Paediatric Emergencies

For many clinicians the thought of assessing and treating the seriously ill or injured child triggers considerable uncertainty and for good reason. The early features of serious illness or injury in the very young child are easily missed especially by those lacking experience or not afforded the time to undertake a careful assessment or the option of continuing observation.

History and examination are often difficult and incomplete, especially in the very young and may be complicated by the emotional state of the child. Investigations and procedures that are straight forward in the adult, pose a significant challenge in the infant and require a child specific approach. This generally involves the use of topical anaesthesia or procedural sedation to facilitate venesection, intravenous cannulation, repair of wounds, removal of ENT foreign bodies or undertake advanced imaging such as CT head.

While there is overlap with many of the core principles of adult emergency medicine (such as for example the "Primary Survey"), there are numerous areas where the emergency paediatrics differs from adults. These include the "normal range" for vital signs, the susceptibility of the infant to hypoglycaemia, the sudden and rapid deterioration that may occur in a child (once their extraordinary physiological compensatory mechanisms are exceeded), the nature of the pathology seen in a child and the requirement to adjust the dosing of IV fluids and drugs in the child.

The following chapters and resources developed for the LearnEM website have been designed to assist you to develop the knowledge to recognise the subtle signs of serious illness in the young child and become skilled in the diagnosis and treatment of acute paediatric illness and injury.

On-line Resources @ www.learnem.com.au

Clinical case studies, e-tutorials/videos and clinical resources relevant to each of the 11 sections in the ABCDs of Emergency Medicine may be found on the LearnEM website as part of the *EDGE21* course, the *RESP High Risk Emergencies* (Online) Workshop and the 30 specialised *CPD courses*.

The CPD accredited Courses relevant to the topic of Paediatric Emergencies include :

1. ABCDs of Resuscitation
2. ABCDs of the Critically ill Child
3. Paediatric Emergencies in Primary Care

Chapter 43
The Seriously Ill Child

Key Points

1. **In the unwell child, a careful assessment should be made looking for clues to serious illness. It may not always be obvious that a child is seriously ill.**
2. **High risk clinical presentations include high fever, persistent fever, pallor, irritability, lethargy, drowsiness, hypotonia and poor feeding.**
3. **Begin by assessing the airway and looking for respiratory distress. Assess the child for dehydration and circulatory shock. Check the child's BGL and temperature and undress them to assess for rash or injuries.**
4. **Call for assistance if resuscitation is required. Immediate management is focused on ensuring a clear airway, correcting hypoxia, treating shock, and treating threats to the brain from hypoglycaemia and seizures. Commence empiric antibiotics in suspected sepsis.**
5. **Major diagnoses to consider include sepsis, meningitis, acute abdomen, asthma, bronchiolitis, poisoning, seizures, hypoglycaemia, intracranial haemorrhage, non-accidental injury and congenital heart disease.**

Some children are obviously critically ill when they present for care, for example the child who is semi-conscious, fitting, in severe respiratory distress or whose peripheries are pale/mottled and cold to touch. In other children the clinical features of serious illness are harder to detect, subtle or delayed in onset. A careful assessment and a healthy degree of suspicion are essential to avoid missing serious disease in a child.

Recognising the Seriously ill Child

In every child presenting for care a careful assessment should be made looking for clues to serious illness. It may not always be obvious that a child is seriously ill. For example, the baby lying peacefully in the mother's arms may be sleeping contentedly or be moribund and critically ill.

Presentations associated with a high risk of underlying serious illness include :

- Irritable, lethargic, drowsy child
- Persistent fever and / or hyperpyrexia T > 39 degrees
- Pallor
- Altered behaviour
- Poor feeding / Dehydration / Decreased urine output

The greater the number of serious signs and symptoms, the higher the risk of serious illness. One of the most serious combinations is an infant who is drowsy and pale with very a high temperature - think sepsis !

Primary Survey

Always begin assessment in a child with a Primary Survey. Assess the airway and examine the child's breathing. A careful examination is essential to identify the child with respiratory distress. Look particularly for soft tissue indrawing, grunting and nasal flaring.

Feel the child's hands – are they warm or cold ? Assess the pulse and check the capillary refill centrally by pressing for 5 seconds on the sternum or forehead. Assess the child's conscious state and remember to assess the pupils and perform a BGL. Undress the child and look for a rash, bruising or other injuries suspicious for abuse and document the temperature.

Paediatric Primary Survey

Danger - Response - Send for Help

Airway + Haemorrhage

Assessment

Look, Listen, Feel

Look for external bleeding

Look in mouth / check breathing

Listen for obstructive noises

Feel air movement at the lips

Routine Action

Apply High Flow O_2

Limit severe bleeding

Stabilise C-spine if history of major trauma

Breathing

Assessment

Look, Listen, Feel

Look : Resp Rate / Distress

Listen : Auscultate / Percuss

Feel for Trachea midline

Routine Action

Attach Oximetry to monitor O2 saturation

Circulation

Assessment

Begin at hands, work up arm

Assess hands for Colour / Temp

Assess Central Capillary Refill

Pulse Rate, Rhythm, Volume

Check Blood pressure

Routine Action

Obtain vascular access

Collect bloods / Commence IV fluids

Attach ECG and Blood pressure monitoring

Disability

Assessment

Check CNS function

Conscious state (AVPU scale)

Check Pupils : Reaction to light, Size and Equality

Look for limb movement

Routine Action

Check Blood Glucose

DEFDG = Don't ever forget glucose

Exposure

Assessment

Patient environment

Undress patient for examination

Check the child's Temperature

Routine Action

Temperature

Keep child warm

Reassess ABCDs

The Importance of Observation

Perform a routine examination of the chest, ear, nose, and throat (ENT), abdomen and back. Examine the movement of the limbs and joints to avoid missing septic arthritis, osteomyelitis, or occult trauma due to abuse.

During the examination carefully observe the child. Behavioural clues provide a useful tool for identifying serious illness. Consider the following questions

- Is the child normally reactive to you or the parent (s) given their current developmental milestones ?
- Is the child very irritable or excessively lethargic ?
- Do they dislike being handled by their carer, preferring to be left alone ?
- Are they excessively drowsy or difficult to wake up ?
- What posture does the child assume when they are laid on the bed ?
- Do they look non-specifically 'ill' or toxic ?

Look for Abnormal Vital Signs

Carefully check the vital signs as they often provide an important clue to serious illness. As vital signs change during childhood it is important to be aware of the normal for the child's age group. The table on the following page provides a guide to the normal values for vital signs in children.

Identifying the Seriously ill Infant

Of all ages, infants in the first month or two of life are the most difficult to assess. Have a high index of suspicion for serious illness.

When assessing a baby, it is important to ask about alterations to the pattern of the baby's feeding, sleeping, alertness and activity. The parents may provide an extremely good account of how these have changed in the last 24 – 48 hours. Ask specific questions when parents say their baby "is not right" such as "How has your baby's behaviour, feeding, sleeping or responsiveness changed ?" You will find most parents can tell you minute details of how their baby responds "normally" and how this has changed.

Consider serious illness in a baby with any of the following "Red Flags"

- Fever (T > 38 ºC)
- Jaundice
- Increased sleeping
- Poor feeding
- Decreased activity and hypotonia
- Pallor
- Respiratory recession

Determine the baby's fluid intake and output as precisely as you can and measure the babies weight comparing it to previous measurements and percentile charts.

It is important to consider factors that may place the baby at greater risk of illness. These include a history of low birth weight and/or prematurity, frequent hospitalisation, associated comorbidities / chronic illness, and a poor social situation due to social disadvantage, issues with parenting/family or lack of transport.

Paediatric Resuscitation

Preparing to manage the emergency

Resuscitating a child is stressful and requires many hands. The moment it is apparent that a child is unwell a call for assistance should be activated. Move the child to a resuscitation area with monitoring and equipment and drugs for advanced life support.

If there is warning given that a sick child is in transit to the hospital use this time to take a few moments to work out the basic doses and equipment appropriate to the age of the child. (A table with the standard formulae and drug doses is shown below). Where available a standardised chart in the resuscitation room may be helpful. Use the opportunity to prepare staff and allocate roles.

After the child arrives be prepared to use parents constructively as they provide a ready source of knowledge about the child and may be directed to provide reassurance for a frightened child.

Paediatric Resuscitation

Vital Signs in Children

Age	Heart Rate	Resp Rate	Systolic Blood Pressure
< 1 year	110 - 160	30 - 40	60 - 70
1 - 4 years	95 - 140	25 - 30	70 + 2 x age in years
5 - 12 years	80 - 120	20 - 25	70 + 2 x age in years
> 12 years	70 - 100	15 - 20	70 + 2 x age in years

Weight

Estimating Weight in Kg

- Child < 12 months = (Age in months + 9) / 2
- Child 1 - 4 years = 2 x Age (years) + 10
- Child 5 - 14 years = 4 x Age (years)

Airway

LMA #1 < 6.5 kg	LMA #1.5 < 13 kg	LMA #2 < 20 kg
LMA #2.5 < 25 kg	LMA #3 20 – 30 kg	LMA #4 > 30 kg

Endotracheal Tube : Newborn

Full term Newborn : 3.0 - 3.5 Preterm Newborn : 2.5 – 3.0

Endotracheal Tube : Paediatric

Cuffed ETT = age/4 + 3.5 Depth = 3 x ETT size

Cardiac Arrest

Paediatric Arrest

Defibrillation	4J/kg
IV Adrenaline	0.1 ml/kg of 1:10,000 Adrenaline
IV Amiodarone	5 mg/kg

Resuscitation

Paediatric Resuscitation

Fluid Resuscitation	10 ml/kg (repeated if required)
Hypoglycaemia	2 ml/kg 10% Glucose
Anaphylaxis	IM Adrenaline 0.01 ml/kg 1:1000 Adrenaline
Seizures	IM Midazolam 0.15 mg/kg
Analgesia	Intranasal / IV Fentanyl 1 - 2 ug/kg

Intubation

Rapid Sequence Intubation

IV Propofol : 1.5 - 2.5 mg/kg IV Ketamine : 1.5 - 2 mg/kg

IV Rocuronium : 1.2 - 1. 5 mg/kg IV Suxamethonium : 2 mg/kg

Rescue Medication : IV Atropine 20 mcg/kg

IM Induction : IM Ketamine 4 mg/kg + IM Suxamethonium 3 mg/kg

Airway

Begin assessment by checking the child's airway. Look for external signs of upper airway obstruction such as drooling and seesaw breathing. Listen for stridor and other airway noises. In a child who is conscious with airway obstruction, let them adopt a position of maximal comfort – this will usually mean sitting up with the head extended.

If the child is obtunded place the head in the neutral position for infants and in an extended position for older children. In trauma the neck should be kept in a neutral position. The chin lift and jaw thrust manoeuvres are the same as the adult. Only the jaw thrust should be used in trauma. Use a paediatric Yankauer sucker as it has a pressure control point and is smaller. Do not use vigorous blind suction, remove what you can see, not what you can't see.

There are 3 basic airway adjuncts available for managing airway obstruction - the oropharyngeal airway, the nasopharyngeal airway, and the laryngeal mask airway

The *oropharyngeal airway* (OPA) is sized from the centre of the incisor teeth to the angle of the jaw and is inserted convex side up using direct visualisation with a tongue depressor.

The *nasopharyngeal airway* (NPA) is sized, as being equal in diameter to the size of the child's little finger, which usually corresponds to the nostril diameter. It is lubricated first, then inserted directly backwards, parallel to the floor of the hard palate with bevel flat against the septum. Remember to use some form of device (e.g., a safety pin) to ensure it will not be lost down the posterior nasal space.

The *laryngeal mask airway* (LMA) protects the airway and is available in a range of sizes them to be used in all patients, from premature newborns through to adults.

The LMA iGel™ is most recent addition to the LMA range and incorporates a bite block, a gastric access port and has a relatively rigid structure. It is distinguished from other types of LMAs by not having an inflatable cuff. The cuff is made of a gel designed to expand in response to body temperature in the posterior pharynx with the aim of providing an effective seal.

In the absence of airway pathology, the laryngeal mask airway provides an excellent method for managing the airway in a child requiring airway protection and /or assisted ventilation. This is particularly the case with newborn resuscitation and critically ill neonates where endotracheal intubation is associated with significant complications from repeated attempts, hypoxia, intracranial haemorrhage and airway injury. A size #1 LMA may be successfully used in newborns with birth weights as low as 1500g or 34 weeks gestation.

The LMA is contraindicated in the presence of airway pathology such as epiglottitis, deep space infections of the neck, oropharyngeal burns, foreign bodies, or anaphylaxis with glottic oedema. In these circumstances endotracheal intubation is required and should be performed by a clinician skilled in paediatric intubation.

Paediatric Intubation[1]

As a rule, children when compared to adults, are easier to ventilate using a bag and mask but are more challenging to intubate. Children have a large tongue and a high anterior larynx, and these make visualisation of the vocal cords more difficult increasing the risk for failed intubation or intubation of the oesophagus.

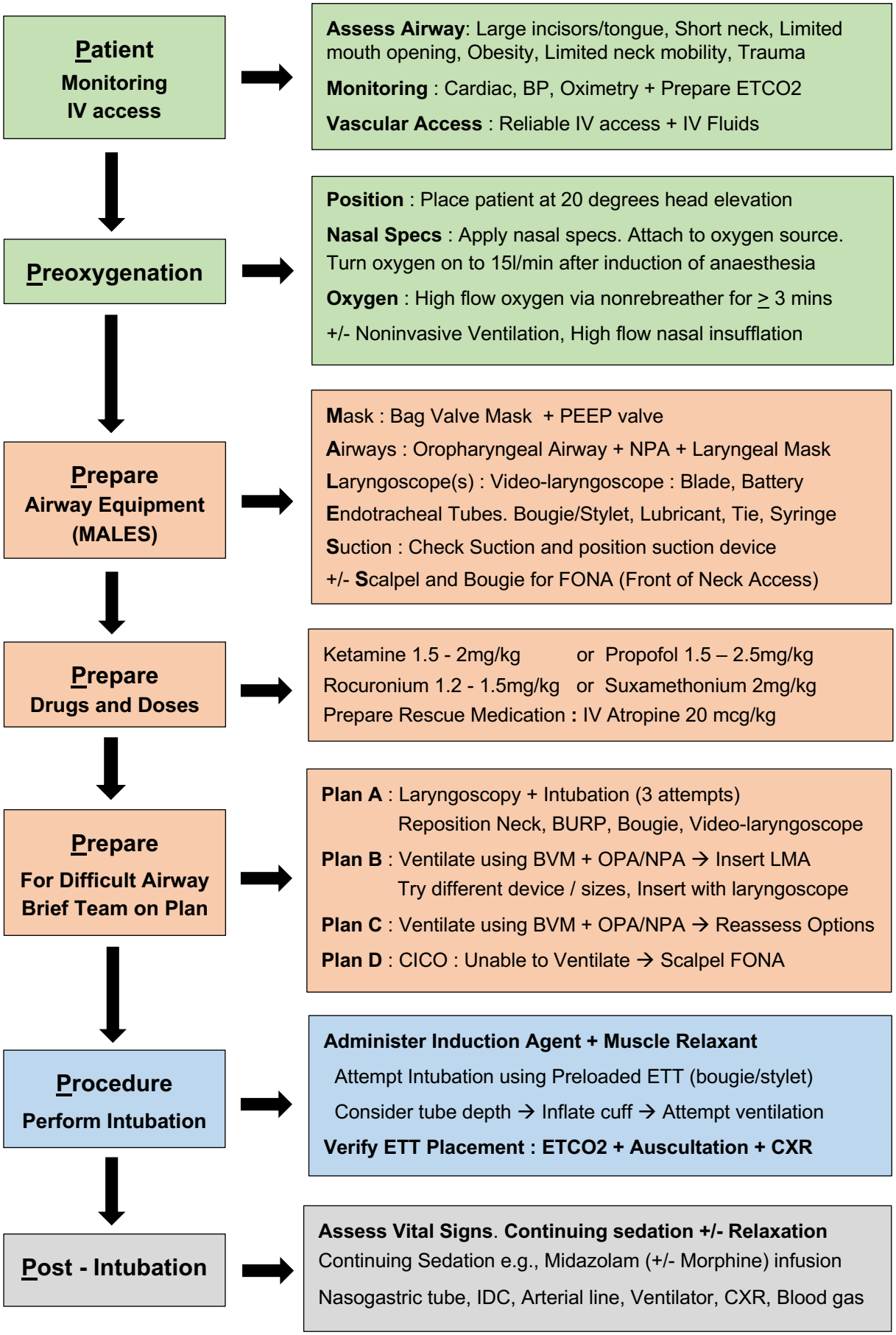
Careful selection of the appropriate size endotracheal tube is required in the child to avoid causing injury to the subglottic area. It is now recommended (with the exception of newborns) that cuffed endotracheal tubes should be used for all ages in order to reduce the risk for aspiration and enhance effective ventilation (by improving airway seal) and providing a more accurate measurement of end-tidal CO_2 concentration.

Paediatric Endotracheal tube

- Use uncuffed ETT in the newborn.
- Use cuffed ETT for all other ages. These ETTs are specifically designed for higher volume/lower cuffs compared to adult endotracheal tubes and provide a better airway seal compared to uncuffed with low pressure on the endotracheal walls to minimise soft tissue swelling post extubation.
- ETT Size : Use size 2.5 - 3.5 mm uncuffed tube in the newborn and 3.5 mm cuffed tube in 1 - 2 year old
- ETT Size = Age/4 + 3.5 (for a *cuffed ETT)* in children $\geq$ 2 years old
- ETT Depth (in cms) = 3 x size of ETT
- The cuffs should not be inflated above 25 cm H_20

[1] A summary of rapid sequence intubation is shown on the following page and discussed in detail in Chapter 7.

Paediatric Rapid Sequence Intubation



RAPID SEQUENCE INTUBATION : PAEDIATRIC DRUG DOSES[2]												
Induction Agents												
WEIGHT	**Dose/kg**	**3**	**6**	**9**	**12**	**15**	**18**	**20**	**24**	**28**	**32**	**36**
Ketamine	**1.5mg/kg**	4.5	9	13.5	18	22.5	27	30	36	42	48	54
Ketamine	**2 mg/kg**	6	12	18	24	30	36	40	48	56	64	72
Propofol	**1.5mg/kg**	4.5	9	13.5	18	22.5	27	30	36	42	48	54
Propofol	**2.5mg/kg**	7.5	15	22.5	30	37.5	45	50	60	70	80	90
Muscle Relaxation												
WEIGHT	**Dose/kg**	**3**	**6**	**9**	**12**	**15**	**18**	**20**	**24**	**28**	**32**	**36**
Suxamethonium	**2mg/kg**	6	12	18	24	30	36	40	48	56	64	72
Rocuronium	**1.2mg/kg**	3.6	7.2	10.8	14.4	18	21.6	24	28.8	33.6	38.4	43.2

Breathing

Assess the breathing by examining the child for signs of respiratory distress. In the child with altered conscious state, examine for concomitant respiratory depression.

Check the child's effort and adequacy of breathing by examining respiratory rate, soft tissue recession, use of accessory muscles, airway noises and in the very young look for nasal flaring and head bobbing. Check the oximetry reading. Clinical cyanosis is a late sign. Remember to look at the patient first – not the oximeter.

Oxygen Delivery / Assisted Ventilation

All children requiring resuscitation and especially those with respiratory difficulties should receive high flow oxygen therapy. The only exception is duct-dependent congenital heart disease in the newborn.

Begin oxygen therapy using a high flow oxygen mask, ideally a non-rebreathing mask including a reservoir bag with flow rates of 10 - 15 litres/minute. Only after the patient is stabilised should an attempt be made to titrate the inspired oxygen to the child's saturation with the aim of avoiding hyperoxia.

A useful option in children with severe respiratory distress requiring high flow oxygen mask therapy or with hypoxia despite routine nasal oxygen is humidified high flow nasal prong (cannula) therapy (HFNP).

Humidified high flow nasal prong (cannula) therapy is a form of non-invasive respiratory support that has been used successfully to treat respiratory distress of the newborn and bronchiolitis and more recently to treat adults and children with respiratory distress from a wide range of causes. The primary role of HFNP is as a bridge between low flow oxygen therapy (e.g., nasal specs at 2 l/min) and CPAP/BiPAP. HFNP therapy is discussed in detail in Chapter 9.

If the child's breathing is inadequate, ventilation should be assisted using a bag-valve–mask apparatus with high flow oxygen and a reservoir bag. Such a device can administer an FiO2 of up to 95%. Different bag sizes are available from a neonatal 100 ml, infant 250 ml, small child 500 ml to a larger child 1500 ml.

When using a bag and mask remember the desired delivered tidal volume is no greater than 10 mls/kg. Use the appropriate fraction of the bag deemed necessary to deliver that tidal volume. Use a slow inspiratory effort and avoid over-inflating the child's lungs, to avoid barotrauma and gastric inflation. The standard bag-valve apparatus fits a variety of sizes of self-sealing transparent silicone masks, which should fit snugly over the child's mouth/nose and cheeks.

[2]It remains the clinician's responsibility to verify that the doses are appropriate to the patient before administering medications.

Circulation

The next step is to assess the circulation for evidence of shock. This involves carefully looking for signs of poor peripheral perfusion and the signs of brain or kidney dysfunction.

Assessment should focus on examining the child's capillary refill, skin colour, skin temperature, pulse, blood pressure, mental status, and urinary output. Capillary refill is assessed in the child by pressing the sternum or forehead for 5 seconds and then releasing. The time for return of blush should be < 2 seconds.

Fluid Resuscitation

An infant in severe shock is floppy, drowsy, has pale peripheries and delayed capillary refill. Urgent intervention is required. This involves immediate oxygen administration, IV cannulation and the rapid bolus of 10 - 20 mls/kg of normal saline. Use warmed fluids where possible.

If intravenous access is not gained with 2 attempts in the seriously ill child, consider insertion of an intra-osseous (IO) access. In recent years the IO route has become more widely used due to the introduction of the intraosseous drill (EZY IO) and the Bone Injection Gun (BIG). In the child the intra-osseous needle is inserted one fingerbreadth inferior and medial to the tibial tuberosity in a non-fractured lower leg. All resuscitation fluids and drugs can be administered via the IO needle.

The response to the fluid bolus should be assessed and a further bolus administered if required. Intravenous bolus fluid is the initial resuscitation measure and for children with hypovolaemic shock (e.g., Sepsis) fluid resuscitation with up to 40ml/kg may be required. The use of vasopressors (e.g., Noradrenaline infusion) is reserved for those not responding to aggressive and repeated fluid resuscitation.

In haemorrhagic shock blood transfusion should be commenced as soon as possible to ensure adequate oxygen carrying capacity of the circulation. Blood transfusion has been a major area of resuscitation research in recent years and has confirmed the importance of commencing blood as early as possible in the adult or child with severe haemorrhagic shock. Fluids are good but blood is better !

It is important to place an IDC as urine output provides a measure for renal perfusion, an indicator of the adequacy of resuscitation beyond the first 60 mins. Aim for a urine output of 1 – 2 ml/kg/hour in a child.

Lactate clearance may be used as a marker of tissue reperfusion and adequacy of oxygen delivery to the tissues. Serum lactate is an early marker for circulatory shock and severe sepsis. In clinical practice the normal serum lactate is $\leq$ 1 mmol/l. Patients with an initial serum lactate level > 2 mmol/L should be observed closely while patients with levels > 4 mmol/L require continuing close assessment. The time to clearance appears to be more significant than the absolute value with an increasing risk of death, the longer the lactate remains elevated.

Disability

Disability refers to the assessment of the central nervous system (brain). It is important to recognise signs indicating impairment of (brain) function such as altered conscious state as well as identifying immediate (reversible) brain threats such as hypoglycaemia or raised intracranial pressure.

Begin by assessing the child's conscious level using the AVPU scale (Alert, Responds to Verbal stimuli, Responds to Painful stimuli, Unresponsive). Check the pupils for size, equality and reaction to light and look at child's posture (muscle tone and position) and evidence of seizure activity. Always check the child's BGL.

In children with impaired conscious state the first priority is to initiate treatment for threats to the airway, breathing and circulation (ABC). Correct hypoglycaemia and treat seizures using IM or IV Midazolam.

Hypoglycaemia

DEFG = Don't Ever Forget Glucose is often included in the Primary Survey mnemonic to emphasise the importance of checking and correcting hypoglycaemia, a common cause of morbidity in the seriously ill child.

In children hypoglycaemia is recognised as a BGL low enough to cause signs and/or symptoms of impaired brain function. This is usually seen with a BGL <3.3 mmol/L. In neonates <48 hrs old a BGL of less than 2.6 mmol/L is considered as hypoglycaemia requiring urgent intervention.

Treat life threatening hypoglycaemia with 2mls/kg 10% dextrose followed by a repeat BGL at 5 – 10 mins[3]. Give a second 2ml/kg bolus of 10% dextrose if required. IM Glucagon may be used in the child or neonate where IV access is not available. Never use 50% dextrose in the young child.

[3] Practice Point : A 10% dextrose solution can be made by putting 50 mls of 50% dextrose into a 500 ml bag of 5% dextrose.

Exposure

The final step in the primary survey is to uncover the child looking for rash, petechiae or bruising and checking the child's temperature. Undress the child, being considerate not to the embarrass them, and cover the child with blankets to prevent hypothermia.

Assess the temperature with a tympanic thermometer. Be prepared to use a rectal temperature in an ill child or the very young child (< 12 months) where temperature measurement is critical.

Hypothermia

Take great care to search for and treat / prevent hypothermia in the young child. The development of hypothermia in a seriously ill child significantly increases the risk of complications and death.

In a child with unexplained hypothermia always consider the possibility of sepsis.

Think of Hypothermia in the same way as for hypoglycaemia when resuscitating a child : make a careful search for its presence and take active steps to prevent its development during resuscitation. Hypothermia may be managed in most instances with warmed blankets, warmed resuscitation room, hot air warmer blanket (Bair-Hugger) and head coverings.

Suspected Sepsis

The finding of hyperthermia in a seriously ill child should always suggest the possibility of sepsis and in the absence of an obvious cause give consideration to the administration of empiric antibiotics. Neonates presenting with fever should always be assumed have sepsis and treated with empiric antibiotics.

Hyperthermia is managed with paracetamol (15 mg/kg), tepid sponging and fanning. In the child with suspected sepsis draw blood cultures and commence empiric antimicrobials as shown below[4].

Empiric Antibiotics : Source of Sepsis Unclear

Use ideal body weight to calculate dose

Age < 2 months (No Penicillin or Cephalosporin allergy)

- IV Benzylpenicillin 60mg/kg + Cefotaxime 50mg/kg IV
- Administer above antibiotics 12 hrly if < 7 days old, 6 – 8 hrly 7 – 28 days old, 6 hrly for > 28 days old
- Add Acyclovir 20mg/kg IV 8 hrly if HSV suspected

Age > 2 months (No Penicillin or Cephalosporin allergy)

- IV Gentamicin (7.5mg/kg up to 320mg under 10 years old, 7mg/kg up to 560 mg over 10 years old) + Ceftriaxone 50mg/kg IV (up to 2g) 12 hrly + Vancomycin 30mg/kg (up to 1.5g) 12hrly
- Add Acyclovir (20mg/kg if < 5years old, 15mg/kg if > 5years old) IV 6 hrly if HSV suspected

Nb. If No IV access : Give IM Ceftriaxone 100 mg/kg (max 4gram) daily. Can be used in children < 2 months old.

Consult Infectious Diseases Physician URGENTLY if patient has penicillin/cephalosporin allergy or already/recently on antibiotics or had known antimicrobial resistance.

[4] Source : Antibiotic Guidelines (Therapeutic Guidelines) 2021

Secondary Survey

After completing the Primary Survey and initiating resuscitation, the next step is a thorough assessment of the child to determine the possible cause (s) of the illness or identify injuries in the child with trauma. Assessment begins with a detailed history of the presenting problem and past medical history.

In children the past history should include antenatal and neonatal history, family history, immunisation status and current medications.

Always consider the social situation, reliability of caregivers and life stresses being experienced by the family. Emotionally unavailable parents may not respond to a baby's deteriorating condition.

During the secondary survey consider the possibility of Child Abuse (Non-Accidental injury). This is easy to overlook if not given consideration during the assessment. Child abuse is prevalent in all social and ethnic groups and the signs are often non-descript and vague. Abuse is not just deliberate inflicted injury but also injury secondary to neglect. Listen to and use the history. If you suspect child abuse or neglect do not be judgmental or confrontational but arrange for the child to be admitted to a place of safety after immediate treatment is provided.

Differential diagnosis of the sick child

The list of possible causes for the child's illness is wide.

Differential diagnoses that should always be considered in a seriously ill child include sepsis, meningitis, acute abdomen, asthma, bronchiolitis, poisoning, seizures, hypoglycaemia, intracranial haemorrhage, child abuse and congenital heart disease.

The table below provides a useful reference tool for assessment in the seriously ill child. Later chapters explore many of these conditions in detail.

Complaint	Serious causes needing exclusion	Other causes
• Fever	Sepsis, Bacteraemia, Meningitis,	Viral illness, Otitis media
• Stridor	Epiglottitis, Foreign body, Bacterial tracheitis	Viral croup, URTI
• Abdominal pain	Appendicitis, Intussusception, Pneumonia	Constipation, Colic, Functional, Gastroenteritis, Pharyngitis
• Apnoea	Sepsis, SIDS, Hypoglycaemia, Seizures, Apnoea, Child abuse	New parents, GO Reflux, BRUE Normal periodic breathing
• Chest pain	Pericarditis, Mitral valve prolapse, Congenital thoracic anomaly	Musculoskeletal, Pleuritis, Unknown
• Wheezing	Asthma, Foreign body, Bronchiolitis	URTI : Upper airway secretions, Viral bronchitis
• Vomiting	Intracranial pathology, Pyloric stenosis, Reyes syndrome, Obstruction, Intoxication	Gastroenteritis, Viral illness, Minor head trauma

Chapter 44
Advanced Paediatric Life Support

Key Points

1. **In children, cardiac arrest most commonly results from hypoxia caused by airway obstruction, severe respiratory distress, or respiratory depression.**
2. **Basic Life support is summarised by the mnemonic DRS ABCD – check for danger, assess response, send for help, open the airway, check breathing, commence CPR and attach an automatic external defibrillator (AED).**
3. **An "Infant" is between 0 - 1 yr of age and a Child" is between 1 - 8yrs of age**
4. **When performed by healthcare professionals in a healthcare setting, CPR in infants and children should commence with 2 ventilations followed by the delivery of compressions in a ratio of 2 breaths to 15 compressions.**
5. **In the child aged 9 years and over, the adult BLS protocol should be followed with the delivery of 30 compressions to every 2 ventilations.**
6. **The most common arrest rhythms in the child are PEA and asystole. These are managed with Adrenaline (0.1 ml/kg of 1:10,000) every 4 minutes, continuing CPR and a search for reversible causes including hypoxia, hypovolaemia, hyperkalaemia and tension pneumothorax.**
7. **It is essential with ALS in the child to exclude an occult airway foreign body.**

In children, cardiac arrest is most commonly due to hypoxia. This may be the consequence of severe airway obstruction (e.g., foreign body, drowning) or severe respiratory distress (e.g., acute asthma, pneumonia) or respiratory depression (e.g., sedative hypnotic poisoning).

In Australia, the guidelines for Basic Life Support (BLS) and Advanced Life Support (ALS) are developed by the Australian Resuscitation Council[5]. These protocols emphasise the need to correct hypoxia in the child with cardiac arrest by checking and clearing the airway of obstruction and commencing early effective ventilation in association with cardiac compressions.

Basic Life Support

Basic Life Support refers to the use of basic airway opening techniques, cardiopulmonary resuscitation (CPR) and use of an automatic external defibrillator (AED). Cardiopulmonary resuscitation involves the use of rescue breaths and chest compressions to temporarily maintain the circulation of oxygenated blood to vital organs including the brain and the heart. CPR should be commenced in the child who is unresponsive and not breathing (or is breathing abnormally).

Advanced Life Support

Advanced Life Support refers to the use of special resuscitative equipment to manage the airway, breathing and circulation and includes endotracheal intubation, establishment of IV access, defibrillation and pharmacotherapy of arrhythmias.

The most common arrest rhythms in the child with cardiac arrest are pulseless electrical activity and asystole. This reflects the underlying aetiology of hypoxia and advanced life support therefore most commonly follows the nonshockable algorithm with Adrenaline administered 4 minutely and a search for reversible causes including hypoxia, hypovolaemia, hyperkalaemia and tension pneumothorax. It is essential with advanced life support in the child to exclude an occult airway foreign body as the cause for the arrest.

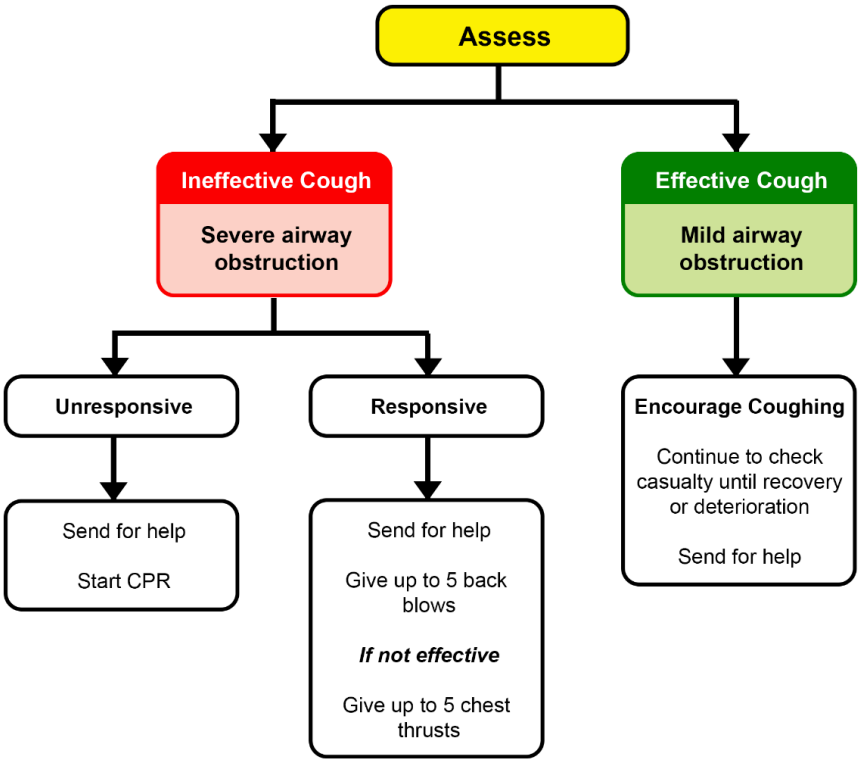
[5] Australian Resuscitation Council - https://resus.org.au/guidelines

Foreign Body Airway Obstruction (Choking)

Foreign body airway obstruction is one of the most frightening emergencies. It can occur at any age, present suddenly and progress unpredictably to complete airway obstruction and death within minutes.

Urgent recognition and intervention are critical. Knowledge of the procedure for managing foreign body airway obstruction is an important and potentially lifesaving skill for all health professionals and may "one day" be responsible for saving a patient or even a family or friend's life !

The ARC Algorithm for the basic management of Foreign Body Airway Obstruction[6] is shown below.



Effective Cough

In the patient with an effective cough the rescuer should provide reassurance and encourage the patient to keep coughing to expel the foreign body. If the obstruction is not relieved promptly an ambulance should be called.

Ineffective Cough

In the conscious patient with an ineffective cough deliver up to five sharp, back blows with the heel of one hand in the middle of the back between the shoulder blades. A check should be made between each back blow to assess whether the airway obstruction has been relieved. In the young child the head may be placed downwards (across the rescuer's lap) prior to delivering back blows.

If back blows are unsuccessful up to 5 chest thrusts are delivered. After each chest thrust, a check is made to assess whether the obstruction has been relieved. Chest thrusts are delivered to the same compression point as for CPR and are similar to chest compressions but are sharper and delivered one at a time. The young child should be placed in a head downwards prone position across the rescuer's thigh. Children and adults may be treated in the sitting or standing position.

Where the obstruction is not relieved, continue administering an alternating series of five back blows and five chest thrusts. If the patient loses consciousness, Basic CPR should be commenced.

Unconscious Patient

Commence basic CPR in the unconscious child with severe airway obstruction. Begin by clearing the airway. This may be performed by rolling the child onto their side to allow foreign material to fall to the side. A visual examination of the mouth should be made to try to identify the foreign body which can then be removed using the fingers or with a finger sweep. Once the airway is cleared the child should be reassessed. In the child who remains unresponsive with absent or abnormal breathing CPR should be commenced.

[6] Australian Resuscitation Council - https://resus.org.au/guidelines

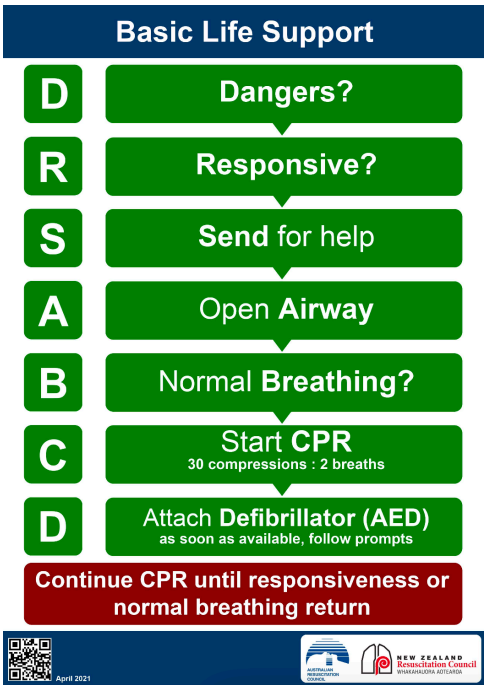
Basic Life Support

DRS-ABCD

In the child with suspected cardiac arrest the Basic Life Support algorithm should be immediately commenced and is summarised by the mnemonic DRS ABCD.

The DRS ABCD algorithm for Basic life support is illustrated in the ARC chart for Basic CPR[7] shown here.

After checking for *D*anger and *R*esponse *S*end for help, open the *A*irway, check *B*reathing and begin *C*ardiopulmonary resuscitation. Where available an automatic external *D*efibrillator should be attached.



When to start CPR

CPR should be commenced immediately in the child with suspected cardiac arrest.

Cardiac arrest should be suspected in the child who is unresponsive to voice and touch (eyes closed, no verbal response, no movement) and who is not breathing or has gasping respirations.

Pulse check may be used but should not delay CPR for more than 10 seconds. If the rescuer is uncertain about the presence of a pulse, then CPR should be started.

By commencing CPR at the earliest possible moment and maintaining ventilation and compressions with minimal interruption, myocardial ischaemia and acidosis will be minimised increasing the likelihood of successful resuscitation. Cardiac compressions should be continued and stopped only to deliver breaths using a bag and mask or to deliver the defibrillation shock.

In Advanced Life Support (ALS) chest compressions should be continued during charging of the defibrillator, ceased for the rhythm check (and delivery of the DC shock) and then recommenced immediately.

CPR in the Infant and Child

The Australian Resuscitation Council define an "Infant" as aged between 0 - 1 year old and a Child" as between 1 – 8 years old.

When performed by healthcare professionals in a healthcare setting (with equipment and drugs) CPR in infants and children should commence with 2 ventilations followed by the delivery of compressions in a ratio of 2 breaths to 15 compressions.

In the child aged 9 years and over, the adult BLS protocol should be followed with the delivery of 30 compressions to every 2 ventilations.

Cardiac Compressions in Infants and Children (1 - 8 years)

- **Location** — Lower half of the sternum
- **Technique** — Use the Thumbs or two fingers in an infant, heel of one hand in a small child and the heels of both hands in the large child
- **Depth of compression** — One third the depth of the chest (4 cm in an infant and 5 cm in a child)
- **Rate** — 100 - 120 compressions / min
- **Ratio (2:15)** — For health professionals : Use a 2:15 ventilation / compression ratio

Nb. Untrained bystanders are taught to use a 30:2 ratio in both adults and children (to reduce confusion)

[7] Australian Resuscitation Council - https://resus.org.au/guidelines/flowcharts-3/

Basic Life Support during the COVID-19 Pandemic

The Covid-19 pandemic has required modifications to basic CPR in order to reduce the risk to rescuers.

Bystander CPR

Recognising that ventilation is critical to CPR in infants and children it is recommended that lay rescuers who are willing, trained and able to do so, consider providing rescue breaths to infants and children in addition to chest compressions.

CPR in Healthcare settings

It is recommended that in the current COVID-19 pandemic, healthcare professionals should use personal protective equipment when delivering basic CPR (compressions, airway management, ventilation) and during delivery of defibrillation. Standard PPE precautions are considered adequate for basic CPR in patients who are neither confirmed nor suspected cases of COVID-19.

Advanced Life Support

The aim in ALS is to restore spontaneous circulation and begins by attached a manual defibrillator.

Charge and Check

After placement of the pads on the child the defibrillator should be immediately charged.

Once the defibrillator is fully charged CPR should be ceased to allow an assessment of the cardiac rhythm. This is referred to as a "*Charge and Check*". The procedure should be repeated every two minutes.

Charge and Check

- Repeat every 2 minutes during CPR. Charge the defibrillator while continuing CPR
- Temporarily cease CPR to check the rhythm
- Where a shockable rhythm is identified instruct rescuers to stand away from the patient. Check all rescuers are away from the patient and deliver the shock. Commence CPR immediately after the shock.
- Where a nonshockable rhythm is identified the charge is *disarmed* and instructions given to the rescuers to recommence CPR immediately.

Compressions should be continued during charging of the defibrillator and the remainder of the resuscitation team instructed clearly to stand away from the patient during the charging. Only the person doing the compressions should be touching the patient as the defibrillator is charged.

Once the defibrillator is charged the person doing the compressions should be instructed to stop CPR. This allows the monitored rhythm to be quickly checked by the resuscitation team leader.

- If a shockable rhythm is identified the rescuer is instructed to "*Stand away*" from the patient and after checking to ensure the team are clear from the patient the shock is delivered followed by the instruction to immediately "*Commence CPR*".
- Where a non-shockable rhythm is identified the machine is disarmed and CPR recommenced

There are four steps to the Charge and Check procedure. It is important to practice these four steps until they become easily remembered in the setting of a cardiac arrest. The precise wording of the commands may vary slightly but the actions should be clear at each step of the procedure.

Steps in the "Charge and Check" Procedure

Step 1 : Charging : *"Team stand back (O2 away), Compressions continue, Charge defibrillator*"

Step 2 : Checking : *"Stop CPR"*, Check the rhythm (decide if it is shockable or non-shockable)

Step 3 : Deliver shock or Disarm : (Everyone) *"Stand back, Deliver Shock (or Disarm)"*

Step 4 : Begin CPR : "*Commence CPR"*

Advanced Life Support Algorithm

There are four major rhythm disturbances seen in cardiac arrest – ventricular fibrillation, pulseless ventricular tachycardia, asystole and pulseless electrical activity. The 4 arrest rhythms are divided for management purposes into Shockable and Non-Shockable rhythms

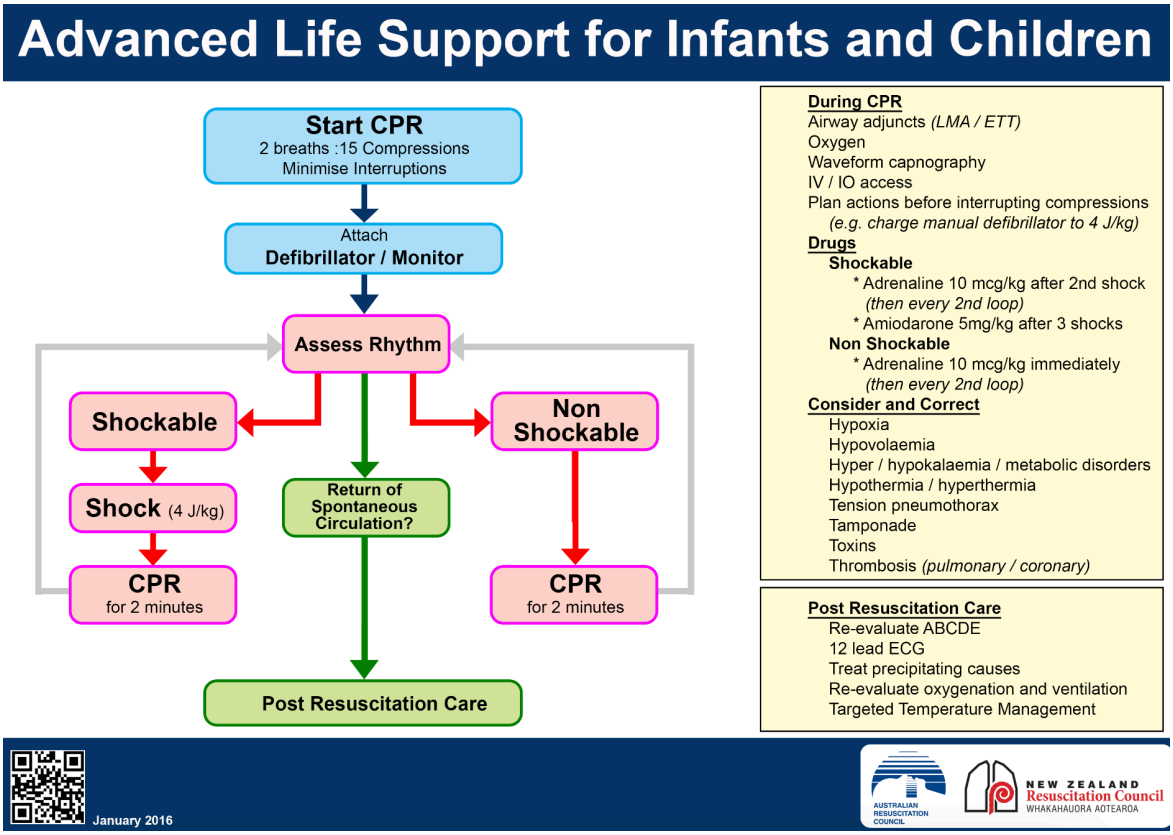
Shockable

- Ventricular Fibrillation : asynchronous, chaotic ventricular activity
- Pulseless Ventricular Tachycardia : wide complex regular tachycardia with no output

Non-Shockable

- Asystole : absence of any cardiac electric activity
- Pulseless Electrical Activity (PEA) : coordinated electrical rhythm with no output

The ARC flowchart for Advanced Life Support[8] in infants and children is shown below.



Management of Shockable Rhythms

In children with Ventricular fibrillation or Pulseless Ventricular tachycardia, give an immediate DC shock using 4 Joules/kg and repeat DC shock every 2 minutes until there is return of circulation. CPR should be continued during charging of the defibrillator, ceased for the delivery of the shock ("hands off") and commenced immediately after defibrillation.

IV Adrenaline should be administered after the second DC shock and then repeated after every second shock (i.e., every 4 minutes). The cycle of Shock / Shock / Adrenaline should be continued until resuscitation is successful or resuscitation is ceased. Amiodarone 5 mg/kg is administered after the third defibrillation attempt and may be repeated later in the resuscitation in a dose of 2.5 mg/kg.

Management of Non-shockable Rhythms

In children with Pulseless electrical activity (PEA) or Asystole, IV Adrenaline should be administered as early as feasible and repeated every 4 minutes. CPR should be continued throughout and interrupted only for a "Charge and Check" every 2 minutes.

[8] Australian Resuscitation Council : https://resus.org.au/guidelines/flowcharts-3/

Reversible Causes

In all children with cardiac arrest a search should be made for possible reversible causes. These are listed in the box located on the side of the ARC flowcharts for Advanced Life Support in the child.

In the child with cardiac arrest always consider the possibility of *Hypovolaemia* (treat with a fluid bolus), *Tension pneumothorax* (treat with needle decompression) and H*yperkalaemia* (treat with IV calcium). In a child, special attention should be given to identifying and treating *Hypoxia* with a careful search made to rule out airway foreign body.

Reversible causes should be considered and may be remembered using the mnemonic of "4 Hs and the 4 Ts" H = Hypo/hyperthermia, Hypoxia, Hypo/Hyperkalaemia, Hypovolaemia and T = Tamponade, Tension Pneumothorax, Toxins/Poisons/Drugs, Thrombosis (PE / AMI).

Important reversible causes and their treatment that should be considered in a child

- Hypoxia (treat by ensuring the airway is clear and effective breaths and compressions are delivered)
- Hypovolaemia (treat with a fluid bolus)
- Tension pneumothorax (treat with needle decompression)
- Hyperkalaemia (treat with IV calcium)
- Cardiac tamponade (treat with pericardiocentesis)
- Toxins (treat with antidote)

Interventions in Advanced Paediatric Life Support

Although the protocols for the management of the cardiac arrest rhythms are similar to adults, the doses of drugs and defibrillation are different and generally determined by the weight of the child. There are only two drugs now routinely used in cardiac arrest, Adrenaline and Amiodarone. Atropine is no longer used.

Interventions in Advanced Paediatric Life Support

- Defibrillation DC Shock 4 J/kg (Biphasic / Monophasic defibrillators)
- Adrenaline 0.1 ml/kg of 1:10,000 Adrenaline every 4 minutes
- Amiodarone 5 mg/kg bolus. A second 2.5 mg/kg bolus may be administered.

The dose of Adrenaline (0.1 ml/kg) is calculated using 1 in 10,000 (one in ten thousand). This is different to adults where 1:1,000 (one in one thousand) concentration is used.

IV access

Options for IV access include cannulation of a peripheral vein (usually in the cubital fossa) or via the bone marrow (intraosseous). Central venous access should not be attempted initially as it is time consuming. If a peripheral IV line cannot be established promptly (within 60 secs) intraosseous access should be established. All IV resuscitation medications may be administered safely using the intraosseous route.

Defibrillation

Defibrillation is indicated as first line treatment for ventricular fibrillation and pulseless VT. It should be used as soon as VF or pulseless VT is diagnosed. Correct position of the defibrillation pads is important : One pad is placed in the left mid-axilla at the level of the xiphisternum, the other to the right of the upper sternum.

Small pads should be used in infants and small children to prevent physical contact between the pads on the chest. If no paediatric pads are available, adult pads may be used by placing them in an AP position on the child.

End-tidal CO2 ($ETCO_2$)

A recent advance in clinical practice has been the increasing use of End-tidal CO2 monitoring during cardiac arrest. $ETCO_2$ levels of 20 mm Hg or greater indicate adequate chest compressions during cardiopulmonary resuscitation (CPR). A failure to achieve a level of at least 10 mmHg after 20 minutes of CPR may help in making the decision to terminate resuscitative efforts. A sudden large rise in the ETCO2 indicates a marked improvement in cardiac output and signals the return of spontaneous circulation (ROSC).

Post Resuscitation Management

In the event of successful resuscitation, the next step is to provide supportive therapy to enable recovery of vital organ function. This will generally require administration of oxygen, intubation with mechanical ventilation, circulatory support using fluids and inotropes and careful monitoring of fluid, electrolyte, glucose and acid base balance. Hyperthermia and hypoglycaemia have been shown to exacerbate neurological injury and care should be taken to treat or prevent these complications in the post-arrest patient.

Targeted Temperature Management

There is insufficient research to determine whether induced hypothermia or normothermia result in improved outcome following cardiac arrest in children. The current recommendation is to institute "targeted temperature management" (TTM) in children who remain comatose after resuscitation from cardiac arrest. TTM should be instituted within 6 hours and maintained for at least 24 hours and up to 72 hours. It requires the routine use of sedatives and often the addition of a muscle relaxant to prevent shivering. The therapy should aim for maintaining either an induced hypothermia (32 - 34ºC) or normothermia (36 - 37.5ºC)[9].

Cessation of Cardiopulmonary Resuscitation

The decision to stop resuscitation requires consideration of a range of variables including underlying cause, time interval between arrest and the commencement of CPR, duration and quality of CPR and response advanced cardiac life support. Resuscitation where there has been no return of circulation despite appropriate advanced cardiac life support for a period > 20 - 30 minutes is associated with a poor prognosis and it is reasonable to consider discontinuing resuscitation.

Resuscitation may be continued for longer in children with cardiac arrest associated with severe hypothermia due to iced water drowning or associated with poisoning as there is some evidence that in these circumstances prolonged resuscitation may be associated with better outcomes than for other causes of arrest.

[9] ANZCOR Guideline 12.7 Management After Resuscitation in Paediatric Advanced Life Support. Jan 2016. https://resus.org.au/guidelines/

Chapter 45
Paediatric Sepsis

Key Points

1. **Clinical assessment of the child with fever focuses on identifying serious infection and sepsis**
2. **Paediatric fever is defined as a rectal temperature of 38°C or more. Caution is required with the use of tympanic thermometer readings in infants less than 3 months old.**
3. **Even with treatment paediatric sepsis is associated with a mortality rate of between 15% – 20%**
4. **Clinical clues to severe infection and sepsis in a child include fever or hypothermia, irritability, drowsiness, pallor, poor peripheral perfusion, altered behaviour, tachypnoea and tachycardia/bradycardia**
5. **Assess ABCDs and in a child that appears toxic or significantly unwell obtain IV access, draw blood cultures and administer empiric antibiotics**
6. **In neonates (< 1 month old) a full septic workup and empiric antibiotics are required with a temp of < 36°C or > 38°C, or in the drowsy poorly feeding infant**
7. **In the very young infant (1 - 3 months) clinical signs of severe sepsis are subtle. Septic screen and empiric antibiotics are required if there is any clinical suspicion of sepsis**
8. **In the immunised young child (< 2 years) who appears well but with no focus of infection a period of observation for 4 - 6 hrs is advised with the aim of identifying clinical features indicating serious bacterial infection.**

Fever is a common presenting symptom accounting for 1 in 5 children attending the emergency department. The challenge for the clinician is to determine whether fever is a symptom of a devastating illness or a symptom of an illness that is likely to resolve by itself with no sequelae.

Fever in a child is defined as a rectal temperature of 38° C or more. Tympanic temperature however is more commonly used in clinical settings and although reliable in children more than 6 months old may yield falsely low values in young infants. In children less than 3 months it is recommended that the temperature be taken rectally if doubt exists about the reliability of the tympanic measurement. Axillary temperature is safe, but generally underestimates core temperature.

For axillary and tympanic temperature measurement fever is considered if the temperature is 37.5° C or more.

Recognising Sepsis

In a child presenting with a fever, the possibility of paediatric sepsis should always be considered. Sadly, paediatric sepsis despite improvements with respect to recognition the treatment, remains a leading cause of childhood morbidity and mortality with a mortality rate of 15% - 20%. The presentation, particularly in neonates and the young infant, is often vague and non-specific making early diagnosis a challenge.

Paediatric sepsis is defined as 'the systemic inflammatory response syndrome (SIRS) in the presence of, or as the result of, suspected or proven infection'. The systemic inflammatory response syndrome is characterised by the presence of fever or hypothermia, tachycardia or bradycardia, tachypnoea and elevated or depressed white cell count. Septic shock is a subset of sepsis in which profound circulatory, cellular, and metabolic abnormalities are associated with a greater risk of mortality.

Assessment

Assessment of the child with fever focuses on identifying clues to serious bacterial infection or sepsis. In very small children this can be extremely difficult and subtle signs of serious illness are easily overlooked.

Clinical clues to serious infection or sepsis include :

- Irritable, lethargic, drowsy child
- Persistent fever and / or hyperpyrexia T > 39 degrees
- Pallor
- Poor peripheral perfusion (cool, pale, mottled extremities with delayed capillary refill)
- Altered behaviour
- Altered vital signs : Tachypnoea, Tachycardia/Bradycardia, Hypothermia

Of all ages, infants in the first month or two of life are the most difficult to assess. Have a high index of suspicion for possible sepsis. Ask about alterations to the pattern of the baby's feeding, sleeping, alertness and activity. Consider sepsis in a baby with any of the following findings : fever (T > 38 ºC), increased sleeping, poor feeding, decreased activity, hypotonia, pallor, bradycardia and tachypnoea.

Children with underlying disorders that affect their immunity are at significantly greater risk for sepsis. These include oncology patients, children with cystic fibrosis, known immune deficiency or receiving long-term steroid therapy. In these children fever requires immediate investigation, treatment and urgent consultation and referral. Always seek specialist advice in these patients.

Significance of Age

In terms of management children are often divided into four age categories :

- Neonates (< 1 month old)
- Young infants (1 - 3 months)
- Infants (3 - 24 months)
- Older Children (over 2 years)

Management is determined by the age of the child. The younger the child, the lower threshold for initiating investigation and treatment.

Up to 25% of febrile neonates are septic. There are no features on clinical examination that can be used to rule out sepsis in the neonate and all neonates should be managed with a full septic workup and IV antibiotics.

In the very young infant (1 - 3 months) clinical signs for severe sepsis are subtle. Full septic workup and empiric IV antibiotics are required if there any clinical suspicion of sepsis.

In the child over 3 months clinical signs for serious illness are more reliable and clinical assessment may be used to more reliably determine the risk for serious illness.

Resuscitation

Assess the ABCDs

Assess the airway and examine the child's breathing. A careful examination is essential to identify the child with respiratory distress. Look particularly for soft tissue indrawing, grunting and nasal flaring. In the critically ill child commence resuscitation by clearing the airway and correcting hypoxia with supplemental oxygen and initiating respiratory support.

Feel the child's hands – are they warm or cold ? Assess the pulse and check the capillary refill centrally by pressing for 5 seconds on the sternum or forehead. In the child with circulatory shock, obtain IV or IO access and commence fluid resuscitation with a 10 - 20 ml/kg bolus of normal saline.

Assess the child's conscious state and remember to assess the pupils. Check the BGL and correct hypoglycaemia (BGL $\leq$ 3.3 mmol/l) with administration of 2 ml/kg of 10% dextrose followed by a repeat BGL. Undress the child and look for a rash and document the temperature.

In a child that appears toxic or significantly unwell immediate treatment is required. Obtain IV access, draw blood cultures (if possible) and administer empiric antibiotics (see table on the following page).

Paediatric Sepsis : Diagnosis / Management

Recognise Clinical Findings

- Altered Mental State, Weak cry, Grunting
- Reduced perfusion (Cool, Pale, Mottled, CRT< 2 secs)
- Temp > 38.5 or < 35.5
- Tachycardia in > 1 yr old, Bradycardia in < 1 yr old
- Tachypnoea +/- hypoxia

Risk factors : Less than 3 months, Oncology patient, Cystic fibrosis, Immunocompromised, Low term steroid therapy

Primary Survey + Resuscitation

A - Assess / Maintain airway

B - Assess / Administer oxygen (aim for SpO2 94- 96%)

C - Immediate vascular access (Consider IO)
Blood Culture, BGL, iStat/EPOC and INR
Fluid Resuscitation (10 - 20 ml/kg 0.9%NS to 40 ml/kg)
Administer antibiotics/antivirals within 60 mins

D - Assess level on consciousness (AVPU), Pupils and BGL

E - Examine for sepsis source. Look for meningococcal rash
Urine collection : Clean catch or suprapubic tap
Consider CXR, Cutaneous virology (HSV, Varicella)

F - Strict fluid input /output.
Consider IDC (aim for urine output of 0.5 - 2ml/kg/hour)

G - Treat BGL < 3.3 mmol/l with 2ml/kg 10% glucose IV

Discus with Retrieval
Intensive Care

Continued Close Monitoring

Discuss with Retrieval Service / ICU if

- Tachypnoea or Tachycardia (Red or purple zone),
- Capillary refill > 2 secs
- Decreased level or no improvement in consciousness,
- Acidosis, Increasing lactate, Abnormal coagulation
- Urine output < 1ml/kg/hour, Hypoglycaemia

Empiric Antibiotics : Source of Sepsis Unclear *(Use ideal body weight to calculate dose)*

Age < 2 months (No Penicillin or Cephalosporin allergy)

- IV Benzylpenicillin 60mg/kg + Cefotaxime 50mg/kg IV (Give these antibiotics 12 hrly if < 7 days old, 6 – 8 hrly 7 – 28 days old, 6 hrly for > 28 days old)
- Add Acyclovir 20mg/kg IV 8 hrly if HSV suspected

Age > 2 months (No Penicillin or Cephalosporin allergy)

- IV Gentamicin (7.5mg/kg up to 320mg under 10 years old, 7mg/kg up to 560 mg over 10 years old) + Ceftriaxone 50mg/kg IV (up to 2g) 12 hrly + Vancomycin 30mg/kg (up to 1.5g) 12hrly
- Add Acyclovir (20mg/kg if < 5years old, 15mg/kg if > 5years old) IV 6 hrly if HSV suspected

Nb. If No IV access : Give IM Ceftriaxone 100 mg/kg (max 4gram) daily. Can be used in children < 2 months old.

Consult Infectious Diseases Physician URGENTLY if patient has penicillin/cephalosporin allergy or already/recently on antibiotics or had known antimicrobial resistance.

Management

Neonates (< 1 month)

There are no features on clinical examination that rule out sepsis in a neonate. Any neonate presenting with a core temperature > 38ºC or < 36ºC requires a full septic workup and should be admitted for IV antibiotics.

A septic workup should also be given serious consideration even where the neonate has a normal temperature but appears drowsy or overly sleepy (as evidenced by poor feeding).

Sepsis in the Neonate

1. Septic Workup includes

- Insertion of an IV cannula. Take blood for CBE, EUC, Glucose, and Blood Culture
- Urine specimen, collected either by suprapubic aspiration of 2 mls of urine with a 23 G needle, or an in-out catheter using a 5Fr neonatal NG tube (normally found in nurseries for tube feeding babies)
- Lumbar puncture may be considered depending on the clinical context.
- Chest X-ray +/- Stool cultures (depending on clinical context)

2. Administer Empiric Antibiotics

Age < 2 months (No Penicillin or Cephalosporin allergy)

- IV Benzylpenicillin 60mg/kg + Cefotaxime 50mg/kg IV
- Administer the above antibiotics 12 hrly if < 7 days old, 6 – 8 hrly 7 – 28 days old, 6 hrly for > 28 days old
- Add Acyclovir 20mg/kg IV 8 hrly if HSV suspected

Very young Infants (1 – 3 months)

Infants between 1 and 3 months with a temperature > 38ºC should have a septic workup and receive empiric antibiotics if there is any clinical suspicion of serious illness. Have a low threshold for investigating and treating this age group.

The closer a child is to one month the more consideration should be given to managing them as a neonate. Look for high-risk features such as prematurity and / or low birth weight, recent use of antibiotics, abrupt onset of illness, underlying chronic illness and frequent hospitalisation.

Look carefully for the following clues on clinical history and examination :

- An unwell child that is feeding poorly
- An unwell child with a fever that doesn't respond to paracetamol or ibuprofen
- A child with a non-blanching rash
- A child that has not had any immunisations

Red flags associated with an increased risk for missing paediatric sepsis in neonates and infants include : Representation within 48 hours, High level of parental concern, Clinical deterioration despite treatment and Recent surgery or burns.

Management

A child with risk factors or clinical features suggesting possible serious illness should undergo full septic workup and empiric antibiotics and be referred for early paediatric consultation and admission.

In a well looking baby, a search should be made for the focus for infection. This involves a thorough physical examination and a paedibag urine to screen for UTI. If a focus of infection is found, and the child looks well, they can be safely discharged home provided they have follow up with a GP in the next 24 - 48 hrs.

Where no focus of infection is identified the child should be managed with observation for a minimum of 4 – 6 hours. This aids in the management of fever and hydration, provides the opportunity for parental advice and support and allows the opportunity for the clinician to reassess the child. This is important where the signs of serious bacterial infection such as meningitis may be subtle and overlooked during the initial assessment.

If the child remains well, is drinking / feeding normally and has adequate family support, discharge is appropriate with arrangements for follow up by the GP in 24 – 48 hours.

Older Infants (3 months – 2 years)

Clinical examination is more reliable in identifying serious infection in this age group. Look for signs of severe sepsis and search for a focus of infection. In the toxic looking child investigations and treatment should be commenced immediately.

The history may provide clues (e.g., past history of ear infections or pneumonia, history of a cough, runny nose or earache). In the very young however, symptoms are often non-specific and may even be misleading. Vomiting, for example, is common with many non-GIT infections including serious bacterial infections such as meningitis. Examination should routinely include the ENT, respiratory, abdominal and musculoskeletal system and the child should be assessed for the presence of a rash, cellulitis and meningism.

A urinalysis should be routinely performed. If the urinalysis on the bag urine suggests UTI, a clean specimen of urine needs to be collected and sent to the lab to confirm a UTI before commencing treatment. The reason for this is that all children < 4 years with a positive urine culture will require renal ultrasound and follow up by a paediatrician to determine the presence of predisposing factors such as vesico-ureteric reflux or posterior urethral valves.

No source of infection

In the child who appears well but in whom no focus of infection is identified, viral illness is the most common cause. *Provided the child has been fully immunised to pneumococcus* they may be managed with a short period of observation (4 – 6 hours or longer as indicated).

Short-term observation is a useful clinical management tool in the young infant. It aids in the management of fever and hydration, provides the opportunity for parental advice and support and allows the opportunity for the clinician to reassess the child. This is important in the very young child where the signs of serious bacterial infection such as meningitis may be subtle and overlooked during the initial assessment. If the child remains well, is drinking / feeding normally and has adequate family support, discharge is appropriate with arrangements for follow up by the GP in 24 – 48 hours.

The Child with "No source of infection" and Incomplete Pneumococcal vaccination

Before the introduction of the conjugated pneumococcal vaccine *occult bacteraemia* was known to occur in approximately 5% of the well looking young children with high fever and "no source of infection".

These children were at risk for developing serious bacterial infection including meningitis and were managed with close observation and/or parenteral antibiotics. Diagnosis was made using blood cultures. Pneumococcus was most often the cause with Haemophilus influenzae B accounting for the remainder of cases.

Since the introduction of conjugated pneumococcal vaccine, the risk for occult bacteraemia has dramatically declined. However occult bacteraemia should still be considered in the child (< 3 years) who presents with a high fever (> 40^{o}C) with no focus of infection and has a *history of incomplete Pneumococcal vaccination*. These children should be observed closely for evidence of serious bacterial infection.

Some authorities advocate the use of laboratory testing (CBP, Blood cultures) in these children and administration of empiric antibiotics (Ceftriaxone) with a WCC < 5,000 or > 15,000 until the blood culture result is available.

Older Children (> 2 years)

Older children may be defined as greater than 2 years of age. In general, these children are treated in a similar way to adults with management determined by the findings on history and examination.

A significant fever in this age group is considered to be any temperature > 39 ^{o}C. In general children over the age of 2 years will present either looking unwell, for which they need workup to exclude serious bacterial infection (e.g., meningitis, pneumonia, pyelonephritis, abdominal sepsis) or they appear well looking, feeding normally and urinating well (at least 3 times a day).

If the child is unwell, it is worth considering a trial of Paracetamol (15 mg/kg) or Ibuprofen (10 mg/kg). If the fever resolves and the child looks well, it is unlikely the child has a serious infection, and can be safely discharged home. A focus of infection should be sought and treated.

Chapter 46
Upper Airway Emergencies

Key Points

1. **Cardinal findings in the child with upper airway obstruction are inspiratory stridor and respiratory distress.**
2. **Viral Croup is the most frequent cause of airway obstruction in a child and is characterised by preceding coryza and fever, barking cough and the onset of inspiratory stridor at night.**
3. **Oral steroids should be administered early in viral croup. Severe croup is managed with nebulised adrenaline +/- intubation.**
4. **Other important differential diagnoses include epiglottitis, foreign body, anaphylaxis and bacterial tracheitis.**

Obstruction of the upper airway (larynx and trachea) may be life threatening. In young children the small cross sectional area of the upper airway renders them particularly vulnerable to obstruction by oedema, secretions or an inhaled foreign body.

Most cases of upper respiratory tract obstruction in children result from infection. Other important causes include inhalation of a foreign body or hot gases (e.g., house fires), angio-oedema (due to anaphylaxis) and trauma. The differential diagnosis for acute upper airway obstruction in a child is shown below.

Causes of Airway Obstruction in the Young Child

Incidence	Diagnosis
Very common	Viral Croup
Common	Recurrent or spasmodic Croup
Uncommon	Anaphylaxis, Laryngeal Foreign body
Rare	Retropharyngeal Abscess, Epiglottitis, Diphtheria, Trauma, Bacterial Tracheitis

Clinical Presentation

Common clinical findings of upper airway obstruction in children are :

- Inspiratory Stridor
- Tachypnoea
- Chest retractions and Nasal Flaring

The cardinal features of upper airway obstruction are inspiratory stridor and respiratory distress. Clinical features of respiratory distress include marked tachypnoea and tachycardia, ability to speak only single words or phrases and an upright posture associated with the use of accessory muscle and marked intercostal and sternal recession. Late signs indicating life-threatening hypoxia are cyanosis and decreasing conscious level.

Normal limits for the Respiratory Rate in a Child

Age	Respiratory rate
< 1 year	30 - 40
1 to 4 years	25 - 30
5 to 12 years	20 - 25
> 12 years	15 – 20

Viral Croup

Croup is an acute clinical syndrome characterised by inspiratory stridor, barking cough, hoarseness and variable degrees of respiratory distress. Acute viral laryngotracheobronchitis (or viral croup) is the most common form of croup and accounts for 95% of laryngotracheal infections. Parainfluenza viruses are the most common pathogens.

Allergic or Recurrent Croup is common and results in recurrent episodes of croup without fever or URTI symptoms in a child.

The typical features of viral croup are barking cough, harsh stridor and hoarseness usually preceded by fever and coryza for 1 - 3 days. The symptoms often start and are worse at night. Many children have stridor and a mild fever (< 38.5 degrees C), with little or no respiratory difficulty.

If tracheal narrowing is minor, stridor will be present only when the child hyperventilates or is upset. As the narrowing progresses, the stridor becomes both inspiratory and expiratory and is present even when the child is at rest. Some children, and particularly those below the age of three years, develop the features of increasing obstruction and hypoxaemia with marked sternal and subcostal recession, tachycardia, tachypnoea and agitation. X-rays are not routinely required.

Differential diagnosis

Accurate diagnosis is critical. Other causes should be excluded particularly Epiglottitis. Epiglottitis is characterised by acute onset, toxic appearance, drooling and absent or muffled cough. A comparison of the clinical features for croup and epiglottitis is shown in the table below.

Distinguishing clinical features for Croup and Epiglottitis

Feature	Croup	Epiglottitis
Onset	Over days	Over hours
Preceding coryza	Yes	No
Cough	Severe, Barking	Absent or slight
Able to drink	Yes	No
Drooling saliva	No	Yes
Appearance	Unwell	Toxic, Very ill
Fever	< 38.5 ºC	> 38.5 ºC
Stridor	Harsh, rasping	Soft
Voice	Hoarse	Reluctant to speak, muffled

Management

Children with croup are often miserable, frightened and uncomfortable. Crying increases their oxygen demand and may increase the laryngeal swelling. Gentle confident handling reassures the child and parents. Children prefer to be on their parent's lap. Disturbance of the child should be kept to a minimum.

Patients may be classified based on the degree of airway obstruction as :

- Mild — Stridor only when agitated
- Moderate — Stridor at rest + Moderate respiratory distress
- Severe — Stridor at rest + Severe respiratory distress
- Life threatening — Altered mental state / Severe hypoxia

Most cases of viral croup resolve spontaneously within 2 to 4 days. In others increasing distress necessitates hospital admission. The respiratory rate and sternal recession are the best clinical indicators of the degree of respiratory distress. Patients presenting late at night or with continuing stridor at rest should be admitted for observation. A clinical guideline for the management of croup is shown on the following page.

Steroids modify the natural history of croup, and a single dose should be administered to all children presenting with suspected viral croup. Options include oral Prednisolone (1 mg/kg) or Dexamethasone (0.15 mg/kg IM or orally).

Suspected Viral Croup in a Child

In a Child presenting with Inspiratory Stridor always consider following causes :

- **Airway Foreign Body** : Suspect in absence of characteristic barking cough and preceding coryza
- **Anaphylaxis** : History of Allergen, Sudden onset, Wheezing and/or Hypotension, Rash, GI symptoms
- **Epiglottitis** : Non-immunised to HIB, Absent cough, Fever / Toxicity, Drooling, Posture

Mild Croup
Barking Cough
No Stridor at rest

→

Management
Administer Oral Steroid
- Dexamethasone 0.15 mg/kg (max 12mg)
  or Prednisolone 1 mg/kg (max 50mg)

Parental advice
Discharge home
(No antibiotics, No antitussives (codeine), No Heliox)

Moderate Croup
Barking cough
Stridor at rest
Minimal respiratory distress

→

Management
Consider Adrenaline Neb (0.5mg/kg to max 5mg 1:1000)
Administer Oral Steroid
- Dexamethasone 0.15 mg/kg (max 12mg)
  or Prednisolone 1 mg/kg (max 50mg)

Admission for observation
(No antibiotics, No antitussives (codeine), No Heliox)

Severe Croup
Increasing irritability +/- lethargy
Loud Stridor at rest
Marked respiratory distress
- Marked increased resp rate
- Tracheal tug, Nasal Flaring
- Marked chest retraction

Hypoxaemia is a late sign !

→

Management
Administer High flow Oxygen (but avoid upsetting child)
Give Adrenaline Neb(s) (0.5mg/kg to max 5mg 1:1000)
- Repeat Adrenaline Nebs @ 10 - 20 mins if required
- Dexamethasone 0.6 mg/kg (IM/IV) to max 12 mg

Observe closely for deterioration
Consider GPA notification
Transfer to Tertiary Hospital for observation

Life Threatening Croup
Altered mental state
Soft or absent stridor
Decreased respiratory rate
Hypoxaemia (prearrest sign)

→

Management
Administer High flow Oxygen
Adrenaline Neb (0.5mg/kg to max 5mg 1:1000)
- Repeat Adrenaline Nebs as required
- Dexamethasone 0.6 mg/kg (IM/IV) to max 12 mg

Reassess Diagnosis : Consider Airway FB, Epiglottitis
Have Bag valve mask ready to assist ventilation
Call GPA for airway support : Prepare for intubation
Contact Retrieval / ICU

Management of Severe Upper Airway Obstruction due to Viral Croup

Signs of severe upper airway obstruction in the child with croup include extreme restlessness, decreasing conscious state, decreasing respiratory effort, decreasing stridor and decreasing breath sounds.

In children with severe croup begin by applying oxygen (whilst avoiding upsetting the child) and administer nebulised Adrenaline 1:1000 (0.5 mg/kg to a max 5 mg).

- Administer Oxygen : Hold mask in proximity to face
- Nebulised Adrenaline : May be repeated as required
- Intubation : Required in severe life threatening cases not responding to adrenaline
- Assess hydration : Ensure adequate fluids are given
- Steroids : Dexamethasone 0.6 mg/kg IM or orally (max 12mg) or Oral Prednisolone (1 mg /kg)

Patients given nebulised adrenaline warrant at least 2 hours of observation regardless of initial improvement.

Epiglottitis

Epiglottitis is now rare in the childhood population following introduction of Haemophilus influenzae B (HIB) immunisation. Caused most commonly by HIB and affecting children aged 2 - 7 years old, the disease presents with the abrupt onset (within hours) of fever, sore throat, dysphagia and drooling.

On examination the child appears toxic, anxious and breathing quietly with little air movement. In contrast to croup there is *no hoarseness* and *no cough* and the child (if they speak at all) speaks in a whispering voice. Characteristically the child is sitting upright with their chin forward, neck slightly hyperextended (the sniffing position) and refuses to lie flat.

Management

In the child with suspected epiglottitis the management is to examine the throat under anaesthesia. Do not attempt to examine the throat or lay the child down as this may precipitate acute airway obstruction.

- Call an anaesthetist
- Prepare for intubation using a gaseous induction followed by bag and mask ventilation
- Examine the throat under anaesthesia
- Intubation is performed with an endotracheal tube one size less than for age
- Following airway control : Provide Humidified Oxygen, IV fluids, Antibiotics (Ceftriaxone)
- ICU care and sedation. Extubate in 24 - 48 hours

Adult Epiglottitis

With widespread immunisation, the incidence of HIB epiglottitis in young children has dramatically decreased and the disease is now most commonly seen in teenagers and young adults. In this age group the disease presents more subtly (often over several days) beginning with a severe sore throat and fever and progressing to drooling and finally to stridor and life threatening airway obstruction. Causes include infection with streptococcus, staphylococcus or even pneumococcus.

The diagnosis is easily overlooked in teenagers and adults unless it is considered in the differential diagnosis of a severe sore throat. The clinical finding that should always prompt consideration for adult epiglottitis is when a patient's symptoms (severe throat pain / unable to swallow / drooling) do not match the clinical findings of mild to moderate pharyngeal inflammation. These patients require urgent assessment.

Depending on the clinical context a soft tissue neck X-ray, CT of the neck tissues and fibreoptic nasopharyngoscopy may be used to confirm the diagnosis. Treatment involves attention to ensuring the airway is maintained, ICU admission and IV antibiotics.

Foreign Body Aspiration[10]

This is the most common cause of (in home) accidental death in children < 6 years. Foreign bodies include peanuts, sunflower seeds, sausages and small toys. The child may present with unilateral or bilateral wheezing, inspiratory stridor, apnoea, coughing or persistent pneumonia. The usual site is the right mainstem bronchus and less commonly the larynx or trachea.

A triphasic clinical course is described beginning with an acute choking or gagging episode (that may pass unobserved by the parents), followed by a latent asymptomatic period and finally the development of complications from retained foreign body including pneumonia, atelectasis and wheezing.

As many as 30% to 40% of FB aspirations are not witnessed or recalled by patient or parents. Therefore, always retain a high index of suspicion !

Soft tissue neck X-ray and CXR are useful in children with suspected foreign body aspiration. If the foreign body is radio-opaque the foreign body should be readily identified on X-ray. If, however it is radiolucent indirect signs may indicate the presence of a foreign body. In the upper airway the FB may be outlined by air in larynx or trachea. A foreign body in the mainstem bronchus may cause hyperinflation in the expiratory / decubitus films or in severe cases a shift in the mediastinum away from the side with the foreign body.

In children with suspected foreign body aspiration, bronchoscopy and/or oesophagoscopy will be required to identify and remove the foreign body.

Bacterial tracheitis (Membranous Laryngotracheobronchitis)

This is a life-threatening cause for upper airway obstruction usually due to superinfection of a viral URTI. Causative organisms include Staphylococcus aureus, Pneumococcus and Gram-negative organisms. It occurs most commonly in children less than three years but may also occur in older children.

The disease is characterised by profuse airway secretions, severe respiratory distress, toxicity and a raspy hoarse voice. In contrast to epiglottitis patients do not have dysphagia and X-ray findings demonstrate subglottic airway narrowing.

Management

Management involves securing the airway (intubation), IV antibiotics (Vancomycin and Ceftriaxone) and ICU admission.

Retropharyngeal Abscess

Retropharyngeal abscess is most common in children 6 months to 4 years. Patients appear unwell (toxic) and present with fever, drooling, dysphagia and inspiratory stridor. Sudden airway obstruction (and death) may occur from acute rupture of the abscess and complications include aspiration pneumonia, empyema and erosion of great vessels and arteries.

A widened retropharyngeal space may be seen on lateral X-ray differentiating abscess from cellulitis.

Management

Treatment is intubation, antibiotics and operative drainage. Great care is required with the intubation to avoid rupture of the abscess.

[10] See Chapter 44 for discussion of the immediate management of foreign body airway obstruction in a child.