6 to <10Kg	4-12 months	400-700ml
10 to <12Kg	12m to 2 years	700-900ml
12-19 Kg	32– 5 yrs	900-1400ml

- Continue breast feeding if applicable
- Reassess after 4 hours and reclassify dehydration
- If wants more ORS give more: sips from cup or teaspoon every 1-2 minutes
- Use age only if weight not available

WHO PLAN B

Severe ≥ 10%

Signs of severe malnutrition?

No

- If shocked, follow 'Shock Pathway'
- Give ORS and start IV fluids
- Either WHO PLAN C OR

Estimate deficit, maintenance needs and on-going losses

Yes → See later

Deficit in mls

% dehydration x wt (kg) x 10

In 10% dehydration = 100ml/kg

Maintenance

Body wt	Fluid/24hrs	Fluid/hr
1st 10 kg	100ml/kg	4 ml/kg
2nd 10kg	50ml/kg	2 ml/kg
Subsequent kg	20ml/kg	1ml/kg

On-going losses

After each loose stool give extra fluid

- ≤ 2yrs old give 50-100 ml
- > 2 yrs old give 100-200ml

Fluid replacement

- Start IV at once and give 100ml/kg Ringer's lactate or 0.9% saline as follows

Infants < 1 year	30ml/kg in 1 hour	Then 70ml/kg in 5 hrs
Children ≥ 1 year	30ml/kg in 30 mins	Then 70ml/kg in 2.5 hrs

- Repeat once if pulse still very weak
- If available check initial U&E and repeat at 4 hours
- Give ORS as soon as child can drink (about 5ml/kg/hr)
- Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year
- Reassess and re-classify at 3 hrs for child and 6 hours for infant
- If no IV/IO access, give fluid through NGT at 20ml/kg/hr for 6 hours
- Do not discharge patient until oral re-hydration is established

Consider and treat severe hypokalaemia with acidosis

In poorly resourced countries severe hypokalaemia with acidosis is common in severe gastroenteritis (BMJ 2002:324;369-270). Potassium replacement here needs to be at a higher rate than recommended; namely up to 2mmol/Kg per hour and up to a maximum daily requirement of 15mmol/Kg/24 hours. Earlier we suggested the following regime for treating severe hypokalaemia: Initially an IV infusion of 0.5mmol/Kg over 30 minutes followed by an IV infusion of potassium not exceeding 0.5mmol/Kg per hour.

Reassess

ABC

state of intravascular repletion

plasma electrolytes if possible

urine output and urine electrolytes

give fluid according to plan, don't forget ongoing losses

reassess regularly (including biochemistry if possible)

don't forget glucose

Gastroenteritis in Childhood (IMEESC 3.2)

Gastroenteritis is an acute infection of the small bowel leading to diarrhoea, and often vomiting, and is common in children below the age of three years. In 80% of cases it is viral and settles over 3-5 days. Bacterial cases may be associated with prolonged or severe symptoms and a higher fever. Dehydration risk is greatest in infants < 1year old; stool frequency > 8/day; vomiting for > 2 days

Making the diagnosis

Diarrhoea, abdominal discomfort +/- vomiting; headache and fever often present
Alternative diagnoses – especially if vomiting is more prominent than diarrhoea

- Surgical abdomen
  - Intussusception / Appendicitis / Volvulus / Incarcerated hernia
- Medical causes – DKA; pneumonia

Infants and young children are more likely than older children or adults to present with shock due to sudden fluid loss in gastro-enteritis or with **concealed fluid loss secondary to a surgical abdomen such as a volvulus.** This is due both to the infants low physiological reserve and his/her increased susceptibility to these conditions. **Cholera** is also a common cause.

In infants gastroenteritis may occasionally present as a circulatory collapse with little or no significant preceding history of vomiting or diarrhea. The infecting organism can be any of the usual diarrhea pathogens, of which the most common is rotavirus. The mechanism leading to this presentation is that there is a sudden massive loss of fluid from the bowel wall into the gut lumen, causing depletion of the intravascular volume and the appearance of shock in the infant. This occurs before the stool is passed so that the diagnosis may be unsuspected. Usually during resuscitation of these infants, copious watery diarrhea is evacuated.

Management

The two essential elements in management of all children with diarrhea are re-hydration and continued feeding. Do not give any drugs to control diarrhea or vomiting, as they can have

serious side effects, and do not improve hydration or nutritional status. Antibiotics are only used for acute bloody diarrhea or suspected cholera.

Oral Fluids

Recommendations for oral replacement therapy in gastroenteritis are:

- use either low-sodium ORS (containing 40-60 mmol/L of sodium), or
- if unavailable, use ORS containing 75-90 mmol/L of sodium and 75mmol/l of glucose with an additional source of low-sodium fluid (eg breast milk, formula, or clean water)
- encourage the mother to continue breastfeeding her child
- giving high osmolar fluids may contribute to hypernatraemia, whilst giving water alone, or low salt drinks may cause hyponatraemia
- oral glucose within ORS enhances electrolyte and water uptake in the gut
- high sugar drinks (hyper-osmolar) such as coca cola or fruit juices can worsen diarrhea by their osmotic effects.

Intravenous Fluids

- even in patients who are drinking poorly, try to give enteral fluids by mouth or by gastric tube until the IV drip is running
- use Ringer's Lactate or Hartmann's Solution which has Na 131mmol/l; K 5mmol/l; HCO3 29mmol/l; Ca 2mmol/l
- Hartmann's solution has no glucose to prevent hypoglycaemia: this can be corrected by adding 100ml of 50% glucose to 500ml of Hartmann's giving approximately a 10% glucose solution (adding 50ml gives a 5% solution)
- Ringer's Lactate Solution already prepared with 5% dextrose has the added advantage of providing glucose to help prevent hypoglycaemia.
- If Ringer's Lactate or Hartmann's is unavailable, use 0.9% saline. It does not contain a base to correct acidosis and does not replace potassium losses, therefore add 5mmol/litre of Potassium Chloride. Also it does not contain glucose and therefore add 100ml of 50% glucose to 500ml of 0.9% saline to give approximately a 10% glucose solution.
- **do NOT use plain 5% glucose solutions, or 0.18% saline + 4% glucose. They do not contain adequate electrolytes, do not correct the acidosis or hypovolaemia and can produce dangerous hyponatraemia**
- all patients should start to receive some ORS solution (about 5 ml/kg/hour) when they can drink without difficulty, which is usually within 3 - 4 hours (for infants) or 1 - 2 hours (for older children). This provides additional base and potassium, which may not be adequately supplied by the IV fluid. Alternatively give as soon as possible by gastric tube.
- Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year

Management of diarrhea using WHO guidelines

See pathway of care above for plans A and B (no or some dehydration)

Diarrhea with severe dehydration

If no signs of Severe malnutrition: **Plan C treatment:**

While setting up IVI (or Intraosseous if needed), give ORS

Start IV immediately; 100mls/kg of Ringer's lactate or Normal Saline divided as follows:

Age	First give 30ml/Kg in:	then give 70mls/kg in
Infants < 12 months	1 hour *	5 hours
Children 1 to 5 years	30 minutes *	2.5 hours

* Repeat once if pulse is still very weak; reassess every 15-30 minutes until strong radial pulse present:

- then reassess every 1-2 hours – if hydration not improving give IV more rapidly. If available take U&E initially and at 4 hours but don't let this delay your treatment.
- Also give ORS (about 5mls/kg/hour) as soon as the child can drink
- Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year as soon as child can drink
- Reassess and Reclassify
- at 3 hours for child, 6 hours for infant and choose appropriate plan for continued management
- If IV or IO access not possible, and child not able to drink, give ORS by NGT at 20mls/kg/hour for 6 hours, reassessing every 1-2 hours (IV or IO access must be obtained if hydration status not improving)
- If possible, observe the child for at least 6 hours after rehydration to be sure adequate hydration can be maintained orally.

If signs of Severe Malnutrition:

- Remember that dehydration is generally over diagnosed in malnourished children, but that low circulating volume can co-exist with oedema
- Do NOT use IV route for rehydration **except in cases of shock**.
- Standard ORS is not suitable (Sodium to high, Potassium too low); use ReSoMal (can be prepared by adding one 1 litre WHO-ORS packet to 2 litres of water, adding 50g Sucrose and 40 mls of Electrolyte/mineral solution)
- Give ReSoMal PO or NG more slowly than well-nourished child rate:
  - 5mls/kg every 30 minutes for first 2 hours
  - then 5-10 mls/kg/hour for the next 4-10 hours
- Then proceed to starter-F-75 solution (see Malnutrition section)
- Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year
- Monitor every 30 minutes for first 2 hours – be alert to signs of over-hydration (increasing respiratory and pulse rates): stop and reassess after one hour if found

Zinc treatment

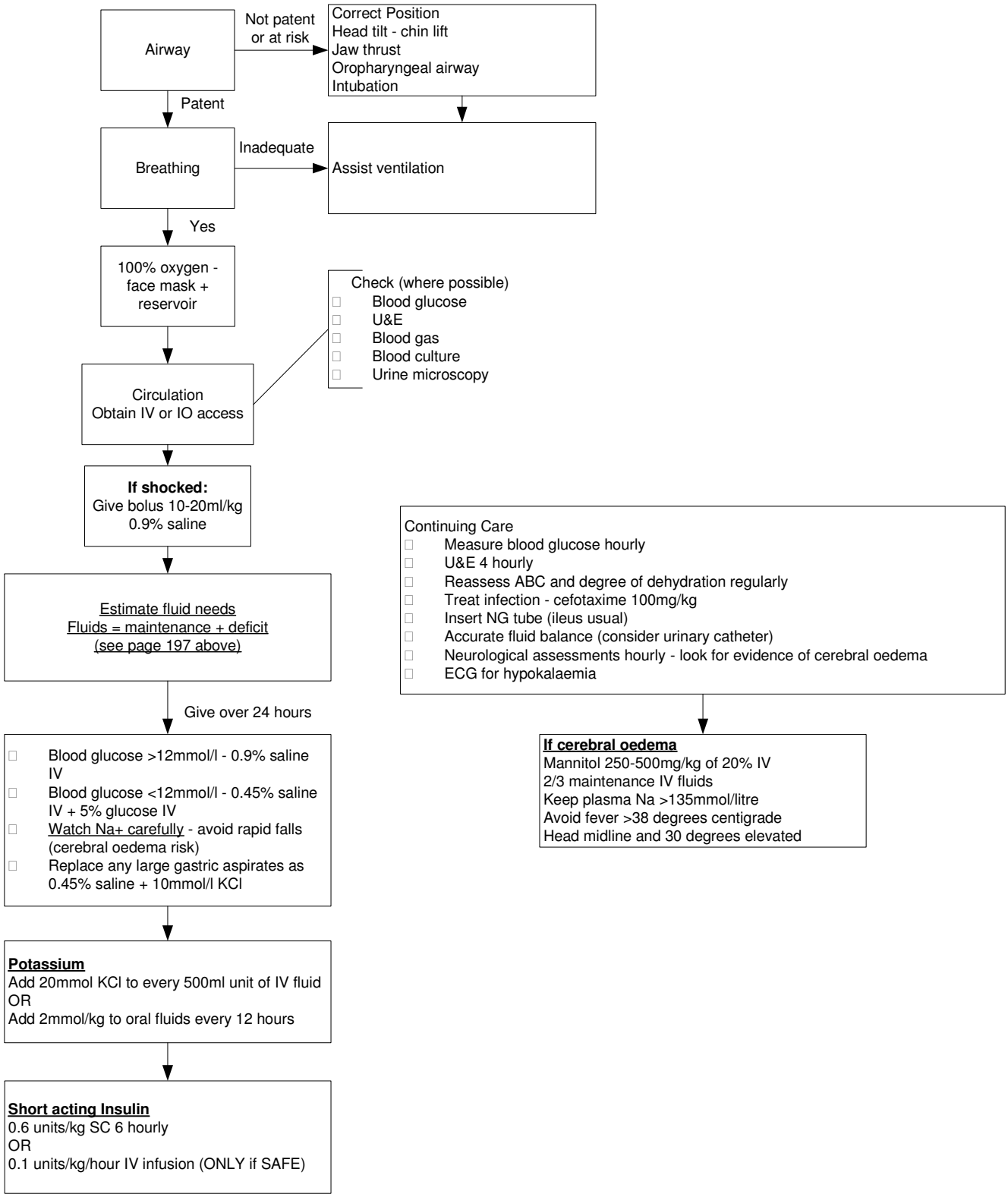
Zinc is an important micronutrient for a child's overall health and development. Zinc is lost in greater quantity during diarrhea. Replacing the lost zinc is important to help the child recover and to keep the child healthy in the coming months. It has been shown that zinc supplements given during an episode of diarrhea reduce the duration and severity of the episode, and lower the incidence of diarrhea in the following 2–3 months. For these reasons, all patients with diarrhea should be given zinc supplements as soon as possible after the diarrhea has started.

Up to 6 months give 1/2 tablet (10 mg) per day
6 months and more give 1 tablet (20 mg) per day for 10–14 days

Diabetic Ketoacidosis (IMEESC 13.8)

DKA is the commonest endocrine emergency and should be suspected in any patient presenting with dehydration, abdominal pain, ketotic breath, altered level of consciousness. The mainstay of treatment is to correct dehydration; reduced blood glucose levels and treat any intercurrent infection. The most serious acute complication of DKA is cerebral oedema (mortality rate 80%) which is thought to be due to over vigorous resuscitation

Pathway of care for DKA



Septicaemia

In septic shock, the cardiac output may be normal or raised, but fail to deliver as much oxygen as the body needs. This is partly due to the changes in small blood vessels which become dilated and leaky, so blood is not distributed normally. In addition, in septic shock, cells do not take up oxygen as effectively.

Features of septic shock
- Fever
- Hyperventilation
- Tachycardia
- Prolonged capillary refill
- Altered mental state

Late signs
- Hypotension
- Irregular or slow pulse or breathing pattern

Meningococcal septicaemia
- Purpuric non-blanching rash
- 7% no rash; 15% blanch
- not always associated with meningitis

Toxic shock syndrome
- high fever, headache, confusion
- red conjunctivae and oral mucosa
- scarletiniform rash+ desquamation
- subcutaneous oedema
- vomiting and watery diarrhoea

Non-typhoidal salmonella
Common in malarial areas

It can be difficult to tell the difference between severe dehydration and septic shock in the malnourished child. Always treat for septic shock.

Resuscitation in septic shock
- Oxygen – consider assisting ventilation if respiratory effort is great, or oxygenation poor
- Fluids – start with 20ml/kg and repeat
- After 40ml/kg, the child will need ventilatory support
- Check glucose and correct hypoglycaemia with 5ml/kg 10% glucose
- Give ceftriaxone 100mg/kg/IV as soon as possible (add ampicillin in neonates) (WHO Benzyl penicillin + chloramphenicol)
- Check and treat any clotting abnormality with vit K, FFP, platelets if available
- Inotropes e.g. dobutamine 5 – 20 mcg/kg/min, or adrenaline 0.05 – 2 mcg/kg/min may be needed and expert advice should be sought
- Correct any fall in potassium or calcium-if possible monitor acid base.

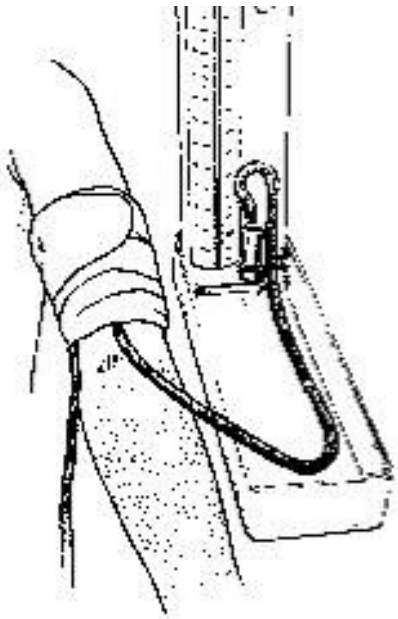
Dengue Haemorrhagic Fever

Dengue fever affects older children and young adults. It is characterised by a biphasic fever with headache, muscle and joint pains, rashes and a low white cell count. It is usually benign but can be incapacitating with severe muscle and joint pain – known as 'break-bone fever'. Occasionally it is associated with severe haemorrhage – Dengue haemorrhagic fever. This is an emergency and can progress to untreatable shock

Management is focused on correcting shock caused by increased vascular permeability, and on treating the bleeding disorder. Fluid losses are monitored by evaluating the cardiovascular status and checking for rising haematocrit and for evidence of pleural effusions and ascites. Clotting disorders are monitored by serial measurement of platelets and APTT if available (or by measuring the whole blood clotting time.

Grading of Severity of Dengue Haemorrhagic Fever		
Grade	**Features**	**Management**
1	Fever; general malaise; positive tourniquet test	Antipyretics; analgesics; oral fluids – avoid NSAIDs
2	Spontaneous bleeding in skin ± other haemorrhage	As above plus IV fluids if needed
3	Evidence of shock; weak pulse, low BP; rising haematocrit	IV fluid resuscitation with 0.9% saline
4	Profound shock with undetectable BP or peripheral pulse	Careful fluid resuscitation with colloid if available. May need blood transfusion and correction of clotting disorder

Treat Dengue fever with shock along the lines of the common care pathway for shock, but be careful not to fluid overload. If fluid overload does occur, treat with frusemide 1mg/kg IV and repeat as necessary.



Tourniquet test in Dengue Haemorrhagic Fever

Apply BP cuff inflated to level of mean arterial pressure (systolic + diastolic, divided by 2). Leave inflated for 5 minutes; a positive test is if there are ≥10 petechiae in 1 sq inch after the cuff is removed

Cardiogenic shock

Causes

- **Abnormal pulse rate or rhythm**
- Congenital cardiac abnormality *(see neonatal section)*
- Cardiomyopathy

Abnormal pulse rate or rhythm - Presentation

- History of palpitations
- Poor feeding
- Heart failure or shock
- Episodes of loss of consciousness

When a child presents in shock or imminent cardiac failure due to an abnormal pulse, the treatment priorities are to secure the airway and breathing, and provide oxygen.
Treatment of the rhythm will depend on a few simple criteria

Most serious diseases or injury states are associated with a sinus tachycardia, which might be as fast as 220 in infants and 180 in children. Sinus tachycardia can be caused by fever, dehydration or blood loss and usually responds to basic resuscitation such as oxygen and fluids.
An abnormally slow rate, bradycardia, is defined as ≤ 60 or a rapidly falling heart rate in a child who is deteriorating. Bradycardia is most commonly a finding that will rapidly lead to cardio-respiratory arrest and is associated with respiratory failure and/or shock. Vigorous resuscitation is required.

Assessment

- Is the child stable or in shock?
- Is the rate too fast or too slow?
- Is the pulse regular or irregular?
- If there is an ECG, are the QRS complexes wide or narrow?
- Is there a non-cardiac cause of the problem?

Emergency treatment

- Airway Secure the airway with simple opening manoeuvres and adjuncts as necessary
- Breathing High flow oxygen. Assisted ventilation will be needed if the child is shocked
- Circulation
  - Heart rate < 60
    - start chest compressions and vigorous resuscitation
    - ensure adequate oxygenation
    - give a bolus of fluid 20ml/kg IV or IO
    - try atropine 20mcg/kg and adrenaline 10mcg/kg
    - if organophosphate poisoning, give atropine 50-100mcg/kg IV or IM
  - If heart rate 150 - 180 (up to 220 in infant) no ECG and no history of cardiac disease or exposure to drugs causing VT, presume the child has SVT.
  - If ECG shows SVT (or no ECG available)
    - Apply vagal manoeuvres (ice pack on face; valsalva; firm carotid massage
    - If shocked and access to defibrillator give 0.5, 1 and 2 joules
    - If not shocked or no defibrillator, give IV adenosine 50mcg/kg; followed by 100mcg/kg and 250mcg/kg as necessary
    - If no adenosine or defibrillator, try digoxin
  - If ECG shows VT and the child is shocked
    - Cardiovert with 0.5, 1 then 2joules/kg as needed
    - If no defibrillator, give amiodarone 5mg/kg over 30 mins
    - If no other options available
      - treat hyperkalaemia with calcium gluconate and glucose plus insulin
      - give magnesium sulfate (25-50mg/kg) over a few minutes
  - If poisoning with Tricyclic antidepressants
    - treat with sodium bicarbonate 1mmol/kg followed by phenytoin 15mg/kg over 15 minutes if no improvement

After Resuscitation and Emergency Treatment

After emergency treatment of shock a search should be made for organ damage so that appropriate treatment may be given and further morbidity avoided. The problems are similar but of a lesser degree than those expected following resuscitation from cardiac arrest. The most important consideration is renal function.

Section 12 Quiz 9

When considering the cause of shock, which of the following symptoms and/or signs may indicate the likely cause?

a) if the heart rate is very high and heart failure is present, an arrhythmia may be the cause
b) if there is fever with a non-blanching rash, the child should be treated for septicaemia
c) if there is diarrhea, gastroenteritis is likely
d) diabetic ketoacidosis should be suspected if the child is dehydrated with a history of polyuria

Section 12 Quiz 10

Which of the following are signs of severe dehydration?

a) loss of weight of 10% or more when compared with pre-illness weight
b) no urine output
c) decreased capillary refill (> 3 seconds)
d) decreased conscious level
e) sunken eyes

Section 12 Quiz 11

When considering gastroenteritis in children which of the following statements are true?

(a) in infants, circulatory collapse is always preceded by significant vomiting and diarrhea
(b) if there is moderate dehydration, ORS can be given prior to full history and examination
(c) if there is severe dehydration, deficit, can be calculated by % dehydration x wt (kg) x 5 in ml and replaced over 24 hours in addition to maintenance requirements and ongoing losses.
(d) patients should be reassessed regularly after initiating treatment and treatment modified if necessary
(e) reassessment should include biochemistry if available

Section 12 Quiz 12

During treatment of diabetic ketoacidosis which of the following statements are true?

a) 0.9% saline should be given IV until blood glucose is <12 mmol/L
b) rapid fall in plasma Na+ levels may lead to cerebral oedema
c) insertion of NG tube is recommended
d) total body potassium is increased so potassium supplements are not needed
e) if short-acting insulin is given subcutaneously, 0.6 units/kg is an appropriate initial dose

Section 12 Quiz 13

Which of the following statements regarding septic shock are true?

a) there is always a low cardiac output
b) a prolonged capillary refill time may occur
c) hypotension is an early sign
d) confusion may occur
e) there are similar features to those of severe dehydration in the malnourished child

Section 12 Quiz 14

Which of the following statements regarding Dengue haemorrhagic fever are true?

a) the accompanying shock is treated in a similar way to the shock of meningococcal sepsis
b) it most often affects children in the first year of life
c) it can lead to ascites
d) it may cause coagulation disorders

ANSWERS

9. a,b,c,d **10.** a,b,c,d,e **11.** a,b,d,e **12.** a,b,c,e **13.** b,d,e **14.** a,c,e

The infant or child with acute renal failure

Introduction

Minimum urine output: >1ml/Kg/hour in children
>2ml/Kg/hour in infants

Types

- **Pre-renal**:
  - insult to renal tubule cells from poor perfusion, usually due to shock. This is most commonly associated with gastroenteritis, but must also be thought about in trauma, burns, sepsis and heart failure.
- **Renal:**
  - usually due to the same problem causing pre-renal failure, but is more serious. Other causes include poisoning by drugs eg gentamicin, end stage glomerular diseases and haemolytic-uraemic syndrome. Prognosis depends on whether only tubule cells are damaged or if glomeruli are involved. If damage is confined to the proximal tubule (the most vulnerable part of the kidney), this causes acute tubular necrosis (ATN). This will recover fully in 2 to 4 weeks if health can be retained during period of renal failure. More severe insults damage to some or all glomeruli as well, which are in renal cortex. Glomerular damage is irreversible, and acute cortical necrosis usually results in chronic or end-stage renal failure. No reliable imaging can differentiate ATN from cortical necrosis.
- **Post renal:**
  - Acute complete obstruction is rare. Causes include a stone obstructing urethra, and in patient with single kidney include a ureteric stone, or a pelviureteric junction narrowing.

Diagnosis and initial management of ARF

	Pre-renal Failure	**Renal Failure**
Urine Na+ mmol/l	<10	>10
Urine osmolality ÷ plasma osmolality	>1.5	<1.5
FENa	<1%	>2% **
Microscopy of Urine	no casts	granular/red cell casts
(**Fractional excretion of sodium is the diagnostic test for discriminating between pre-renal and renal failure)		

Pre-renal acute renal failure

- **Clinical diagnosis** reflects **features of shock**
  - usually low BP. However, BP may be unexpectedly high because of powerful renin drive in response to hypovolaemia.
  - abdominal pain (induced by splanchnic ischaemia as blood flow diverted from gut to more vital organs).

- **Laboratory diagnosis** by measuring fractional excretion of sodium **(FENa).** Measure the sodium and creatinine in a simultaneously obtained sample of urine (by catheter if necessary) and blood.

FENa (%) = U/P sodium x P/U creatinine x 100

- If FENa <1% , renal tubule cells are still alive, and able to respond to shock by reabsorbing sodium which confirms a diagnosis of pre-renal failure. No other tests, including measurements of osmolality, of urinary Na concentration alone, nor urine microscopy can reliably differentiate pre-renal from established renal failure. Ultrasound looks normal or echo-bright.
- **Treatment is by urgent rehydration**. Give 20 ml/kg as rapidly as possible initially, and repeat if necessary. Thereafter give normal (0.9%) saline to fully correct the fluid deficit within 2 to 4 hours. The deficit can be estimated by multiplying the child's weight by the estimated percentage **dehydration**.
- Once rehydration has started give frusemide 2 mg/kg orally or IV.
- If blood pressure remains markedly depressed after rehydration, it may be due to cardiogenic shock; consider inotropes (if available).

Established acute renal failure

- Laboratory diagnosis FENa is typically > 2% because damaged tubules unable to reabsorb sodium avidly.
- Fluid repletion and frusemide will not result in recovery of renal function.
- If FENa not available, give trial of frusemide (2mg/Kg IV) and consider a fluid challenge if evidence of dehydration
- If not dehydrated (or after correction of dehydration) carefully maintain fluid and electrolyte balance and nutrition while waiting/hoping for recovery.
- Dialysis may be needed (if available).
- If recovery not started by 4 weeks, it is unlikely.

Post-renal ARF

- All cause severe acute colicky abdominal pain: unilateral with ureteric obstruction or lower abdominal with bladder neck obstruction.
- Ultrasound, if available, will reveal stones and dilatation proximal to obstruction.
- Remove or bypass the obstruction. For a bladder neck stone obstruction, catheterise. Pain relief with an opiate and a muscle relaxant may allow time for an obstructing stone in the ureter to pass, or for the intermittent blockage from a pelviureteric junction narrowing to clear. If not, stone removed cystoscopically or by ureterolithotomy, or the upper renal tract drained by insertion of a percutaneous nephrostomy under ultrasound guidance. This may require transfer to another centre

Ongoing management of persistent ARF

Good general care:

Meticulous fluid balance:

- Accurately measure all intake and losses. For babies, stool and urine losses estimated by weighing clean and dirty nappies.
- Insensible water losses: (see appendix for table of estimate of body surface area)
  - 300ml/m2/24 hours or
  - 12ml/Kg/24 hours if > 1 year
  - 15ml/Kg/24 hours if an infant
  - 24ml/Kg/24 hours if a preterm infant
- Increased in hot climate by around 50%.
- Best guide is to weigh twice daily.

Adequate nutrition is important but difficult to provide. Aim to

- provide normal calorie intake from carbohydrates and fats
- limit protein intake to about 1 g/kg/day to minimise uraemia.
- Young infants who normally take milk, and children too ill to eat solid food, or with gastrointestinal involvement, will need NG feeding or IV nutrition
- nutrition may have to be delivered in a large fluid volume.
- If there is polyuric renal failure or high non-renal water losses such as from diarrhoea or drain fluids this can be achieved.
- if oligoanuric, it is not possible to give sufficient nutrition without fluid overload leading to hypertension and pulmonary oedema.
- Concentrated fat-based oral feeds can be made up from double cream.
- sophisticated IV fluids with high glucose content and individually adjusted sodium (and bicarbonate) concentrations, tailored to balance losses are usually only available in well resourced settings.

Usually necessary to limit salt intake to prevent sodium retention with hypernatraemia, leading to insatiable thirst, and fluid overload.

Provide some bicarbonate to prevent acidosis, typically at a starting dose of 1 mmol/kg/day sodium bicarbonate (note, 1 ml of an 8.4% sodium bicarbonate solution contains 1 mmol, and 1 g of powder contains 12 mmol)

Dietary potassium must be restricted to avoid hyperkalaemia. Hyperkalaemia causes arrhythmias, especially in ARF where other metabolic changes may exacerbate the risk (for example, hypocalcaemia). Aim to keep plasma potassium < 6.5 mmol/L in an older child and < 7.0 mmol/L in neonates who tolerate hyperkalaemia better.

Dietary phosphate restricted to prevent hyper-phosphataemia. Giving calcium carbonate with the food (eg, 0.5 to 2 grams with each meal) will bind the intestinal phosphate and reduce hyper-phosphataemia as well as improving the tendency to hypocalcaemia.

Blood pressure monitoring and anti-hypertensives may be needed

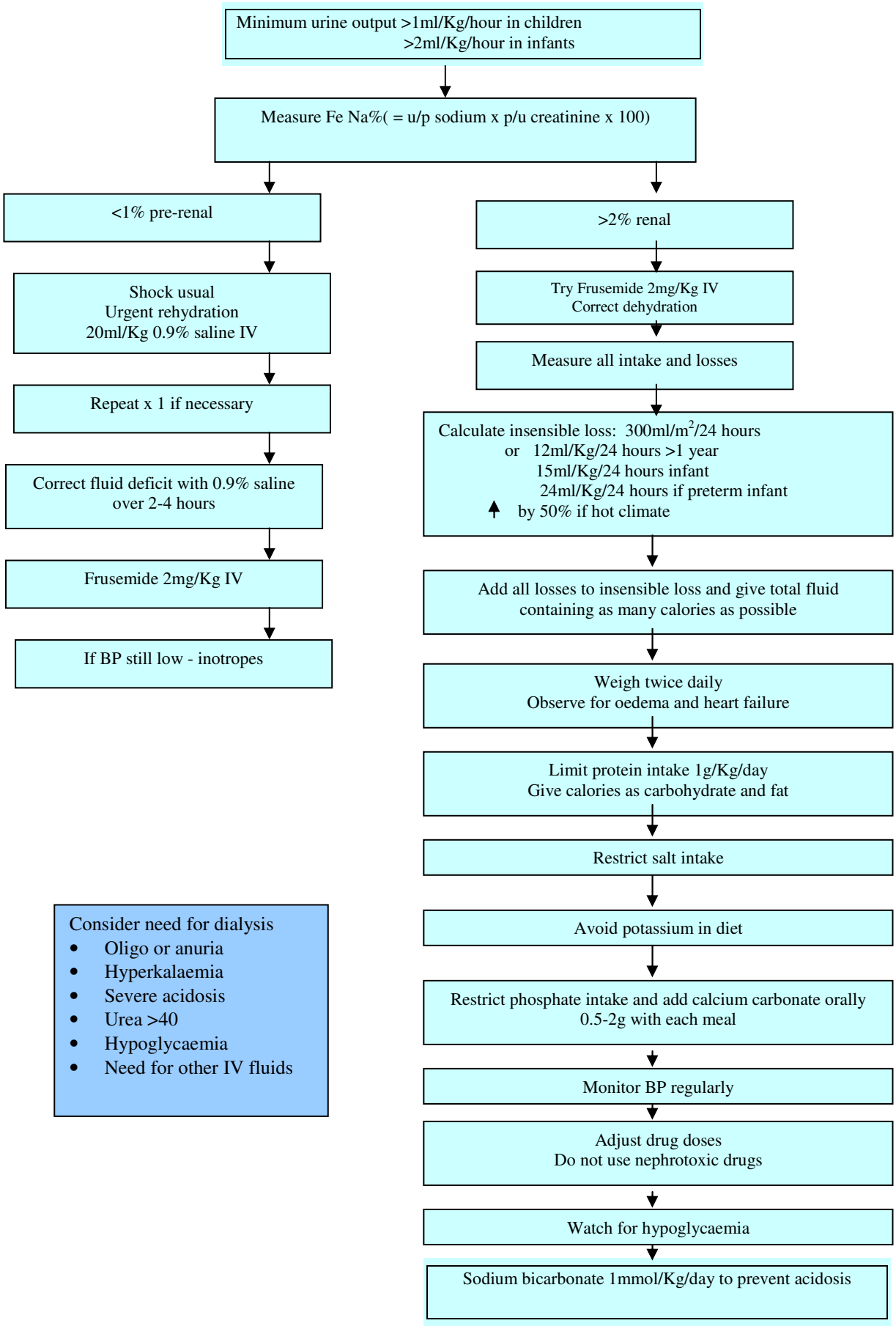
Many drug dosages will need adjustment as they are renally excreted

Peritoneal dialysis

This is indicated if

- oligo-anuria persists
- hyperkalaemia occurs (the commonest indication)
- severe metabolic acidosis. Treatment with sodium bicarbonate is limited because this may lead to massive sodium overload, and hence to dangerous levels of hypernatraemia, and to greater fluid retention.
- hypoglycaemia occurs and needs IV glucose solutions
- other fluids are required such as platelets.
- urea rises > 40 mmol/L causing clinical uraemia

Pathway of care Acute Renal Failure in a child



Section 12 Quiz 15

Which of the following statements are true when considering acute renal failure?

a) minimum urine output for a child is >2ml/kg/hour
b) ultrasound scan, if available, may help diagnose a post renal cause
c) fractional excretion of sodium is the only reliable way of differentiating pre-renal from established renal failure
d) shock may cause pre-renal, renal or post renal failure
e) if recovery from pre-renal or renal failure has not started within 4 weeks, it is unlikely

Section 12 Quiz 16

Which of the following treatments may be helpful in the management of persistent ARF?

a) strict fluid balance management, including insensible losses
b) a protein-limited diet
c) limited sodium and potassium intake
d) phosphate supplement
e) an adjustment to the doses of drugs excreted by the kidneys

ANSWERS

15. b,c,e **16.** a, b,c, e

The Infant or Child in Coma (IMEESC 14.6)

Coma may be the presentation of many illnesses. It is unusual for children to have a structural problem so the cause of coma is most likely to be a diffuse metabolic or infective process, or to be associated with trauma.

In order to function normally, the brain needs an adequate supply of oxygenated blood and glucose. The supply of oxygen might be compromised by problems affecting airway, breathing and circulation. If these are all stable and secure, the problem relates to the brain itself.
For blood to circulate around the brain, the pressure inside the skull – the intracranial pressure (ICP) must be low enough to allow blood to flow.

Causes of coma
- Hypoglycaemia
- **Malaria**
- **Meningitis** (including TB)
- Head injury –see trauma section
- HIV
- **Drugs / poisons**
- **Post convulsion**

Cerebral perfusion pressure (CPP) = mean arterial pressure (MAP) – ICP

Normally for a child < 3 this would be about 60mmHg, and for an older child 70mmHg. By the age of 12, the child has an adult CCP of about 80mmHg.

Primary assessment

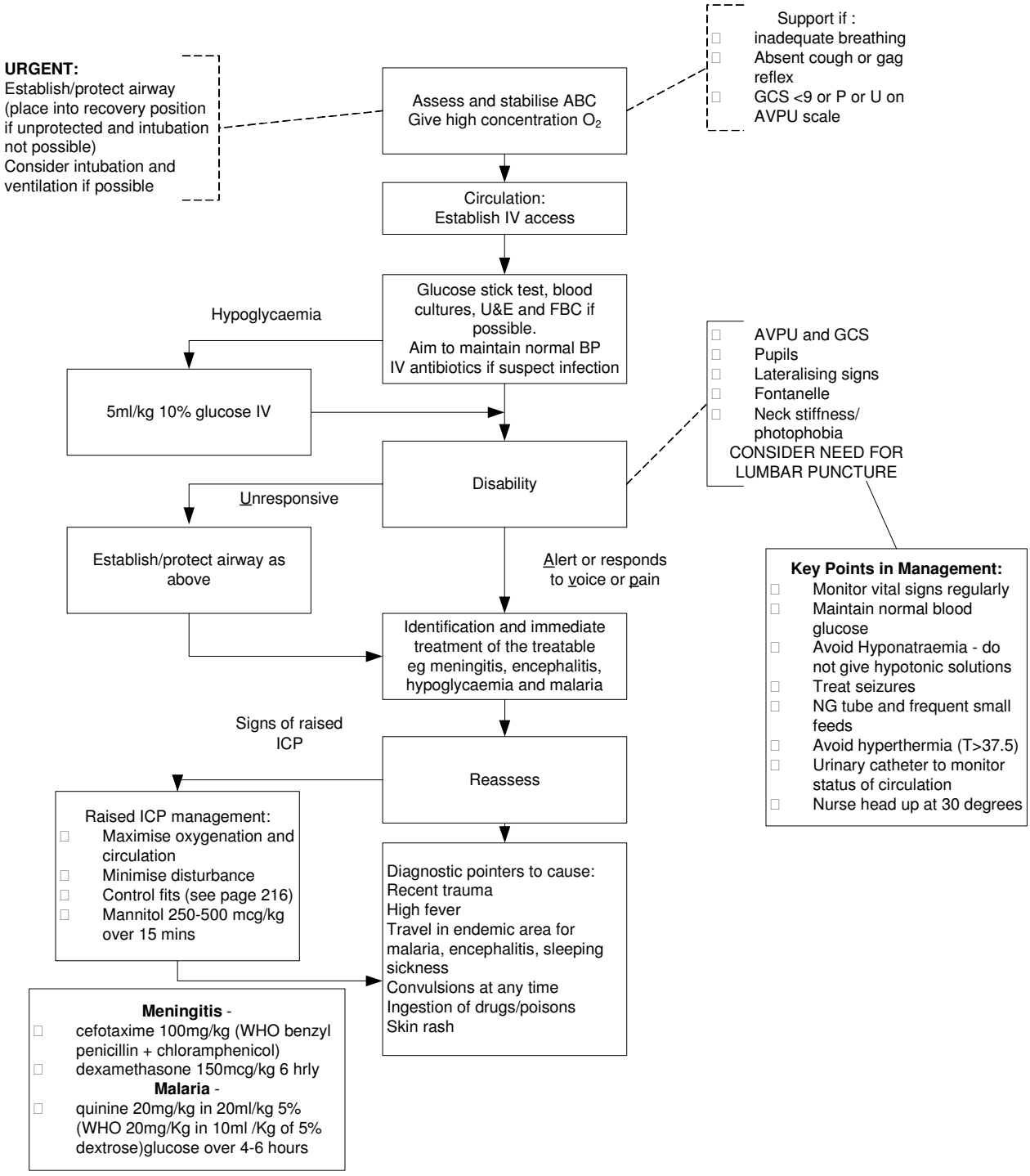
The first steps in managing a child with an altered level of consciousness are to assess and, if necessary, support Airway, Breathing and Circulation.

- **Airway** – this is at risk if the child scores 'P' or 'U' on the AVPU scale
- **Breathing** – this may be the cause of coma, by inadequate oxygenation or increasing CO_2; or be compromised by coma with centrally driven hypoventilation. **MUST HAVE BAG VALVE MASK SYSTEM AVAILABLE AT ALL TIMES WHEN MANAGING A CHILD IN COMA OR WITH REDUCED CONSCIOUS LEVEL**
- **Circulation** – hypotension leads to under-perfusion of the brain. In late stages of raised intracranial pressure, the child becomes hypertensive in an attempt to preserve CPP.
  The body responds by reducing heart rate.
  Hypertension and bradycardia are very serious signs.
- **Disability**
  - Assess using AVPU score
  - Check blood glucose
  - Check pupils for size, equality and reaction to light
  - Palpate fontanel for signs of raised ICP

  A more formal assessment may be made using the Glasgow Coma Scale (GCS)

Pupillary changes	
Pupil size & reactivity	Causes
Small, reactive	Metabolic disorder Medullary lesion
Pin-point	Metabolic disorder Narcotics /orgnophosphates
Fixed, dilated	Hypothermia Hypoxic / ischaemic brain During and post seizure Anticholinergics / barbiturates
One fixed. dilated pupil	Ipsilateral lesion Tentorial; herniation III cranial nerve lesion Epileptic seizure

Pathway of Care for Child in Coma (IMEESC Best Practice Protocol and 13.1 and 13.6)



Specific conditions

1. Meningitis or encephalitis (after the neonatal period)

The three common organisms causing meningitis are

- *Neisseria meningitides* which has a high mortality and morbidity;
- *Haemophilus influenzae* which is much less common in areas with immunisation programmes
- *Streptococcus pneumoniae* which is more commonly seen in disadvantaged countries and in immunocompromised patients
- *Gram negative organisms such as Ecoli* in neonates

Classic signs might be absent in a small child. A bulging fontanel is a clear sign of intracranial infection, but may be masked by associated dehydration. Meningitis is almost always associated with raised ICP, so the symptoms and signs are related to this.

There is a risk of coning if an LP is performed in a child with raised ICP

Diagnosis in a child ≤ 3 yrs old

- Reduced level of consciousness
- Irritability
- Poor feeding or vomiting
- Fever with no apparent cause
- Convulsions with or without fever
- Apnoeic or cyanotic episodes
- Purpuric rash
- Recent head injury

Diagnosis in a child ≥ 4 years old

- Headache or neck pain
- Vomiting
- Neck stiffness
- Opisthotonous
- Photophobia
- Rash
- Altered level of consciousness
- Recent head injury

Early diagnosis is essential for effective treatment.

.

On examination, look for:

- a stiff neck
- repeated convulsions
- lethargy
- irritability
- bulging fontanel
- a petechial rash or purpura
- evidence of head trauma suggesting possibility of a recent skull fracture.

Also, look for any of the following signs of raised intracranial pressure:

- unequal pupils
- rigid posture or posturing
- focal paralysis in any of the limbs or trunk
- irregular breathing

Laboratory investigations

If possible, confirm the diagnosis with a lumbar puncture and examination of the CSF. If the CSF is cloudy, assume meningitis and start treatment while waiting for laboratory

confirmation. Microscopy should indicate the presence of meningitis in the majority of cases with the white cell (polymorph) count above 100/mm3. Confirmatory information can be gained from the CSF glucose (low: <1.5 mmol/litre), CSF protein (high: >0.4 g/litre), and Gram staining and culture of the CSF, where possible.

If there are signs of increased intracranial pressure, the potential value of the information gained from a lumbar puncture should be carefully weighed against the risk of the procedure. If in doubt, it might be better to start treatment for suspected meningitis, and delay performing a lumbar puncture. In general LP is safer in infants where sutures are still open.

Specific causes of meningitis

During a confirmed epidemic of meningococcal meningitis it is not necessary to perform a lumbar puncture on children who have petechial or purpuric signs, which are characteristic of meningococcal infection. During such epidemics, give oily chloramphenicol (100 mg/kg IM as a single dose up to a maximum of 3 grams) for the treatment of meningococcal meningitis. The oily suspension is thick and may be difficult to push through the needle. If this problem is encountered, the dose can be divided into two parts and an injection given into each buttock of the child. This simplified treatment schedule is particularly useful in situations where there are limited resources to deal with the epidemic.

Consider tuberculous meningitis if:

— fever persists for 14 days
— fever persists for more than 7 days and there is a family member with tuberculosis
— a chest X-ray suggests tuberculosis
— the patient remains unconscious
— CSF continues to have moderately high white blood cell counts (typically, <500 white cells per ml, mostly lymphocytes), elevated protein levels (0.8–4 g/l) and low glucose levels (<1.5 mmol/litre).

In children known or suspected to be HIV-positive, tuberculous or cryptococcal meningitis should also be considered. For diagnosis of cryptococcus, do a CSF stain with India ink.

Treatment

If the CSF is obviously cloudy, treat immediately with antibiotics before the results of laboratory CSF examination are available. If the child has signs of meningitis and a lumbar puncture is not possible, treat immediately.

Antibiotic treatment

Give antibiotic treatment as soon as possible. Choose one of the following two regimens:

1. Chloramphenicol: 25 mg/kg IM (or IV) every 6 hours plus ampicillin: 50 mg/kg IM (or IV) every 6 hours
OR
2. Chloramphenicol: 25 mg/kg IM (or IV) every 6 hours plus benzylpenicillin: 60 mg/kg (100 000 units/kg) every 6 hours IM (or IV).

Where there is known significant drug resistance of common pathogens (e.g. Haemophilus influenzae or Pneumococcus) to these antibiotics, follow the national guidelines. In many

circumstances, the most appropriate treatment will be a third-generation cephalosporin such as:
— ceftriaxone: 50 mg/kg IM/IV, over 30–60 minutes every 12 hours; or 100 mg/kg IM/IV, over 30–60 minutes once daily; or 1month-12 years: 50-80mg/kg OD, 12-18 years: 1g, up to 2-4g in severe infections
— cefotaxime: 50 mg/kg IM or IV, every 6 hours.

Review therapy when CSF results are available. If the diagnosis is confirmed, give treatment parenterally for at least 5 days. Once the child has improved, give chloramphenicol orally unless there is concern about oral absorption (e.g. in severely malnourished children or in those with diarrhoea), in which cases the full treatment should be given parenterally. The total duration of treatment is 10 days.

If there is a poor response to treatment:
— Consider the presence of common complications, such as subdural effusions (persistent fever plus focal neurological signs or reduced level of consciousness) or a cerebral abscess. If these are suspected, refer the child to a central hospital with specialized facilities for further management
— Look for other sites of infection which may be the cause of fever, such as cellulitis at injection sites, arthritis, urinary tract infection or osteomyelitis.

-Repeat the lumbar puncture after 3–5 days if the fever is still present and the child's overall condition is not improving, and look for evidence of improvement (e.g. fall in leukocyte count and rise in glucose level).

Consult national tuberculosis programme guidelines if TBM is found or strongly suspected. The optimal treatment regimen, where there is no drug resistance,
comprises:
— isoniazid (10 mg/kg, max 300mg) for 6–9 months; and
— rifampicin (15–20 mg/kg, max 600mg) for 6–9 months; and
— pyrazinamide (35 mg/kg max 2g) for the first 2 months.

Steroid treatment
There is not sufficient evidence to recommend routine use of dexamethasone in all children with bacterial meningitis in poorly resourced countries.

Do not use steroids in:
• newborns
• suspected cerebral malaria
• suspected viral encephalitis
• areas with a high prevalence of penicillin-resistant pneumococcal invasive disease.

Dexamethasone (0.6 mg/kg/day for 2–3 weeks, tailing the dose over a further 2–3 weeks) should be given to all cases of tuberculous meningitis.

Antimalarial treatment

In malarial areas, take a blood smear to check for malaria since cerebral malaria should be considered as a differential diagnosis or co-existing condition. Treat with an antimalarial if malaria is diagnosed. If for any reason a blood smear is not possible, treat presumptively with an antimalarial drug.

Supportive care
Examine all children with convulsions for hyperpyrexia and hypoglycaemia. Treat the hypoglycaemia. Control high fever (≥39 °C or ≥102.2 °F) with paracetamol.

In an unconscious child:
- Maintain a clear airway.
- Nurse the child on the side to avoid aspiration of fluids.
- Turn the patient every 2 hours.
- Do not allow the child to lie in a wet bed.
- Pay attention to pressure points.
- Monitor for signs raised intracranial pressure Give mannitol 250-500mg/kg if deteriorating

Oxygen treatment
Oxygen is not indicated unless the child has convulsions or associated severe pneumonia with hypoxia (SaO2 <90%) (EMCH <94%), or, if you cannot do pulse oximetry, cyanosis, severe lower chest wall in-drawing, respiratory rate of >70/minute.

Fluid and nutritional management
There is no good evidence to support fluid restriction in children with bacterial meningitis. Give them their daily fluid requirement, but not more because of the risk of cerebral oedema. Monitor IV fluids very carefully and examine frequently for signs of fluid overload. Give due attention to acute nutritional support and nutritional rehabilitation. Provide food as soon as it is safe. Breastfeed every 3 hours, if possible, or give milk feeds of 15 ml/kg if the child can swallow. If there is a risk of aspiration, give the sugar solution by nasogastric tube. Continue to monitor the blood glucose level and treat accordingly (as above), if found to be <2.5 mmol/ litre or <45 mg/dl.

Complications

Convulsions
If convulsions occur, ensure hypoglycaemia is not the cause by checking blood glucose and treating hypoglycaemia first or if a glucose test is unavailable by giving IV/IO glucose. If the convulsion does not stop with IV/IO glucose or the stick test shows a normal blood sugar give anticonvulsant treatment.

Hypoglycaemia
Give 5 ml/kg of 10% glucose solution IV or intraosseous rapidly. If IV or IO access is not immediately available give sublingual sugar 1 teaspoon moistened with 1-2 drops of water. (Sublingual sugar appears to be a child-friendly, well-tolerated and effective promising method of raising blood glucose in severely ill children. More frequent repeated doses are needed to prevent relapse. **Children should be monitored for early swallowing which leads to delayed absorption, and in this case another dose of sugar should be given.** Sublingual sugar could be proposed as an immediate "first aid" measure while awaiting intravenous or intraosseous glucose).
If sublingual sugar is given, repeat doses at 20 minute intervals.
Recheck the blood glucose in 20 minutes and if the level is low (<2.5 mmol/litre or <45 mg/dl), repeat the IV/IO glucose (5 ml/kg) or repeat sublingual sugar.

Prevent further hypoglycaemia by feeding; where possible (see above). If you give IV fluids, prevent hypoglycaemia by adding 10 ml of 50% glucose to 90 ml of Ringer's lactate or normal saline. Do not exceed maintenance fluid requirements for the child's weight. If the child develops signs of fluid overload, stop the infusion and repeat the 10% glucose bolus (5 ml/kg) at regular intervals.

2. Malaria

Features

- There are no pathognomic signs; fever in an endemic area is malaria until proven otherwise
- Typical features include high swinging fever, chills, rigors, sweating, myalgia, arthralgia, headache, lethargy, cough, nausea, vomiting and diarrhea
- In infants the only findings may be fever and failure to feed properly (malaria is very rare in < 2/12 old because of the protective effect of HbF)
- Severe disease may cause altered level of consciousness, fits, severe anaemia and jaundice
- Cerebral malaria is associated with raised ICP and rapid onset coma

Malaria may be accompanied by non-typhoid salmonellosis or meningitis

Signs of severe malaria

- Altered conscious level
- Convulsions
- Severe anaemia
- Acidosis
- Hypoglycaemia
- Hyperpyrexia
- Pulmonary oedema) uncommon
- Renal failure) in
- Jaundice) children
- DIC)

Poor prognostic features

- Acidosis
- Hypoglycaemia
- Deep coma
- Repeated convulsions
- Age < 3 years
- Leucocytosis
- Hyperparasitaemia

Cerebral malaria

- Plasmodium falciparum
- Altered level of consciousness
- Commonest cause coma in age 1-5 in endemic areas
- Convulsions, severe anaemia, hypoglycaemia, hyperpyrexia and acidosis are common
- Signs of raised ICP
- Other causes of coma such as meningitis should be sought

Diagnosis

Investigations (if available)	
Investigation	**Findings**
Thick & thin blood films	Thick confirms diagnosis; thin identifies species
FBC and sickle test	Anaemia; sickle disease / trait
Blood glucose	Hypoglycaemia
U&E	Effect of vomiting / diarrhea
Group & save	? need transfusion
Urinalysis	UTI, haemoglobinurea (may cause renal failure)
Lumbar puncture – not if signs of raised ICP. However, if suspect RICP assume meningitis is present and give antibiotics IV.	?meningitis
CXR	? pneumonia / pulmonary oedema
Blood gases	Monitor acid / base status

Management

Airway & Breathing

- Assess and provide support as needed. Protect airway if altered level of consciousness. Consider NGT to prevent aspiration
- High flow oxygen
- Check for acidotic breathing

Circulation

- IV or IO access; if not possible, or risk of fluid overload, use NGT
- Treat hypoglycaemia (less than 2.5 mmol/litre (45mg/dl) with 5ml/kg 10% glucose (via NGT if no IV access)
  - Recheck glucose after 30 mins and repeat if needed
- Treat severe anaemia – Hb < 5g/dl; or haematocrit < 15%; or evidence cardiac failure
  - Packed cells 10ml/kg or whole blood 20ml/kg over 3-4 hours
  - If severely malnourished there is a risk of overload; if occurs treat with frusemide 1-2mg/kg
- If acidosis (or acidotic breathing in absence of blood gas analysis) give extra fluids
- Monitor urine output and aim for 1ml/kg/hr. Rehydrate to maintain output; consider use of frusemide if unable to achieve 4ml/kg/24hrs
- Shock is unusual in malaria – if present treat with fluid bolus 20ml/kg. Take blood cultures and start broad spectrum antibiotics in addition to anti-malarial treatment

Disability

- Treat/prevent hypoglycaemia
- Treat convulsions
- Consider lumbar puncture but avoid if V, P or U on AVPU (GCS <13); signs raised ICP or papilloedema (treat for meningitis as well if these signs are present)
- Consider other causes of coma
- Avoid or treat hyperpyrexia (T > 39, or > 38 if cerebral malaria) – use tepid sponging, fanning and oral / rectal Paracetamol 20mg/kg

Malarial treatment

Weigh the child or estimate weight from known age

For an infant up to 1 year: birth weight doubles by 5 months and triples by 1 year

After 1 year use the following formula: weight (Kg) = 2 (age in years + 4)

If blood smear confirmation of malaria is likely to take more than one hour, start antimalarial treatment before the diagnosis is confirmed. The following drugs can be given:

1. artesunate IV or IM or
2. quinine (IV infusion or divided IM injection) or
3. artemether IM (which should only be used if none of the above alternatives are available as its absorption may be erratic).

1. IV or IM artesunate Give 2.4 mg/kg IV or IM on admission (time 0), followed by 1.2 mg/kg IV or IM after 12 hours, then daily for a minimum of 3 days until the child can take oral treatment

2. IV Quinine Give it preferably IV in 0.9% or 0.45% saline with 5% or 10% glucose; if this is not possible, give it IM. Replace with oral administration as soon as possible. If giving quinine as an IV infusion, hypoglycaemia is more likely when given in N Saline without glucose.

- **IV quinine**. **Never give IV quinine as a bolus as it is very likely to cause cardiac arrest.** Giving IV quinine too rapidly can result in cardiac arrhythmias. Give a loading dose of quinine (20 mg/kg of quinine dihydro chloride salt) in 10 ml/kg of IV fluid over a period of 4 hours.

8 hours after the start of the loading dose, give 10 mg/kg quinine salt in IV fluid over 2 hours, and repeat every 8 hours until the child is able to take oral treatment. Infusion rate must not exceed a total of 5mg quinine salt/kg/hour.

It is essential that the loading dose of IV quinine is given only if there is close nursing supervision of the infusion and control of the infusion rate. If this is not possible, it is safer to give IM quinine.

- **IM quinine.** If IV infusion is not possible, quinine dihydrochloride can be given in the same dosages by IM injection. Give 10 mg of quinine salt per kg IM and repeat after 4 hours. Then, give every 8 hours until the malaria is no longer severe and oral medication is tolerated. The parenteral solution should be diluted before use because it is better absorbed and less painful.

3. IM artemether. Give 3.2 mg/kg IM on the first day, followed by 1.6 mg/kg IM daily for a minimum of 3 days until the child can take oral treatment. Use a 1 ml tuberculin syringe to give the small injection volume. (note absorption may be erratic and therefore only use if quinine and artesunate are not available)

Following parenteral administration, CONTINUED FOR AT LEAST 24 HOURS, the treatment of severe malaria must be completed by giving a full course (7 days) of one of the artemisinin-based combination therapies (ACT) described below or oral quinine 10mg/kg every 8 hours combined with clindamycin to complete 7 days of treatment.

The following ACTs are recommended:
- artemether plus clindamycin
- artemether plus lumefantrine,
- artesunate plus amodiaquine,
- artesunate plus sulfadoxine-pyrimethamine.

- dihydroartemisinin plus piperaquine.

The choice of ACT in a country or region will be based on the level of resistance of the partner medicine in the combination.

Patients with HIV infection who develop malaria should receive prompt, effective antimalarial treatment regimens as recommended above.

Treatment with ACT involving sulfadoxine-pyrimethamine should not be given to HIV-infected patients receiving cotrimoxazole (trimethoprim plus sulfamethoxazole) prophylaxis.

Treatment in HIV-infected patients on zidovudine or efavirenz should, if possible, avoid Amodiaquine-containing ACT regimens.

Give the same doses of antimalarial drugs in patients with severe malnutrition.

Supportive care

Examine all children with convulsions for hyperpyrexia and hypoglycaemia. Treat hypoglycaemia (see below). If a temperature of ≥39 °C (≥102.2 °F) is causing the child distress or discomfort, give paracetamol.

If meningitis is a possible diagnosis and cannot be excluded by a lumbar puncture (see above), give parenteral antibiotics immediately

Avoid useless or harmful ancillary drugs like corticosteroids and other anti-inflammatory drugs, urea, invert glucose, low-molecular dextran, heparin, adrenaline, prostacyclin and cyclosporin.

In an unconscious child:

Maintain a clear airway. Nurse the child on the side to avoid aspiration of fluids. Turn the patient every 2 hours. Do not allow the child to lie in a wet bed. Pay attention to pressure points.

Take the following precautions in the delivery of fluids:

- Check for dehydration and treat appropriately.
- During re-hydration, examine frequently for signs of fluid overload. The most reliable sign is an enlarged liver. Additional signs are gallop rhythm, fine crackles at lung bases and/or fullness of neck veins when upright. Eyelid oedema is a useful sign in infants.
- If, after careful re-hydration, the urine output over 24 hours is less than 4 ml/kg body weight, give IV frusemide, initially at 2 mg/kg body weight. If there is no response, double the dose at hourly intervals to a maximum of 8 mg/kg body weight (given over 15 minutes).
- In children with no dehydration, ensure that they receive their daily fluid requirements but take care not to exceed the recommended limits Be particularly careful in monitoring IV fluids.

Complications

Coma (cerebral malaria)

• Assess the level of consciousness according to the AVPU or another locally used coma scale for children
• Give meticulous nursing care and pay careful attention to the airway, eyes, mucosae, skin and fluid requirements.
• Exclude other treatable causes of coma (e.g. hypoglycaemia, bacterial meningitis). Perform a lumbar puncture **if there are no signs of raised intracranial pressure**. If you cannot do a lumbar puncture and cannot exclude meningitis, give antibiotics as for bacterial meningitis.

Convulsions

These are common before and after the onset of coma. When convulsions are present, give anticonvulsant treatment after first treating for possible hypoglycaemia-see below.
Correct any possible contributing cause such as hypoglycaemia or very high fever. If there are repeated convulsions, give phenobarbital.

Shock

Some children may have a cold, clammy skin. Some of them may be in shock (cold extremities, weak pulse, capillary refill longer than 3 seconds). These features are not usually due to malaria alone. Suspect an additional bacteraemia and give both an anti-malarial and antibiotic treatment, as for septicaemia.

Severe anaemia

This is indicated by severe palmar pallor, often with a fast pulse rate, difficult breathing, confusion or restlessness. Signs of heart failure such as gallop rhythm, enlarged liver and, rarely, pulmonary oedema (fast breathing, fine basal crackles on auscultation) may be present.
Give a **blood transfusion** as soon as possible to:
— all children with a haematocrit of ≤12% or Hb of ≤4 g/dl
— less severely anaemic children (haematocrit >12–15%; Hb 4–5 g/dl) with any of the following:

- — clinically detectable dehydration
- — shock
- — impaired consciousness
- — deep and laboured breathing
- — heart failure
- — very high parasitaemia (>10% of red cells parasitized).

Give packed cells (10 ml/kg body weight), if available, over 3–4 hours in preference to whole blood. If not available, give fresh whole blood (20 ml/ kg body weight) over 3–4 hours.

A diuretic is not usually indicated because many of these children have a low blood volume (hypovolaemia).

Check the respiratory rate and pulse rate every 15 minutes. If one of them rises, transfuse more slowly. If there is any evidence of fluid overload due to the blood transfusion, give IV frusemide (1–2 mg/kg body weight) up to a maximum total of 20 mg.

After the transfusion, if the Hb remains low, repeat the transfusion.
In severely malnourished children, fluid overload is a common and serious complication. Give whole blood (10 ml/kg body weight rather than 20 ml/kg) once only and do not repeat the transfusion.

Hypoglycaemia

Hypoglycaemia (blood glucose: <2.5 mmol/litre or <45 mg/dl) is particularly common in children under 3 years old, in children with convulsions or hyperparasitaemia, and in comatose patients. ***It is easily overlooked because clinical signs may mimic cerebral malaria.***

Give 5 ml/kg of 10% glucose solution IV/IO rapidly. If IV or IO access is not immediately available give sublingual sugar 1 teaspoon moistened with 1-2 drops of water. (Sublingual sugar appears to be a child-friendly, well-tolerated and effective promising method of raising blood glucose in severely ill children. More frequent repeated doses are needed to prevent relapse. **Children should be monitored for early swallowing which leads to delayed absorption, and in this case another dose of sugar should be given.** Sublingual sugar could be proposed as an immediate "first aid" measure while awaiting intravenous or intraosseous glucose).

If sublingual sugar is given repeat doses at 20 minute intervals.

Recheck the blood glucose in 20 minutes, and repeat the glucose (5 ml/kg IV/IO or sublingual sugar) if the level is low (<2.5 mmol/litre or <45 mg/dl).

Prevent further hypoglycaemia in an unconscious child by giving 10% glucose infusion (add 10 ml of 50% glucose to 90 ml of a 5% glucose solution, or 10 ml of 50% glucose to 40 ml of sterile water). Do not exceed maintenance fluid requirements for the child's weight. If the child develops signs of fluid overload, stop the infusion; repeat the 10% glucose (5 ml/kg) at regular intervals.

Once the child is conscious, stop IV treatment. Feed the child as soon as it is possible. Breastfeed every 3 hours, if possible, or give milk feeds of 15 ml/kg if the child can swallow. If not able to feed without risk of aspiration, give sugar solution by nasogastric tube. Continue to monitor the blood glucose level, and treat accordingly (as above) if found to be <2.5 mmol/ litre or <45 mg/dl.

Respiratory distress (acidosis)

This presents with deep, laboured breathing while the chest is clear— sometimes accompanied by lower chest wall in-drawing. It is caused by systemic metabolic acidosis (frequently lactic acidosis) and may develop in a fully conscious child, but more often in children with cerebral malaria or severe anaemia.

Correct reversible causes of acidosis, especially dehydration and severe anaemia.
— If Hb is ≥ 5 g/dl, give 20 ml/kg of normal saline or an isotonic glucose//electrolyte solution IV over 30 minutes.
— If Hb is <5 g/dl, give whole blood (10 ml/kg) over 30 minutes, and a further 10 ml/kg over 1–2 hours without diuretics. Check the respiratory rate and pulse rate every 15 minutes. If either of these shows any rise, transfuse more slowly to avoid precipitating pulmonary oedema

Aspiration pneumonia

Treat aspiration pneumonia immediately because it can be fatal. Place the child on his/her side. Give IM or IV chloramphenicol (25 mg/kg every 8 hours) until the child can take this orally, for a total of 7 days. Give oxygen if the SaO2 is <90% (<94% EMCH), or, if you cannot do pulse oximetry, there is cyanosis, severe lower chest wall in-drawing or a respiratory rate of ≥70/minute.

Monitoring

The child should be checked by nurses at least every 3 hours and by a doctor at least twice a day. The rate of IV infusion should be checked hourly. Children with cold extremities, hypoglycaemia on admission, respiratory distress, and/ or deep coma are at highest risk of death. It is particularly important that these children be kept under very close observation.

Monitor and report immediately any change in the level of consciousness, convulsions, or changes in the child's behaviour.

Monitor the temperature, pulse rate, respiratory rate (and, if possible, blood pressure) every 6 hours, for at least the first 48 hours.

Monitor the blood glucose level every 3 hours until the child is fully conscious.

Check the rate of IV infusion regularly. If available, use a giving chamber with a volume of 100–150 ml. Be very careful about over-infusion of fluids from a 500 ml or 1 litre bottle or bag, especially if the child is not supervised all the time. Partially empty the IV bottle or bag. If the risk of over-infusion cannot be ruled out, re-hydration using a nasogastric tube may be safer.

Keep a careful record of fluid intake (including IV) and output.

Section 12 Quiz 17

Which of the following statements are true in a child with coma?

a) part of the primary assessment includes checking blood glucose
b) the Glasgow coma score is the quickest way of assessing disability
c) compromised airway, breathing or circulation may lead to coma
d) hypertension with bradycardia are serious signs
e) hyponatraemia should be avoided

Section 12 Quiz 18

When considering the causes of coma, which of the following statements are true?

a) malaria is a common cause in a 1 year old child
b) if meningitis is suspected, a lumbar puncture should always be performed before giving IV antibiotics
c) if malaria is suspected, IV quinine can cause cardiac side effects if given too quickly
d) shock is common if malaria is the cause
e) high flow oxygen should be given, whatever the cause.

ANSWERS

17. a,c,d,e **18.** a,c,d,e

Management of the infant or child with convulsion

NEVER FORGET GLUCOSE AND ALWAYS HAVE BAG-VALVE MASK IMMEDIATELY AVAILABLE

Remember, cerebral malaria, meningitis, including TB, HIV, metabolic disorders (more likely with consanguineous marriages) are common cause of convulsions

Introduction

Status epilepticus is defined as either a generalised convulsion lasting > 30 minutes, or repeated convulsions without return of consciousness between fits. It occurs in 1- 5% of patients with epilepsy, and up to 5% of children with febrile convulsions.

Pathophysiology

Injury to the brain during status epilepticus occurs as a result of one, or more, of the following

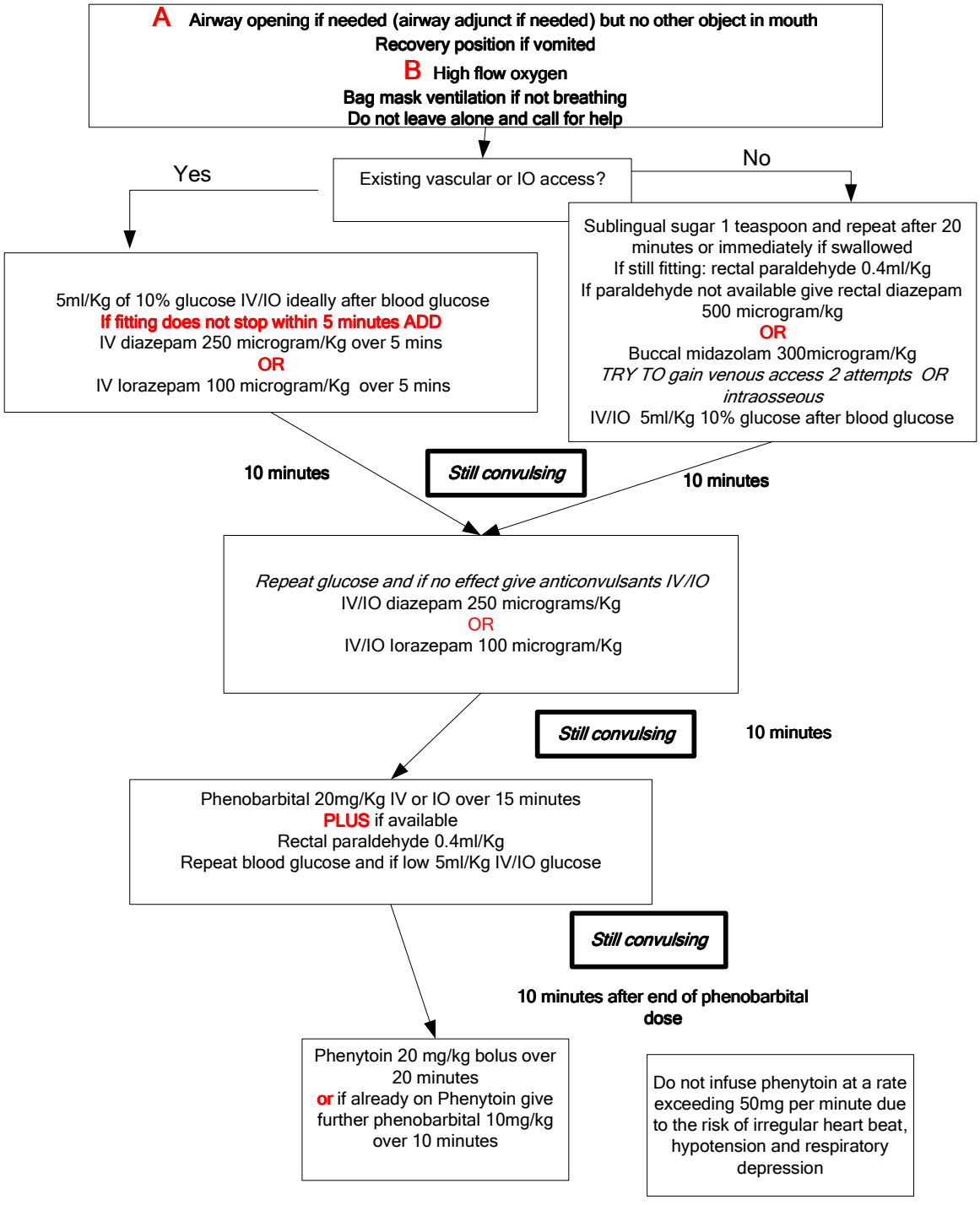
- The underlying disease – malaria, meningitis, trauma
- Systemic complications of the convulsions, especially hypoxia, acidosis and raised intracranial pressure
- Direct injury from repetitive neurone firing

Management

This is focused on terminating the fit, preventing secondary damage from hypoxia or hypo-perfusion of the brain and identifying and treating the most likely underlying cause

Diagnostic pointers	
Fever	suggestive of infection, but also occurs with ecstasy, cocaine and salicylate poisoning
Hypothermia	associated with ingestion of barbiturates or alcohol
Rash	Purpuric suggestive of meningococcal disease
Bruising	Consider trauma, including non-accidental injury or bleeding disorder
Retinal bleed/bruises/fractures	Suggest subdural bleed; consider child abuse
Urinalysis	If available, check for evidence of poisoning or drug ingestion

Pathway of Care Prolonged Fitting [A] in post-neonatal infants and children



NOTES

1). Indications: Still fitting when seen (ETAT) OR If already in hospital where onset of fit is seen and generalised convulsion lasting > 10-15 minutes or repeated convulsions without return of consciousness between fits.

2). Hypoglycaemia is blood glucose <2.5 mmol/l (45mg/dl) if well nourished and < 3.0mmol/l (55mg/dl) if severe malnutrition

3). If blood glucose cannot be measured treat initially as hypoglycaemia.

4). If hypoglycaemia has been present give feed (milk or sugar water) orally or NG when conscious. To make an oral or NG sugar solution dissolve 4 level teaspoons of sugar (20 gram) in 200ml of clean water.

5). Only 0.9% saline can be used to infuse phenytoin. All other IV fluids will cause crystallisation. Flush IV line with 0.9% saline before and after infusing phenytoin. Complete administration within 1 hour of preparation.

6). If IV/IO glucose does stop fitting, repeat blood glucose 30 minutes later and treat if hypoglycaemia

Febrile Convulsions

Definition a seizure in a child aged up to 6 years, caused by fever arising from infection or inflammation outside the central nervous system in a child who is otherwise neurologically normal. Simple febrile convulsions are generalized, tonic-clonic seizures. They usually last < 10 minutes (50% last < 3 minutes). A small proportion (5%) last more than 30 minutes. This is a common condition with an estimated prevalence of 2-4% and there is often a family history. Long term effects are rare.

Management

- Temperature control
  - Paracetamol 20mg/kg and / or ibuprofen 4-10mg/kg
  - Tepid sponging
  - fanning
- Identification of the cause of infection – always check the urine

Any child with a prolonged or focal seizure, or who has not recovered within an hour, should be suspected of having serious pathology.
Although most children rapidly make a good recovery, it is important to have considered other causes of fever and/or convulsions before planning to discharge

Causes of fever ± convulsions

- In an endemic area consider malaria
- Urinary tract infection
- Measles in the un-immunised child
- Meningitis or encephalitis
- Hypoglycaemia
- Metabolic abnormality
- Poisoning

Indications for admission after febrile convulsion

- Age < 18 months unless very clear focus of infection
- Signs of meningitis
- Child is drowsy, irritable or systemically unwell
- Recent or current treatment with antibiotics (partially treated meningitis can be missed)
- Complex convulsion, or delayed recovery
- If there are concerns the child may not be able to get back if deteriorates

If a child is being discharged home, make sure the parents

- understand what has happened
- know what treatment their child is on
- understand the importance of keeping the child's temperature down
- will bring the child back if there is a worsening in their condition

Severe Malnutrition in the Child

In children, there is a high mortality rate associated with malnutrition. This can be reduced a great deal by the delivery of good care.

Clinical evaluation of the severely malnourished child

Nutritional status is assessed according to weight for length/height; height for age; and the presence of oedema. Children who are below –3S.D. or who have oedema of both feet, are severely malnourished (see Table)

Mid upper arm circumference (MUAC) is a good way of identifying wasted children as it is relatively constant between 1 and 5 years of age when a MUAC of less than 12.5cm indicates malnutrition.

Features

- Characterised by oedema or wasting (e.g. of the buttocks), anorexia and infection
- Anaemia is frequently present
- Biochemical abnormalities include : low protein, potassium, urea, magnesium and glucose
- Two overlapping clinical pictures are seen, marasmus and kwashiorkor.

Marasmus

- Affects young children
- Due to lack of calories over many weeks
- Extreme thinness with loss of subcutaneous fat and muscle mass
- Prominent bones and joints
- Sunken eyes
- Often hungry and active
- Weight for length < 70% median

Kwashiorkor

- Acute illness, appears over a few days
- Affects children < 4 yrs old
- Maybe be precipitated by acute illness – measles or diarrhoea
- Involves sodium retention and pitting oedema of peripheries
- Causes dermatosis and desquamation
- Dry, brittle hair
- Child is apathetic and feeds poorly
- Associated with persistent anorexia, diarrhoea and vomiting

Mortality from malnutrition can be reduced by correct early treatment. The common causes of early death are

- Hypoglycaemia
- Hypothermia
- Fluid and electrolyte imbalance – particularly hypokalaemia
- Infections and septic shock
- Failure to correct vitamin and micronutrient deficiencies
- Inappropriate IV fluid treatment, including blood transfusion

Harmful aspects of treatment for severe malnutrition

- Too much energy and protein given during first phase of treatment

- Diuretics given to treat oedema causing hypokalaemia
- Anaemia treated with iron early leading to free radical damage and infections
- Vitamin A and measles vaccine not given
- Albumin or amino acids infused
- High sodium ORS and intravenous fluids administered
- Routine antibiotics not given
- Failure to monitor food intake
- Lack of overnight feeding
- Hypoglycaemia not monitored and treated
- Hypothermia not monitored and treated
- Inadequate staffing and poor organisation of care

Principles of Treatment

Stabilisation phase (up to7 days)	**Transition over 48 hours**	**Catch up growth Phase (usually 14-21 days)**
Treat or prevent dehydration, hypoglycaemia, hypothermia		
Treat infection	Treat worms	
Correct electrolyte imbalance Correct micro-nutrient deficiencies		
Do not give iron	Do not give iron	Correct iron deficiency
DIET Maintenance intake	Moderate intake	High intake
Stimulate child	Stimulate child	Stimulate child
		Provide physical activities Prepare for discharge

- Treat dehydration cautiously
- Prevent hypoglycaemia and hypothermia
- Treat infection, congestive heart failure and severe anaemia
- Correct electrolyte and micronutrient deficiency
- Provide standard maintenance nutrition within first few days of treatment
- Remember potential for sodium overload and cardiac failure
- Remember signs of coincidental sepsis may be hidden

General Treatment

- Keep malnourished separate from patients with infections in a warm room without draughts
- wash minimally, with warm water and dry immediately
- avoid IV cannulae / infusions (unless in shock)
    - high risk of heart failure from fluid overload

  - risk of infection
  - give blood transfusion only when anaemia is life-threatening
  - remove IV cannulae immediately after treatment
- use a nasogastric tube for feeding if:
  - anorexia with intake of <80% prescribed
  - severe dehydration with inability to drink oral fluids
  - painful or severe mouth lesions (herpes, cancrum oris, severe oral/oesophageal thrush)
  - recurrent, frequent vomiting

Principles of therapy

Hypoglycaemia (< 2.5 mmol/litre (45mg/dl)

- Presume present if unable to test
- Treat with 50ml of 10% glucose or 50 ml of drinking water with 10 g of sugar via nasogastric tube or 5 ml/kg 10% glucose IV
- If IV or IO access is not immediately available and patient has reduced level of consciousness or is unconscious give sublingual sugar 1 teaspoon moistened with 1-2 drops of water. (Sublingual sugar appears to be a child-friendly, well-tolerated and effective promising method of raising blood glucose in severely ill children. More frequent repeated doses are needed to prevent relapse. **Children should be monitored for early swallowing which leads to delayed absorption, and in this case another dose of sugar should be given.** Sublingual sugar could be proposed as an immediate "first aid" measure while awaiting intravenous or intraosseous glucose).
- If sublingual sugar is given repeat doses at 20 minute intervals.
- Recheck the blood glucose in 20 minutes, and repeat the glucose (5 ml/kg IV/IO or sublingual sugar) if the level is low (<2.5 mmol/litre or <45 mg/dl).
- Prevention by 2 hourly feeds – day and night

Hypothermia

- Check with low reading thermometer and keep T > 36.5
- Treat with passive re-warming – e.g skin to skin contact with carer
- Prevent by keeping child warm, and dry and away from draughts
- Avoid prolonged medical examinations and washing

Dehydration

- Usually over estimated in malnutrition as reduced skin elasticity and sunken eyes are features of malnutrition
- Features suggestive of dehydration as well as malnutrition are
  - Frequent watery stools
  - Minimal urine output (no urine output for 12 hours or more)
  - Thirst
  - Weak pulse
- Treat with oral re-hydration (only give IV if in shock)
- Standard ORS has too much sodium and too little potassium – use ReSoMal

- Check for fluid overload
    - Liver enlargement; basal creps; raised JVP: rising pulse ± respiratory rate: oedema
- If overloaded, treat with fluid restriction NOT with diuretics

Electrolytes

- Malnourished patients have low potassium and magnesium and high total body sodium
- Treat with oral replacement
    - Potassium 3-4 mmol/kg /day
    - Magnesium 0.5 mmol/kg / day

Infection

- Clinical signs may be absent; suspect if hypoglycaemia or hypothermia
- Treat all with broad spectrum antibiotics – orally if tolerated. If very unwell give IV (Amoxicillin plus gentamicin). Note that doses based on actual body weight might be too low – increase by 10% in severe malnutrition
- Give measles immunisation if not previously immunised
- Treat specific infections –always consider malaria, TB, worms and HIV

Acute severe anaemia

- Transfuse at Hb < 4g/dl, or signs of heart failure and Hb 4-6 g/dl
- Partial exchange transfusion is better than giving whole blood or packed cells
    - Withdraw 2.5ml/kg anaemic blood and replace with 5ml/kg whole blood or packed cells
- If not exchanging, give 10ml/kg packed cells over 3-4 hours, with frusemide 1mg/kg

Congestive heart failure

- Serious and common; occurs several days after treatment started; due to cardiomyopathy secondary to malnutrition
- Often caused by over hydration, excess sodium, over transfusion, inadequate correction of potassium deficit
- Treat with fluid restriction and frusemide 1mg/kg

Micronutrients

- Single oral dose vitamin A on admission, plus daily supplements of zinc, potassium, magnesium and copper.
- Give zinc supplement of 10mg per day (elemental formula) up to 6 months of age and 20mg per day (elemental formula) for children > 1 year
- Folic acid 5mg stat and 1mg/day
- **DO NOT GIVE IRON during first 14 days of treatment**
- If xeropthalmia or measles give 3 doses of vitamin A

Nutrition management

- Start feeding as soon as possible
- Give small frequent meals of low osmolality, low sodium, low lactose and low protein
- Feed throughout the day and night

By careful attention to detail, and maintaining treatment throughout the day and night, severely malnourished children have a better chance of survival.

Section 12 Quiz 19

Which of the following are features of the malnourished child?

a) More than 3 standard deviations below weight for height
b) Mid upper arm circumference less than 12.5 cm in the age group 1 – 5 years
c) Hyponatremia
d) May be hungry and active
e) May be apathetic and reluctant to eat

Section 12 Quiz 20

Which of the following are common causes of death in severe malnutrition?

a) Hypoglycaemia
b) Sepsis
c) Iatrogenic
d) Hypokalaemia
e) Inappropriate blood transfusion

Section 12 Quiz 21

Which of the following are important aspects of treatment in severe malnutrition?

a) Iron supplements should be given early
b) Standard ORS should be given if the child is dehydrated
c) Particular care is needed to prevent hypothermia
d) NG feeding is only needed if there is recurrent vomiting
e) Feeding should continue regularly throughout the night
f) Diuretics are needed if oedema is present
g) Potassium and magnesium supplements may be needed
h) Antibiotics should be avoided unless there are obvious clinical signs of infection
i) If Hb is less than 4g/dL packed cell transfusion with frusemide is the best way of giving blood
j) Measles immunisation should be given if not previously immunised

ANSWERS:

1. abde 2. abcde 3. cdegij