2013
STANDARD TREATMENT PROTOCOLS
PAEDIATRICS

[DRAFT ONLY – Please give your feedback to Dr Srilal de Silva, before 14th of April]

SRI LANKA COLLEGE OF PAEDIATRICIANS
[Pick the date]
# Contents

<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Paediatric parameters</td>
<td>3</td>
</tr>
<tr>
<td>Paediatric Triage</td>
<td>4</td>
</tr>
<tr>
<td>Pathways leading to cardiac arrest</td>
<td>7</td>
</tr>
<tr>
<td>Anatomical &amp; Physiological differences in children</td>
<td>8</td>
</tr>
<tr>
<td>Emergency Management of seriously ill patient</td>
<td>11</td>
</tr>
<tr>
<td>Paediatric Basic life Support</td>
<td>12</td>
</tr>
<tr>
<td>Paediatric Cardiac arrest</td>
<td>13</td>
</tr>
<tr>
<td>Asystole, PEA &amp; Ventricular Fibrillation</td>
<td>14</td>
</tr>
<tr>
<td>Childhood Bradycardia</td>
<td>15</td>
</tr>
<tr>
<td>SVT</td>
<td>16</td>
</tr>
<tr>
<td>Newborn Resuscitation</td>
<td>17</td>
</tr>
<tr>
<td>Respiratory data</td>
<td>18</td>
</tr>
<tr>
<td>Airway Management</td>
<td>19</td>
</tr>
<tr>
<td>Paediatric intubation</td>
<td>20</td>
</tr>
<tr>
<td>Oxygen therapy</td>
<td>23</td>
</tr>
<tr>
<td>Rapid Sequence intubation</td>
<td>24</td>
</tr>
<tr>
<td>Upper airway Obstruction</td>
<td>25</td>
</tr>
<tr>
<td>Viral Croup</td>
<td>27</td>
</tr>
<tr>
<td>Epiglotittis</td>
<td>28</td>
</tr>
<tr>
<td>Bronchiolitis</td>
<td>30</td>
</tr>
<tr>
<td>Acute severe asthma</td>
<td>32</td>
</tr>
<tr>
<td>Inhaled Foreign Body</td>
<td>37</td>
</tr>
<tr>
<td>Community Acquired Pneumonia</td>
<td>38</td>
</tr>
<tr>
<td>Febrile child</td>
<td>42</td>
</tr>
<tr>
<td>SIRS</td>
<td>43</td>
</tr>
<tr>
<td>Febrile Neutropenic guidelines</td>
<td>44</td>
</tr>
<tr>
<td>Febrile Convulsions</td>
<td>45</td>
</tr>
<tr>
<td>Diarrhoea &amp; Dehydration</td>
<td>46</td>
</tr>
<tr>
<td>Child in Shock</td>
<td>47</td>
</tr>
<tr>
<td>Septic shock</td>
<td>48</td>
</tr>
<tr>
<td>Inotropes</td>
<td>49</td>
</tr>
<tr>
<td>Anaphylactic shock</td>
<td>50</td>
</tr>
<tr>
<td>Dengue Shock Syndrome</td>
<td>51</td>
</tr>
<tr>
<td>GGCS</td>
<td>52</td>
</tr>
<tr>
<td>Status Epilepticus</td>
<td>53</td>
</tr>
<tr>
<td>Prolonged tonic clonic seizures</td>
<td>54</td>
</tr>
<tr>
<td>Bacterial Meningitis</td>
<td>56</td>
</tr>
<tr>
<td>Decreased Level of Consciousness</td>
<td>57</td>
</tr>
<tr>
<td>Topic</td>
<td>Page</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Normal fluid &amp; electrolytes</td>
<td>60</td>
</tr>
<tr>
<td>Hyperkaelaemia</td>
<td>62</td>
</tr>
<tr>
<td>Hypokaelaemia</td>
<td>63</td>
</tr>
<tr>
<td>Hyponatatrema</td>
<td>65</td>
</tr>
<tr>
<td>Hypernatraemia</td>
<td>68</td>
</tr>
<tr>
<td>Diabetic Ketoacidosis</td>
<td>69</td>
</tr>
<tr>
<td>Sedation for children</td>
<td>70</td>
</tr>
<tr>
<td>Blood Components administration</td>
<td>73</td>
</tr>
<tr>
<td>Acid Base balance</td>
<td>77</td>
</tr>
<tr>
<td>Urinary Tract Infection</td>
<td>80</td>
</tr>
<tr>
<td>Hypertension</td>
<td>83</td>
</tr>
<tr>
<td>Acute Kidney Injury</td>
<td>89</td>
</tr>
<tr>
<td>Management of snake bite</td>
<td>93</td>
</tr>
<tr>
<td>Management of Acute Poisoning</td>
<td>94</td>
</tr>
<tr>
<td>Structured Approach to the seriously injured child</td>
<td>96</td>
</tr>
<tr>
<td>Metabolic abnormalities</td>
<td>98</td>
</tr>
<tr>
<td>Principle of safe transfer and retrievals</td>
<td>99</td>
</tr>
<tr>
<td>Venessection with broken needles</td>
<td>101</td>
</tr>
<tr>
<td>Intraosseous access</td>
<td>102</td>
</tr>
<tr>
<td>Peripheral intravenous access</td>
<td>104</td>
</tr>
<tr>
<td>Arterial cannulations</td>
<td>109</td>
</tr>
<tr>
<td>Capillary blood sampling</td>
<td>111</td>
</tr>
</tbody>
</table>
# Normal Paediatric Parameters

<table>
<thead>
<tr>
<th>Age</th>
<th>Weight (kg)</th>
<th>Heart rate (per min)</th>
<th>Respiratory rate</th>
<th>BP Systolic (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature</td>
<td>1</td>
<td>145</td>
<td>&lt;40</td>
<td>42 ± 10</td>
</tr>
<tr>
<td>Newborn</td>
<td>2-3</td>
<td>125</td>
<td></td>
<td>60 ± 10</td>
</tr>
<tr>
<td>1 month</td>
<td>4</td>
<td>120</td>
<td>24-35</td>
<td>80 ± 16</td>
</tr>
<tr>
<td>6 month</td>
<td>7</td>
<td>130</td>
<td></td>
<td>89 ± 29</td>
</tr>
<tr>
<td>1 year</td>
<td>10</td>
<td>130</td>
<td>20-30</td>
<td>96 ± 30</td>
</tr>
<tr>
<td>2-3 years</td>
<td>12-14</td>
<td>120</td>
<td></td>
<td>99 ± 25</td>
</tr>
<tr>
<td>4-5 years</td>
<td>16-18</td>
<td>100</td>
<td></td>
<td>99 ± 20</td>
</tr>
<tr>
<td>6-8 years</td>
<td>20-26</td>
<td>100</td>
<td>12-25</td>
<td>105 ± 13</td>
</tr>
<tr>
<td>10-12 years</td>
<td>32-42</td>
<td>75</td>
<td></td>
<td>112 ± 19</td>
</tr>
<tr>
<td>&gt;14 years</td>
<td>50</td>
<td>75</td>
<td>12-18</td>
<td>120 ± 20</td>
</tr>
<tr>
<td>PAEDIATRIC TRIAGE TOOL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PAIN</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Limited movement</td>
<td>Distressed</td>
<td>Obvious deformity</td>
<td>Guards or posts</td>
<td>Insensible</td>
</tr>
<tr>
<td>No pain</td>
<td>Severe pain (pain score 8-10)</td>
<td>Moderate pain (pain score 5-7)</td>
<td>Mild pain (pain score 1-4)</td>
<td></td>
</tr>
<tr>
<td><strong>CIRCULATION</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Colour (pale mottled, cyanosis)</td>
<td>Peripheral pulses (normal to thready)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No pulse</td>
<td>Bradycardia</td>
<td>Severe haemodynamic compromise, uncontrolled bleeding</td>
<td>CRFT &gt; 4 seconds</td>
<td></td>
</tr>
<tr>
<td>Mild</td>
<td>Moderate haemodynamic compromise, minor dehydration</td>
<td>CRFT 2-4 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Severe</td>
<td>Mild haemodynamic compromise, mild dehydration</td>
<td>CRFT &lt; 2 seconds</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td><strong>BREATHEING</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rate, Rhythm, Breaths, Accessory noises, Abdominal breathing, Tracheal position, SpO2 in air</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apnoea, Hypventilation, Severe respiratory distress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respiratory distress (severe to moderate)</td>
<td>Respiratory distress (mild to moderate)</td>
<td>Mild Respiratory distress to normal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>AIRWAY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stridor, Snoring, Drooling, Position (tripod)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obstructed</td>
<td>Partially obstructed + severe respiratory distress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Partially obstructed + moderate respiratory distress</td>
<td>Partially obstructed + mild respiratory distress</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>DISABILITY</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lethargy, Drowsiness, Floppy, Weak cry, Irritable, (insensible cry by parent/carer)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unresponsive</td>
<td>Responds only to pain</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Response only to voice</td>
<td>Severe decrease in activity</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate decrease in activity</td>
<td>Recent seizure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alert to mild decrease in activity</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TRIGGERS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>
Triage of the Sick Child

A  Arousal, Alertness, Activity

B  Breathing difficulty
   (Work of breathing, efficacy, effect on other organs)

C  Colour (pallor) and Circulatory impairment
   (mottling, CRFT, Pulse, BP)

D  Decreased drinking
   (<half the usual amount in the last 24 hrs)
   Decreased Urine output
   (<4 wet nappies in the last 24 hrs for infants)
Risk Factors

- Febrile or Hypothermia (under 3 months, Fever > or = 38°C)
- Rash - Non blanching petechiae or purpura
- Mechanism of injury MVA, Car vs Pedestrian, Penetrating injury, Envenomation, Immersion, Electrocution,
- Co-morbidity – Leukaemia, Renal, Cardiac, Respiratory, Prematurity, Developmental delay,
- Events preceding presentation eg apnoea or seizures at home, fluctuating level of consciousness,
- Child protection issues.

Generally parents know their children best, and recognize when they are unwell. Always listen to parents concerns.

Fluid Balance

- Decrease level of consciousness
- Capillary refill > 2seconds
- Dry oral mucosa
- Sunken eyes
- Decrease skin turgor
- Absent tears
- Deep respiration
- Tachycardia
- Decreased urine output

Sever >6 signs of dehydration
Moderate 3 – 6 signs of dehydration
Mild < 3 signs of dehydration

Temperature per axilla < 3 years
Pathways leading to cardiac arrest

Fluid loss
Blood Loss
Gastroenteritis
Burns

Fluid Maldistribution
Septic shock
Cardiac disease
Anaphylaxis
Dengue Shock Syndrome
Nephrotic Syndrome

Respiratory Distress
Foreign Body Croup
Asthma
Bronchiolitis
Pneumonia
Pneumothorax

Respiratory Depression
Convulsions
Raised ICP
Poisoning
Krait Bite
Guillain-Barre Syndrome

Circulatory Failure
Respiratory Failure

CARDIAC ARREST
Anatomical & Physiological differences in children

Children are not just small adults; they are small adults with big heads.

1. Airway
   a. Neonates are obligatory nasal breathers
   b. Big tongue.
   c. Big occiput
   d. Large head, small jaw and strong muscular tongue
   e. Hyperextension can block airway.
   f. Larynx higher in neck and more anterior “Look up” when intubating.
   g. Epiglottis at 45 degrees angle, large and floppy.
   h. Cervical spine more cartilaginous and flexible.
   i. Trachea is short, ETT are easily dislodged or pushed down right main bronchus; Recheck ETT after all movement.

2. Airway position
   a. Infants – neutral airway (Infant with big occiput - towel under shoulders )
   b. Children – sniffing air
   c. Hyperextension or hyperflexion can cause airway block.
   d. Upright for upper airway obstruction
   e. In the parent’s lap if the child is upset.

3. Breathing differences
   a. Thorax more pliable.
   b. Belly breathers
   c. Higher normal respiratory rate for the age.
   d. Higher metabolic rate relative oxygen consumption and lower functional residual capacity result in rapid oxygen desaturation even with pre-oxygenation

4. Circulation differences
   a. Higher resting pulse rate for the age and tolerate much higher pulse rate
   b. Limited capacity to increase cardiac output / stoke volume.
   c. Age appropriate blood pressure ; lower normal blood pressure
      i. Systolic BP: [Age*2] + [70-90]
      ii. Hypertension in children is pre morbid
   d. Child in shock
   e. Predominantly chronotropic response to shock
f. Volume resuscitation is with isotonic crystalloid solutions

5. Disability/Dextrose
   - AVPU (Alert/ Responds to Voice/ Responds to Pain/ Unresponsive)
   - “P” or “U” means that the child has an unprotected airway.
   - GCS: age appropriate modification (two charts <4 years and >4 years).
   - Children have limited Glycogen stores; Check BSL in all sick children.

6. Exposure/Environment
   - Large surface area in relation to size results in rapid heat loss.
   - Check core temperature in sick children.
   - Look for rashes in skin folds and pressure areas.

7. Normal paediatric parameters- Weight, HR, BP, RR chart

8. Formulae for calculating a child’s weight and blood pressure
   a. Estimating body weight
   b. Broselow tape
| TRIAGE | • Place the child in a resuscitation area and commence their initial stabilisation |
| INITIAL STABILISATION | • Simultaneous assessment and treatment |
| **Position the patient** | • Optimally for the clinical circumstances |
| **Airway** | • Keep patient. This may require a combination of standard airway opening manoeuvres and more complex manoeuvres. If there is any likelihood of cervical spinal injury, perform in-line immobilization followed by the application of a hard cervical collar |
| **Breathing** | • WOB - RR, Rhythm, recession, accessory muscles, alar nasal flaring, noisy, • Effect of breathing - AE, Tracheal position, chest expansion, SpO₂ in air & FiO₂, paradoxical breathing |
| **Circulation** | • If in cardiac arrest → commence CPR, attach cardiac monitor and assess rhythm (shockable / Non-shockable) • Measure pulse rate, pulse volume, CRFT, Line of coldness, BP • Insert IV canula → Blood sugar, Blood culture, FBC, Grouping & DT • If in shock give fluid bolus and inotropes |
| **Disability** | • Measure AVPU and Glasgow Coma Scale and record pupils response and posture. If GCS < 8 and not rapidly improving, consider endotracheal intubation to protect the airway from aspiration. |
| **Measure** | • Temperature and finger prcick blood sugar. If hypoglycaemia is found give 10% dextrose 3-5ml/kg and then re-measure the RBS. |
| **Monitor** | • ECG, SaO₂, BP |
| **Re-assess** | • Reassess the above steps and treat any further abnormalities that may have developed. |
| **DIRECTED HISTORY AND EXAMINATION** | • Focus on the features relevant to the patient's immediate illness |
| **COMMENCE SPECIFIC TREATMENT** | • Identify and perform patient intervention which may be pivotal or time critical to patient's outcome |
| **ONGOING CARE** | • Admit to an area with appropriate staffing and equipment AND/OR • Ensure appropriate patient hand over with clear instructions for ongoing management. AND/OR • Arrange medical retrieval if indicated. |
Emergency Management of Seriously ill patient

1. Triage
   a. Place the patient in resuscitation area and commence their initial stabilization

2. Initial Stabilisation (Simultaneous assessment and treatment)
   a. Position the Patient (Optimally for the clinical circumstances)
   b. Airway
      Keep patent – This may require combination of standard airway opening manoeuvres and more complex manoeuvres. **If there is any likely hood of cervical spinal injury, perform in-line immobilization followed by the application of the hard cervical collar.**
   c. Breathing
      • Assess the respiratory rate and effort. If inadequate assist ventilate with a bag & mask attaché to oxygen.
      • Measure SO2. If <95% and not requiring assisted ventilation administer oxygen via an appropriate face mask at a rate according to the clinical circumstance.
      • Ausculate the chest.
   d. Circulation
      • If in cardiac arrest commence CPR, otherwise >>
      • Measure PR, BP and CRFT
      • Attach to a cardiac monitor and assess rhythm – correct any immediately life threatening rhythm disturbances.
      • Insert an IV cannula.
      • Take blood from the cannula for appropriate blood tests.
      • If the patient is in shock, give fluid and inotropes as appropriate.
   e. Disability
      Measure the GGCS, Posture and pupils (**if GGCS is <8 and not rapidly improving consider endotracheal intubation from to protect the airway from aspiration.**)  
   f. Measure
      • Temperature → check for hypothermia or Hyperthermia
      • Check BM Sick, Hypoglycaemia → 10% Dextrose 3-5ml/kg IV.
   g. Monitor -- (ECG, SaO2, BP)
   h. Reassess – The above steps and treat any further abnormalities that may have developed.

3. Directed history & Examination
   • Focus on the features relevant to the patient immediate illness.

4. Commence specific treatment
   • Identify and perform patient’s intervention which may be pivotal or time critical to the patients outcome.

5. On going care
   • Admit to and area with appropriate staffing and equipment.
   • AND/OR ensure appropriate handover with clear instructions for ongoing management.
   • AND/OR arrange medical retrieval if indicated
Paediatric Basic Life Support

Dangers?

Responsive?

Send for help?

Open airway?

Normal Breathing?
  Give 2 breaths

Check pulse? — Take no more than 10 seconds
  Start CPR — 15 compressions: 2 breaths

Ensure help is coming
  Attach defibrillator / monitor
  As soon as available

Continue CPR until responsiveness or normal breathing return
Paediatric Cardiac Arrest Algorithm

1. **Dangers**

2. **Responsive?**
   - **Send for help?**
   - **Open airway?**
   - **Normal breathing?**
     - **Give 2 breaths**
     - **Check pulse?**
       - **Give 2 breaths**
       - **Start CPR**
         - 15 compressions : 2 breaths
     - **Ensure help is coming**
     - **Attach defibrillator / monitor**
       - As soon as available

3. **Assess Rhythm**
   - Shockable VF / Pulseless VT
   - Non-Shockable PEA / asystole
Algorithm for asystole, PEA and ventricular fibrillation, VT

Start CPR

Attach defibrillator / monitor

Shockable VF / VT

Assess rhythm

Non-Shockable PEA / Asystole

Return of spontaneous circulation?

During CPR
Airway adjuncts(LMA/ETT)
Oxygen
Waveform capnography
IV/IO access
Plan actions before interrupting compressions (e.g. charge manual defibrillator to 4J/kg)

Consider and correct
Hypoxia
Hypovolaemia
Hypothermia/hyperthermia
Hyper/Hypokalaemia/metabolic disorders
Tension pneumothorax
Tamponade
Toxins
Thrombosis (pulmonary/cononary)

Post resuscitation care
Re-evaluate ABCDE
12 lead ECG
Treat precipitating causes
Re-evaluate oxygen ation and ventilation
Temperature control (cool)

Adrenalin 10mcg/kg (immediately then every 2nd loop)

CPR
For 2 minutes

Shock (4J/kg)

Adrenalin 10mcg/kg
After 2nd shock (then every 2nd loop)
Amiodarone 5mg/kg
After 3rd shock

Adrenalin 10mcg/kg (immediately then every 2nd loop)
CPR
For 2 minutes

Post-resuscitation care
Child with Bradycardia

Yes

Treat Hypoxia And shock

No

Seek opinion

Shock present

Yes

Vagal overactivity ?

No

Adrenaline 10 mcg/kg

Atropine 20mcg/kg

Consider Adrenaline infusion Pacing
Emergency Treatment of Supraventricular Tachycardia

- Perform ECG rhythm strip and 12 lead ECG
- Heart rate is usually 220-300/minute, regular with no beat to beat variation
- P waves may or may not be present
- QRS complexes – usually narrow
- Check whether child is in shock or not
- Check electrolytes – Ca, Mg, K

1. **Shock present?**
   - Yes
     - Vagal manoeuvres (if no delays)
     - Establishing vascular access quicker than obtaining defibrillator
   - No
     - Synchronous DC shock 1 J/kg
     - Synchronous DC shock 2 J/kg
     - Consider amiodarone or other antiarrhythmics (Discuss with paediatric cardiologist)
     - Max 12mg (neonate 300mcg/kg)

2. **Shock present?**
   - No
     - Vagal manoeuvre
     - Diving reflex
       - One sided carotid sinus massage

3. **Yes**
   - Adenosine 100 mcg/kg
   - Adenosine 200 mcg/kg
   - Adenosine 300 mcg/kg
   - Consider Adenosine 400-500 mcg/kg
   - Synchronous DC shock
   - Or amiodarone or other antiarrhythmics (Discuss with paediatric cardiologist)
Newborn Resuscitation

At all stages ask: Do you need help?

Yes

Stay with mother

No

Term gestation?
Breathing or crying?
Good tone?

Yes

Prevent heat loss
Ensure open airway
Stimulate

No

Prevent heat loss
Ensure open airway
Stimulate

HR below 100?
Gasping or apnoea?

Yes

Positive pressure ventilation
SpO₂ monitoring

No

Laboured breathing or persistent cyanosis?

Yes

Ensure open airway
SpO₂ monitoring
Consider CPAP

No

Ensure open airway
Reduce leaks
Consider increasing pressure & oxygen

HR below 100?

Yes

Ensure open airway
Reduce leaks
Consider increasing pressure & oxygen

No

HR below 100?

Yes

Add chest compressions
3 compressions to each breath
100% oxygen
Consider intubation or LMA

No

HR below 60?

Yes

Add chest compressions
3 compressions to each breath
100% oxygen
Consider intubation or LMA

No

HR below 60?

Yes

Venous access, adrenaline
Consider volume expansion

Routine care:
Prevent heat loss
Ongoing evaluation

Yes

Colour
Tone
Breathing
Heart rate

No

Ensure Targeted pre-ductal SpO₂ after birth

1 min – 60-70%
2 min – 65-85%
3 min – 70-90%
4 min – 75-90%
5 min – 80-90%
10 min – 85-90%

Adrenaline IV 10-30 mcg/kg
(0.1 – 0.3ml/kg of 1:10,000 solution)
### Respiratory Data

**Oxygen concentration via Semi Rigid Mask**

<table>
<thead>
<tr>
<th>Oxygen flow rate I / min</th>
<th>Approximate FiO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>0.35</td>
</tr>
<tr>
<td>6</td>
<td>0.5</td>
</tr>
<tr>
<td>8</td>
<td>0.55</td>
</tr>
<tr>
<td>10</td>
<td>0.6</td>
</tr>
<tr>
<td>12</td>
<td>0.65</td>
</tr>
<tr>
<td>15</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**Oxygen dissociation curve**

<table>
<thead>
<tr>
<th>Saturation</th>
<th>PO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>25%</td>
<td>14</td>
</tr>
<tr>
<td>50%</td>
<td>27</td>
</tr>
<tr>
<td>75%</td>
<td>40</td>
</tr>
<tr>
<td>90%</td>
<td>58</td>
</tr>
<tr>
<td>94%</td>
<td>69</td>
</tr>
<tr>
<td>95%</td>
<td>74</td>
</tr>
<tr>
<td>96%</td>
<td>81</td>
</tr>
<tr>
<td>97%</td>
<td>92</td>
</tr>
<tr>
<td>98</td>
<td>111</td>
</tr>
<tr>
<td>99</td>
<td>159</td>
</tr>
</tbody>
</table>

**Tidal volume 7-10 ml/kg**

**Minute Volume 100ml/kg**

**Vital Capacity 50ml/kg**

**FEV1 / FVC – 75-80%** (decreased in obstructive, normal or increased in restrictive)

**Left shift** (reduced CO₂, 2,3 DPG, Temperature, H⁺, Foetal Hb, Met Hb, COHb)

**Right up** (up CO₂, 2.3DPG, Temp, H⁺)
Airway Management

1. Basic airway opening manoeuvres and clearance
2. Oxygen delivery
3. Oropharyngeal airway insertion
4. Nasopharyngeal airway insertion
5. Mouth-to-mask ventilation including chin lift and jaw thrust manoeuvres with mask application
6. Bag-mask ventilation
7. Orotracheal intubation of an infant or small child
8. Orotracheal intubation of an older child
9. Ventilation with bag through tracheal tube
10. Discussion of the procedure for Rapid Sequence Induction of anaesthesia and their role as an assistant

Basic airway station &

1) Airway opening manoeuvres
   a) Head tilt / chin lift
   b) Jaw thrust

2) Airway adjuncts
   a) Oral and nasal airways
Rapid Sequence Intubation

3) Intubation
   a) Golden Rules
      • You don’t need an ETT in place to keep an airway open to oxygenate a patient.
      • Don’t give paralytic agent to a patient unless you are sure you can ventilate and oxygenate.
      • All intubations are difficult for inexperienced operator.
      • Have a back up plan ready for the failed intubation before attempting any intubation.

   b) Essential Skills - Intubation using Rapid Sequence Induction (RSI) : the 4 Ps
      Purpose
      • Why intubate
      • Why RSI
      • Prerequisites
        (a) Full stomach- No bagging
        (b) Predict that you can intubate (Skill station 2= difficult intubation)
        (c) Predict that you can ventilate (If you are unsuccessful intubating)

   c) 6 “P”s for the Rapid Sequence Intubation
      1. Preparation
         • Staff
         • Patient
         • Equipment
         • Non-invasive monitoring
         • Drugs
      2. Preoxygenation
      3. Paralysis after induction
      4. Protection and positioning
         • Cricoid pressure
      5. Placement and proof
         • EtCO2 and clinically
      6. Post intubation management
         • Sedation
         • Paralysis
         • Ventilation
         • Monitoring
d) Application of 6 “P” for RSI

- **Staff Roles**
  a) Team leader to undertake the airway management and intubation
  b) Anaesthetic/ Nurse – Equipment, IV access and Drugs –
  c) Doctor – Monitoring nurse to check Oxygen status, Arrhythmias, Blood pressure
  d) Doctor / Nurse – Documentation
  e) Nurse / doctor – Person to apply cricoids pressure (Cricoids pressure is of no proven benefit) & Cervical spine immobilization- when applicable

- **Check for IV access, Equipment and drugs**
  a) Patent IV access
  b) Check for working laryngoscope, Bag & mask,
  c) Appropriate Bag & mask, Laryngoscope with blades, Steylet, Maggi forcep, boguies
  d) Check on working order – oxygen saturation, ECG, NIBP.

- **Patient**
  a) Preoxygenate/Volume
     Bag and mask ventilation (10-15 liters per minute) for 3-5 minutes to maintain the SpO2 >95%
     During this procedure commence nasal prong oxygen 4 liters per minute. Once you remove the mask for intubation, increase the nasal prong oxygen to 10 liters per minute to sustain the oxygenation by passive diffusion method.
  b) Pretreatment/Monitors
     Atropine to reduce the secretions and prevent bradycardia
     Fentanyl to prevent intubation response.
     Monitor SpO2 , BP, ECG

- **Performance**

- **Position check**
  a) Chest expansion
  b) Air entry
  c) Vaporization of ETT
  d) Clinical: 50ml syringe aspiration technique
  e) Aids: Capnography / Capnometry
  f) Pulse oxymetry- Pitfalls

- **Back up plan**
  a) For difficult and failed intubation

4) **Desirable Skills**

  a) Special situations
     - Asthma
     - Raised ICP
     - Head injury
• Haemodynamically unstable

b) Oxymetry
c) Capnometry

Cuffed Endotracheal Tube

1. Indication for cuffed ETT
   1. Stiff lungs needs high positive and expiratory pressure (PEEP)
   2. Higher peak airway pressure may be required
   3. Gas consumption for PEEP on transport to be minimized.

2. Sizing
   • Internal diameter (i.d)
     Motoyama formula: internal diameter (mm) = (age/4 + 3.5)
   • Cuff pressure
     Inflate to just obliterate leak (can assess aurally/using intra oral CO2)
     Ideally < 20 cm H2O
   • Depth (clinical assessment vital)
     length (cm) = Oral (age/2 + 12)
     length (cm) = Nasal (age/2 + 15)

3. Complications and hazards
   • The ‘Black line’ as a guide to depth: this may result in inadvertent endobronchial intubation.
   • Avoid laryngeal cuff placement
     Monitor cuff pressures (manometer) and consider the relative risks of cuff pressure on tracheal perfusion in low cardiac output states.

4. Transport considerations
   Aeromedical transports: A climb in altitude will increase cuff pressure and this should be monitored/adjusted until cruise altitude. Alternatively replace the air in the cuff with water prior to transport.

5. Key messages:
   • PICU children may require higher peak and positive end expiratory pressures than would be routine in elective anaesthesia.
   • A cuffed tube that is too large should be identified at insertion in the usual way.
   • With a cuffed endotracheal tube it is possible to compensate for a slightly ‘small’ endotracheal tube or a patient with deteriorating lung compliance and increasing airway pressure requirements.
6. A
Laryngeal Mask

<table>
<thead>
<tr>
<th>Patient weight</th>
<th>Size</th>
<th>Max inflation volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newborn upto 5kg</td>
<td>1</td>
<td>4ml</td>
</tr>
<tr>
<td>5 – 10kg</td>
<td>1 ½</td>
<td>7ml</td>
</tr>
<tr>
<td>10 – 20kg</td>
<td>2</td>
<td>10ml</td>
</tr>
<tr>
<td>20 – 30 kg</td>
<td>2 ½</td>
<td>14ml</td>
</tr>
<tr>
<td>30 – small adult</td>
<td>3</td>
<td>20ml</td>
</tr>
</tbody>
</table>

Oxygen therapy

1. Oxygen delivery to a spontaneously breathing patient in respiratory distress.
2. Oxygen delivery to a patient in respiratory failure.

Oxygen therapy is very important in any seriously ill child. It relieves hypoxemia, decreases work of breathing and its deleterious effects on myocardium. Humidification and selecting a delivery system that least disturbs the child is important. Giving gentle synchronized support by a bag and mask in a spontaneously breathing child is helpful.

Oxygen delivery systems

<table>
<thead>
<tr>
<th>Nasal cannulae</th>
<th>Use only for supplemental oxygen at only 2 L per minute. High flow more than 6 L per minute may be irritating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nasal catheter</td>
<td>Flexible catheter placed behind uvula. NO advantage</td>
</tr>
<tr>
<td>Oxygen hood</td>
<td>Well tolerated and allows the control of oxygen saturation, humidity and temperature. High flow oxygen (10-15 l/minute) is required to flush CO2. Needs monitoring of oxygen concentration within the hood</td>
</tr>
<tr>
<td>Head box oxygen</td>
<td>Incubators in newborn babies can be used as oxygen tents</td>
</tr>
</tbody>
</table>
| Oxygen tent    | Simple masks – delivers 35-60% Minimum flow rate required to prevent re-breathing of CO2 is 6-10 lit/min
                Partial re-breathing masks – Simple mask with a reservoir bag. Provide 50-60% oxygen, generally flow of 10-12 l/min is required.
                Non re-breathing masks are incorporated with valves to prevent re-breathing of expired air and entry of room air. 95% oxygen can be delivered with 10-12 l/min flow rate.
                Venturi masks- Especially designed mixing chamber allows selection of a precise FiO2. Correct mixing chamber and the flow rate should be selected. Flow rate is marked on the chamber. |
### Rapid Sequence Intubation

**Objective:** To secure the airway rapidly and prevent aspiration of gastric contents.

**Steps**
- Preparation
- Preoxygenation
- Pretreatment
- Paralysis with induction
- Protection and Positioning
- Placement with proof
- Post intubation management

### Preparation
**Assess patient**
- Anatomy (short neck, micrognatia, habitus, injuries)
**Establish IV**
- Monitor SpO2, ECG, BP
**Assemble equipment** (tube and stylet, test cuff)
**Choose laryngoscope**
- blade, test light

### Preoxygenation
**Preoxygenate** for a full three minutes, to wash all of the nitrogen out of the lungs and create a reservoir of O₂.

### Pretreatment
- Often optional step
- Mitigate adverse reactions
  - Lidocaine – 1mg/kg
  - Opiods
  - Atropine for children <8 years
  - Defaculating dose of paralytics

### Paralysis with induction
- Rapidly acting induction agent.
  - Midazolam 0.1-0.5mg/kg
  - Ketamine 1-3mg/kg
- Rapidly acting neuromuscular paralytic
  - Succinylcholine 1-2mg/kg
  - Rocuronium 1mg/kg

### Protection and Positioning
**Watch for apnoea** within 20 seconds
- Bag & mask ventilation
**Sellick’s maneuver**
- Cricoids cartilage pressure helps prevents aspiration
- Continue until tube is placed or paralysis worn off.
- No bagging during RSI after induction

### Post intubation management
- Secure tube
- Recheck vital signs
  - Hear rate
  - Blood Pressure
**Post-intubation management**
- Medications
**Continued paralysis**
- Vecuronium 0.1mg/kg
**Sedation**
- Benzodiazepines
- Opioids
Upper airway obstruction (UAO)

1. Assessment
   The most pertinent clinical sign is stridor, which is usually an inspiratory noise, but sometimes can be both inspiratory and expiratory.

Not to be confused with:
- Wheeze: a sign of lower airway obstruction and narrowing.
- Stridor: signifies upper airway collapse in children with decreased conscious state, pharyngeal hypotonia or swallowing problems.

Causes of stridor:

<table>
<thead>
<tr>
<th>Common</th>
<th>Uncommon</th>
<th>Rare</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viral</td>
<td>Epiglottitis</td>
<td>Angioneurotic oedema</td>
</tr>
<tr>
<td>laryngotracheobronchitis (croup)</td>
<td>Bacterial tracheitis</td>
<td>Diphtheria</td>
</tr>
<tr>
<td>Superimposed infection on subglottic stenosis or laryngomalacia</td>
<td>Laryngeal foreign body</td>
<td>Retropharyngeal abscess</td>
</tr>
<tr>
<td></td>
<td>Inhalational injury (burns)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Anaphylaxis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Severe bilateral tonsillar enlargement</td>
<td></td>
</tr>
</tbody>
</table>

Key message:
Identify and treat serious upper airway obstruction. Once the airway is secure, time can be spent on identifying the specific cause for UAO.

Specific points in history:
- Is this a first presentation?
- Is there history of previous intubations or previous difficulty with intubation?
- Is the airway stable?

Danger signs and useful pointers to the cause of UAO:
- Sudden or rapid onset – foreign body, epiglottitis, tracheitis, anaphylaxis
- Soft or low pitched stridor – epiglottitis, tracheitis
- Toxic appearance and high fever - epiglottitis, tracheitis, retropharyngeal abscess
- Drooling, open mouth, sitting forward - epiglottitis, retropharyngeal abscess, severe tonsillar obstruction
2. Initial management

Irrespective of the cause for UAO, some general management guidelines apply:

2.1 General management: AVOID UPSETTING THE CHILD

- Leave child with parent in a comfortable position
- DO NOT insert tongue depressor
- DO NOT attempt IV access or blood tests
- DO NOT ask for a Chest or lateral neck X-ray
- DO NOT force an oxygen mask over face.
- Adrenaline nebulisers may temporarily relieve severe airway obstruction, usually in a dose of 0.5 ml/kg of 1:1000 solution, up to a maximum of 5 ml. The effect of adrenaline is temporary.
- Pulse oximetry is a poor guide to severity when oxygen is delivered
- Consider Heliox

2.2 Specific management of selected conditions:

- **Viral croup**: summarized in flow chart given in the next page.

- **Foreign body obstruction**: The management depends on the site and severity of airway obstruction. Intubation may result in further impaction of the foreign body, and should be considered ONLY when there is impending/actual cardio-respiratory arrest. The anaesthetist will then try to visualize/clear the object under direct laryngoscopy. Otherwise, examination under anaesthetic with rigid bronchoscopy by ENT team is the best option.

- **Bacterial tracheitis**: Stridor may be soft or absent even in severe airway obstruction. Consider early intubation by anaesthetist. After intubation the ET may become blocked with secretions.

- **Inhalational injury**: Along with the history, other pointers may include soot in sputum, singed nasal hair, soot around mouth and face, and facial burns involving mouth and nose. The airway must be secured at the earliest opportunity. Delay can lead to progressive airway obstruction due to oedema and a situation where intubation becomes impossible. Call anaesthetic team and intubate electively.
The scheme of management for Viral Croup

**Clinical syndrome**
- Inspiratory stridor
- Barking cough
- Hoarse voice
- Variable degree of respiratory distress

**Stridor**
- 0 – none
- 1 – at rest audible with stethoscope
- 2 – at rest audible without stethoscope

**Recession**
- 0 – none
- 1 – mild recession
- 2 – moderate recession
- 3 – severe recession

**Cyanosis**
- (SpO₂ < 92% in air)
- 0 – none
- 1 – with agitation
- 2 – at rest

**Level of consciousness**
- 0 – none
- 5 – altered mental state

**Supportive to diagnosis**
- During winter
- 6 months – 5 years
- Mild fever < 38.5
- Acute coryza
- Symptoms worse at night
- Exclude a FB inhalation

**Mild Croup (Score 0-1)**
- Stridor only with agitation
- Normal RR
- No recession
- Normal pulse rate
- Normal SpO₂
- Normal conscious level

- Reassure
- Consider dexamethasone 0.15mg/kg po
- Discharge home if no stridor or improved

**Moderate Croup (Score 2-7)**
- Normal or raised RR
- Mild recession
- AE decreased but easily audible
- Increased pulse rate
- SpO₂ > 93%
- Normal conscious level

- Dexamethasone 0.6mg/kg po (max 8mg) single dose or nebulised budesonide 2mg if po not possible.
- Observe for improvement or deterioration for 2-3 hours
- Discharge home if no stridor or improved

**Severe Croup (Score >8)**
- Raised RR
- Moderate marked recession
- AE decreased, not easily audible
- Increased pulse rate
- SpO₂ > 93%
- Altered level of conscious

- Call for senior help
- Paediatric Registrar
- Senior registrar in PICU
- Anaesthetist on call
- ENT surgeon on call
- Stay with the child and close observation.
- Give nebulised adrenaline 0.5ml/kg of 1:1000 solution upto maximum of 5mls. This dose can be repeated.
- Child might require urgent intubation and transfer to PICU.
- If no improvement or worsening, re-score and act accordingly
- Open access

**Stridor**
- 0 – none
- 1 – at rest audible with stethoscope
- 2 – at rest audible without stethoscope

**Recession**
- 0- none
- 1- mild recession
- 2- moderate recession
- 3- severe recession

**Cyanosis**
- (SpO₂<92% in air)
- 0- none
- 1- with agitation
- 2- at rest

**Level of consciousness**
- 0- none
- 5- altered mental state

**Croup Score**
- 0-1 mild croup
- 2-7 Moderate croup
- >8 severe croup

- Leave the child in comfortable position
- Avoid unnecessary upset to the child
- Child to be with mum in seated position
- Try distraction maneuvers to reduce the distress
- Do not force an oxygen mask over face
- Do not insert tongue depressor
- Do not insert IV line or take blood
- Consider SpO₂, ECG monitoring
- No radiography
The scheme of management for Epiglottitis

<table>
<thead>
<tr>
<th>Do</th>
<th>Do not</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Call for senior help</td>
<td>• Attempt oropharyngeal examination, since this may precipitate complete obstruction.</td>
</tr>
<tr>
<td>- Paediatric registrar / Consultant</td>
<td>• Attempt insertion of an IV cannula or take blood.</td>
</tr>
<tr>
<td>- Anaesthetist registrar / Consultant</td>
<td>• Send the child for neck X-ray or other X-ray</td>
</tr>
<tr>
<td>- ENT surgeon registrar / Consultant</td>
<td>• Upset the child e.g removing parents.</td>
</tr>
<tr>
<td>• Allow the child to remain in its favoured position.</td>
<td>• Leave the child unsupervised</td>
</tr>
<tr>
<td>• The child should be constantly supervised by someone skilled in intubation.</td>
<td>• Rely only on pulse oximetry</td>
</tr>
<tr>
<td>• Give humidified oxygen as tolerated</td>
<td></td>
</tr>
</tbody>
</table>

3. Indications for intubation
   - Suspected epiglottitis
   - Inhalational injury
   - Fall in conscious level
   - Increasing respiratory failure
   - Rising pCO2
   - Exhaustion
   - Hypoxia (SpO2 <92% despite high-flow O2 by mask >5 L/min)

4. Management of intubation
   The most experienced anaesthetist must be present at the intubation. Most anaesthetists would favor a gas induction. The resuscitation team have a backup oxygenation strategy prepared.

   It may be necessary to use croup tubes rather than standard ETT. These are longer than standard ETT, but come in similar sizes, and may be necessary in situations where severe airway narrowing mandates a much smaller ETT than indicated by age (e.g. a 4.0 mm ETT for a 6 year old).

5. Management following intubation
   - Once the airway obstruction is bypassed, most children are easy to ventilate. Exceptions might be in case of bacterial tracheitis (pulmonary involvement), inhalational injury (ARDS), or anaphylaxis (bronchoconstriction).
   - Ensure that the ETT is securely taped.
   - Use sedation and paralysis to ensure safety of ETT.
   - Following a difficult intubation, an ETT should only be changed if there is a clear clinical reason which justifies this risk.
   - Start adjunctive treatments such as iv dexamethasone (0.15 mg/kg QDS) in case of croup; or ceftriaxone (80 mg/kg) in case of epiglottitis or tracheitis.
   - Blood cultures must be taken in suspected cases of infection.
   - In case of inhalation injury and burns, start fluid replacement as per burns guidance.
   - Patients with bacterial tracheitis may become septic, and need fluid resuscitation and inotropic support.
6. **Transport considerations**
   - Children with an unstable airway should not be transported without detailed discussion with on call consultant.
   - ETCO2 monitoring is mandatory during transfer to maintain continuous correct ETT placement.
   - Use continuous muscle relaxation during retrieval to ensure safety of ETT.
   - If transporting an un-intubated child with suspected foreign body obstruction, avoid unnecessary delay and transfer immediately to ENT centre of Teaching or Provincial hospital (directly to theatres if necessary). The team must have a strategy to manage unexpected obstruction or hypoxia.

7. a
Bronchiolitis

History & Assessment

a. Often preceded by coryzal illness
b. Age 2-24 months (peak 2-8 months)

Moderate
- Tachycardia
- RR >50/min
- Flaring
- Accessory muscles
- Recessions
- Head retraction
- Unable to feed

Severe
- Cyanosis
- Getting tired
- Decreased conscious level
- SpO₂ <92% in spite of O₂ therapy
- Rising PaCO₂

Investigations
- FBC
- U&E
- Blood culture

Management Strategies
✓ A-B-C
✓ Assess airway
  - Ensure patent airway
  - Give humidified oxygen to achieve SpO₂ >92%
    ▪ 6-8 l/min via mask with a reservoir bag;
    ▪ Nasal cannula (<2l/min oxygen) for milder and improving cases
    ▪ Consider using humidity, prone position and high flow oxygen
  - Clear nares and patent airway using Yankauer sucker
  - Monitor for apneas (especially age <6 weeks)
✓ Nebulisers are worth trying, but do not persist if no response
  o Ipratropium bromide 125 mcg
  o Adrenaline 1:1000 0.5ml/kg (max 5ml)
  o Salbutamol 2.5mg
  o 3% Saline nebs
✓ Consider CPAP early for respiratory
  o Patients unresponsive to initial treatment
  o Worsening blood gases
✓ GIT & Nutrition
  o Large bore orgogastric tube leave for free drainage to prevent abdominal distension
  o Oral feeds / Breast feeding, N-G feeding, Nil By Mouth.
  o Restrict maintenance to 2/3 requirement
✓ Nebulise with 3% N Saline / Adrenalin may be helpful
✓ Monitor the baby for apnea and hypoventilation esp <2 months
  ▪ SpO₂
  ▪ Respiratory frequency / apnoea
  ▪ pCO₂ – capillary/ end tidal
✓ NIV (Bipap)
✓ Consider intubation and mechanical ventilation (Recurrent apnoea, Exhaustion, severe hypocapnia and hypoxia)
✓ Consider anti viral agents (Ribavirin, Palivizumab)
✓ Bronchodilators, steroids, antibiotics are of no help
**Indications for intubation**
- Exhausted
- Recurrent apnoeas
- Reduce conscious level
- Worsening hypoxemia
- Worsening hypercarbia

**Intubation**
- Pre-oxygenation
- Fluid boluses and resuscitation drugs
- Consider modified rapid sequence induction with ketamine 1-2mg/kg (bronchodilator activity)
- CXR 9 post intubation

**Management following intubation**
- Sedation for ventilation
- Permissive hypercapnia strategy (limit PIP<35cmH2O, TV 5-8ml/kg, Rate <30bpm, Higher rates may leads to air trapping, I:E 1:2,
- PEEP 5-7 is often necessary to counteract intrinsic PEEP. Failure to apply extrinsic PEEP at 85-100% of intrinsic PEEP will result in progressive over inflation and haemodynamic compromise.
- Regular chest physiotherapy and suctioning for mucus plugging.
- Check CXR for ETT position and to exclude pneumothorax.

**Transport Consideration**
- EtCO2 is mandatory to ensure ETT position
- If having problems with CO2 →. Minimize dead space
- Adrenaline can be administered down the ETT tube in severe air trapping.
- If ventilation deteriorates – hand ventilate, auscultate, suction, perform manual decompression, treat pneumothorax.
### Severity: Mild Asthma

**Signs of Severity**
- Normal mental state
- Subtle or no accessory muscle use/recession
- Able to talk normally
- O2 saturation usually > 95% in air

**Management**
- Salbutamol by MDI/spacer
  - 6 effective puffs if < 6 years old,
  - 12 puffs if >6 years old
  - once and review after 20–60 mins.
  - Good response - discharge on B2-agonist as needed.
  - Poor response - treat as moderate.
  - Oral prednisolone (1-2 mg/kg daily for 3-5 days) if on prophylaxis or episode has persisted over several days.

### Severity: Moderate Asthma

**Signs of Severity**
- Normal mental state
- Some accessory muscle use or recession
- Tachycardia
- Talks in short sentences
- O2 saturation usually 92-95% in air

**Management**
- Give O2 if O2 saturation is < 93%.
- Salbutamol by MDI/spacer
  - 6 effective puffs if < 6 years old
  - 12 puffs if >6 years old
  - 3 doses 20 minutely.
  - Review 10-20 min after 3rd dose to decide on further management.
- Ipratropium by MDI/spacer
  - 4 effective puffs if < 6 years old
  - 8 puffs if >6 years old
  - 3 doses in 1st hour.
- Oral prednisolone (1-2 mg/kg daily for 3-5 days)

*The few children of moderate severity who can go home must be discussed with a registrar/consultant and should not leave Emergency until at least two hours after their last Salbutamol.*
# Management of Acute Severe Asthma >2 years

<table>
<thead>
<tr>
<th>Assess severity</th>
<th>Moderate</th>
<th>Severe</th>
<th>Life threatening</th>
</tr>
</thead>
<tbody>
<tr>
<td>SaO2 &gt; 92% in air</td>
<td>SaO2 &lt;92% in air</td>
<td>(Any one of these)</td>
<td></td>
</tr>
<tr>
<td>Normal vital signs</td>
<td>Heart rate &gt;140/min (&lt;5years)</td>
<td>SaO2 &lt;92% in air</td>
<td></td>
</tr>
<tr>
<td>Alert</td>
<td>Heart rate &gt;125/min (&gt;5 years)</td>
<td>Silent chest</td>
<td></td>
</tr>
<tr>
<td>Talking in sentences</td>
<td>Respiratory rate &gt;40/min (&lt;5 years)</td>
<td>Poor respiratory effort</td>
<td></td>
</tr>
<tr>
<td>Audible wheeze</td>
<td>Respiratory rate &gt;30/min ( 5 years)</td>
<td>Cyanosis</td>
<td></td>
</tr>
<tr>
<td>Use of accessory muscles</td>
<td>Difficulty talking, agitated</td>
<td>Altered consciousness</td>
<td></td>
</tr>
<tr>
<td>Exhausted</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Salbutamol

- **<5 years = 5 – 10 puffs via Aroechamber**
- **>5 years = 10 puffs via Aroechamber**
- **Tidal breathing 1 puff every 5 breaths**

#### Oral Prednisolone

- **<12 years: 1-2mg/kg (max 40mg) OD**
- **If the child has been taking oral corticosteroids – 2mg/kg (max 60mg) OD**
- **Reassess hourly**

### Salbutamol nebulised (driven by 6-8 liters/min O₂)

- **2.5mg <5 years; 5mg >5 years**
- **Add Ipratropium 0.25mg (>12years 0.5mg) nebulised. Give every 20 minutes for 1 hour**

### Oral Prednisolone

- **<12 years: 1-2mg/kg (max 40mg) OD for 3-5 days.**
- **If the child has been taking oral corticosteroids – 2mg/kg (max 60mg) OD for 3-5 days.**

#### If poor response after 3 nebs give IV MgSO₄

- **40mg/kg (max 2g) single dose and continue nebulised treatment**
- **Reassess every 20 minutes**

### Salbutamol nebulised (driven by 6-8 liters/min O₂)

- **2.5mg <5 years; 5mg >5 years**
- **Add Ipratropium 0.25mg (>12years 0.5mg) nebulised. Give every 20 minutes for 1 hour**

### IV Hydrocortisone

- **4mg/kg 6 hourly**
- **2-5 years : maximum 50mg**
- **5-18 years : Maximum 100mg**

### Continuous nebulised β₂ agonist + ipratropium ::

- **CXR & Blood gases**
- **Bolus IV Salbutamol (<2 years-5microgram/kg, >2years 15microgram/kg, maximum 250microgram over 5 minutes)**
- **Continuous IV salbutamol infusion 1-5microgram/kg/min(200mcg/ml solution)**
- **Arrange HDU/PICU transfer**
- **Inform Consultant for review**

#### IV MgSO₄ can be administered on any ward as a rescue therapy.

- **If patient has not improved or deteriorated, move to life threatening pathway.**

#### If patient has improved: Admit to ward

- **Repeat Salbutamol 1-4 hourly**
- **Maintain SaO₂ >92%**

#### If oxygen is further required, Ipratropium 0.25mg(>12yrs -0.5mg) nebulised 4-6 hourly.

#### If unable to tolerate oral steroids, change to IV.

- **Stable on 4 hrly Salbutamol**
- **Change to Aroechamber 4 puffs 4hrly until discharge criteria met**

### Poor response or Deteriorating

- **Continuous nebulised β₂ agonist + ipratropium :: Consider**

### IV aminophylline

- **5mg/kg loading dose over 20 minutes with ECG monitoring(omit if on oral theophyllines) followed by continuous infusion 1mg/kg/hr[500mg aminophylline in 500ml sodium chloride 0.9% run at 1ml/kg/hr]**

---

**Discharge criteria met?**

- **SaO2 >94% in air**
- **Heart rate <140/min (<5years)**
- **Heart rate <125/min (>5 years)**
- **Respiratory rate <40/min (<5 years)**
- **Respiratory rate <30/min ( 5 years)**
- **Stable for 4 hours**

### Discharge Plan

- **Continue oral Prednisolone (for a total of 3 days)**
- **Continue bronchodilator via Aroechamber/mask Salbutamol 4 puffs 4 hourly for 4 days and then 2 puffs PRN**
- **Check inhaler technique**
- **Review maintenance therapy**
- **Written discharge plan**
- **Arrange follow up**

---

**IV MgSO₄ can be administered on any ward as a rescue therapy.**

- **If patient has not improved or deteriorated, move to life threatening pathway.**

#### If patient has improved: Admit to ward

- **Repeat Salbutamol 1-4 hourly**
- **Maintain SaO₂ >92%**

#### If oxygen is further required, Ipratropium 0.25mg(>12yrs -0.5mg) nebulised 4-6 hourly.

#### If unable to tolerate oral steroids, change to IV.

- **Stable on 4 hrly Salbutamol**
- **Change to Aroechamber 4 puffs 4hrly until discharge criteria met**
Acute Severe Asthma

1. Assessment

   a. Past History
      - Frequency of attacks
      - Routine medications
      - Number of course of steroids
      - Previous ICU admissions + intubation

   b. Current Status
      - Duration of attack
      - Assessment of severity
      - Treatment (dose / frequency of nebs, IV therapy, steroids)

2. Initial Management of severe asthma

   a. Oxygen
     
     Children with severe or life threatening asthma or SpO2 <92% should receive high flow oxygen via a tight fitting mask or nasal cannula to achieve normal saturation.

   b. Nebulised bronchodilators
     
     Children with severe or life threatening asthma should receive frequent or back to back doses of salbutamol (2.5 – 5mg). add ipratropium bromide nebulizers. Usual doses of ipratropium bromide is 250mcg (125mcg for < 2years).

   c. Steroids Therapy

---

Clinical assessment

- Pulse rate
- Respiratory rate and degree of recessions
- Use of accessory muscles of respiration
- Degree of agitation and conscious level
- SpO2 on air and if post nebulisation SpO2 <92% needs intensive treatment ; Aim is maintain SpO2 94-98%
- PEFR
Steroids should be given early. Benefits are seen in 3-4 hours. In severe asthma 4mg/kg IV hydrocortisone should be given 4 hourly since most children are unable to tolerate oral prednisolone.

d. **IV Salbutamol**

Consider early addition of a 15 meg/kg bolus of salbutamol given over 15 minutes (maximum 250mcg).

Follow this up with a continuous infusion in refractory asthma (usually 1-2 mcg/kg/min). Higher doses up to a maximum of 5mcg/kg/min should be discussed with the Consultant.

Reduced infusion rate if side effects occur: lactic or metabolic acidosis, tachycardia, arrhythmias, tremor, severe hypokalaemia, hyperglycaemia and hypophosphataemia.

Note: increasing tachypnoea on IV salbutamol may indicate toxicity and metabolic acidosis rather than worsening of asthma.

Patients on IV salbutamol should have continuous ECG monitoring and regular monitoring of Potassium.

e. **IV Aminophylline**

Aminophyllin may be useful in children with refractory severe or life threatening bronchospasm. A 5mg/kg loading dose (maximum 500mg should be given over 20 minutes with ECG monitoring. A loading dose must not be given to patients on oral theophylline treatment.

The loading dose is usually followed by a continuous infusion at 1mg/kg/hour (more than 12 years infusion rate: 0.5-0.7mg/kg/hour).

f. **Magnesium Sulphate**

MgSO4 may be useful as an adjunct in acute severe asthma. 40-50mg/kg should be given by slow infusion over 30 minutes. This may be repeated in 1-2 hours. Serial Mg levels measurement is indicated if further doses are being considered. Hypotension caused due to vasodilatation is the most common side effects.

3. **Indication for intubation**

Blood gas analysis is not a substitute for clinical assessment.

a. Consider intubation in any child with the following
b. Intubation

- The most experienced person available should intubate the child.
- Pre-oxygenate
- 10-20mls /kg colloid / crystalloid
- You will need a tight fitting ETT as necessary airway pressure may be high. Consider a cuff tube.
- Consider modified “Rapid Sequence Induction” with Ketamine 1-2mg/kg (has some bronchodilator activity) and suxamethonium 1-2mg/kg.
- Inhalational agents (have bronchodilatory properties) or Fentanyl, midazolam / Ketamine and Vecuronium may be used for sedation and paralysis.
- Avoid morphine and atracurium (histamine release)

4. Management following intubation

Most frequent complication following intubation is hypotension – give fluid boluses as required.
Acute bronchospasm is also common – consider using inhalational agents for sedation.

- Sedate and paralyse for ventilation
- Pursue a pressure limited permissive hypercapnia strategy(pH >7.2).
  - Limit PIP <35 cmH2O
  - Keep TV 5-8ml/kg
  - Rate 10-15 bpm
  - I:E ratio of at least 1:2
- PEEP of 5-7 is often necessary to counteract intrinsic PEEP.
  - Failure to apply extrinsic PEEP at 85-100% of intrinsic PEEP will result in progressive over inflation and haemodynamic compromise.
- High thoracic pressure may compromise venous return resulting in hypotension – give fluid bolus.
- Regular chest physiotherapy and suctioning for mucus plugging.
- Check CXR for ETT position and to exclude pneumothorax.

5. Transport Consideration

- Watch for pneumothorax, auto-PEEP and mucus plugging. If child desaturate, disconnect ventilator, bag, auscultate and consider manual decompression.
- A dose of adrenaline can be via ETT if needed to relieve bronchospasm.
Management of a inhaled Foreign body

**Points in favor of inhaled foreign body**
- Making a comfortable diagnosis is extremely difficult
- Age group – older infants / toddlers
- High degree of suspicious
- Positive history must never be ignored
- Negative history may be misleading
- Children who present with 1st episode of wheezing
- Absence of fever or preceding illness

**Clinical features**
- Violent paroxysms of (intermittent episodes)
  - Coughing
  - Choking
  - Gagging
  - Possible wheezing
  - Cyanotic episodes
- Asymptomatic intervals
  - When FB gets lodged
- Complications
  - Fever, cough
  - Haemoptysis
  - Pneumonia
  - Atelectasis

**Management Strategies**
- Assess the work of breathing, effort, and efficacy of breathing
- Follow the APLS choking child protocol
- Inform Paediatric registrar and PICU
- CXR (both expiratory & inspiratory films) if child is stable
- Inform ENT surgeon, Anesthetist, Paediatric intensivist
- Transfer to PICU in the most comfortable position of the child
- Book the operation theater for video bronchoscopy.
Community Acquired Pneumonia in Children

This guideline is aimed for use in the child with simple community acquired pneumonia. This guideline should not be used for patients with severe or complex illness, aspiration pneumonia, or hospital acquired pneumonia, or those with underlying cystic fibrosis, chronic lung pathology, or immunocompromise. These patients should be urgently discussed with the Medical Consultant on-call or the relevant Subspecialty team.

Clinical Definition
Community Acquired Pneumonia (CAP) is an acute infection of the pulmonary parenchyma acquired outside of a hospital setting and is one of the most common serious infections in children.

Primary Survey and resuscitation
The strongest clinical predictors of pneumonia in children are:

- Fever
- Cough
- Tachypnea (requires a full one-minute count while the child is quiet and is the best predictor of pneumonia of children in all age groups)
- Retractions
- Nasal Flaring
- Expiratory Grunt
- Crackles
- Decreased Breath Sounds

WHO defined tachypnoea

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 2 months of age</td>
<td>over 60 breaths/ min</td>
</tr>
<tr>
<td>2-12 months</td>
<td>over 50 breaths/ min</td>
</tr>
<tr>
<td>1 – 5 years</td>
<td>over 40 breaths/min</td>
</tr>
<tr>
<td>&gt; 5 years</td>
<td>over 30 breaths/ min</td>
</tr>
</tbody>
</table>

Signs of severe pneumonia

- Tachypnoea
- Grunting
- Chest in drawing
- Use of accessory muscles
- Look for signs of deterioration & exhaustion

ANY PATIENT WITH SEVERE PNEUMONIA MUST BE DISCUSSED WITH THE PED REGISTRAR / CONSULTANT ON CALL AS EARLY AS POSSIBLE IN THE ADMISSION PROCESS.

Investigations
- Full blood count
- CRP / ESR
- Blood culture
- Mycoplasma antibody test
- CXR
- Nasopharyngeal aspirate
- Monteux test
- Sputum for routine bacterial mc&ls

Measure & Monitor
- Blood sugar
- SpO2
- Blood Pressure
- ABG

Children who are not improving, Consider
- foreign body aspiration
- Immunodeficiency
- Anatomical abnormality of the lung.
The following patients should be strongly considered for admission and inpatient management with intravenous antibiotics: (Note that where there is an NPA positive for a viral pathogen, thought should be given as to whether antibiotic is indicated at all)

- Children with more severe or complicated pneumonias and who appear toxic. These patients must be urgently discussed with the Paed Registrar / Consultant.
- Those requiring oxygen (saturation < 92% in air) or intravenous fluids.
- Those living in households without resources to comply with treatment plans.
- Children with chronic disorders such as cystic fibrosis, immunocompromise, history of neonatal cardiopulmonary disease or complex anomaly of the airway. These patients must be urgently discussed with the relevant team who will decide upon whether admission is necessary.
- Likelihood of aspiration
- Failure of outpatient management where appropriate antibiotics and doses have been used (consider viral pathogens).
- Infants age < 3 months - discuss with the Paed Consultant
• **Intravenous Antibiotics**
  1) Simple CAP: Benzylpenicillin – 30 mg/kg/dose (max 1.2g) 6 hourly
  2) Age < 3 months: ADD Gentamicin 8 mg/kg iv daily (if age < 4 weeks, consult neonatal dosing guidelines).
  3) If clinical suspicion of Mycoplasma pneumonia or Chlamydophila pneumoniae **AND** patient over 1 month age:
     a) ADD Roxithromycin orally 4 mg/kg/dose (max 150mg) 12 hourly.
     b) If patient unable to tolerate oral antibiotics then use intravenous Azithromycin 10 mg/kg/dose (maximum 500 mg) daily.
  4) For severe/toxic patient (systemic toxicity, increasing O₂ dependence) and/or suspicion of *Staphylococcus aureus* (cavitations, multiple lesions, effusions, empyema, increased incidence in Indigenous and Pacific Island Children)
     1. These patients must be urgently discussed with the PED and General Medical Consultant on-call. Following admission, ID consultation may be considered.
     2. Ceftriaxone intravenous 50 mg/kg/dose (max 1 g) once daily **PLUS**
     3. Flucloxacillin intravenous 50 mg/kg/dose (max 2 g) 6 hourly
     4. If community acquired MRSA is suspected or proven, consult ID for approval of intravenous Vancomycin 25 mg/kg/dose up to maximum 1 g 12 hourly until sensitivity results known.

**Discharge Plan (if improved at 24-48 hours)**

Antibiotics should be directed towards pathogen identified.

1) Amoxicillin orally 25 mg/kg/dose (maximum dose up to 1 g) 8 hourly. Total duration of antibiotic therapy for 7 days
2) Roxithromycin oral dose as above for total 7 days if Mycoplasma pneumonia or Chlamydophila pneumonia identified or strongly suspected
3) Choice and duration of oral therapy for *Staphylococcus aureus* pneumonia should be discussed with ID
4) Early clinic review at 1 week
5) If lobar consolidation, then needs repeat CXR at 4-6 weeks
   a) If normal – nil further action
   b) If abnormal – urgent referral for General Medical OPD review
Inpatient Management Flowchart
(Guideline for inpatient management of community acquired pneumonia in previously well children)

- Age < 3 months or
- Very Unwell
- Drowsy or lethargic
- Lower chest in drawing
- Nasal flaring
- Saturation < 92% in air or
- Extensive consolidation or Pleural effusion

**YES**

Admit to Hospital

- Poor perfusion
- Altered level of consciousness

**NO**

- Pleural effusion

**YES**

Resuscitate
Discuss with Paed Registrar / Paed Consultant and PICU

**NO**

- Severe /toxic patient and/or Suspicion of Staph aureus (cavitations, multiple lesions, effusions)

**NO**

- IV Benzylpenicillin
  - Give Oxygen if Saturation < 92% in room air
  - Age < 3 months add Gentamicin IV

**YES**

Discharge Home

- Oral Amoxicillin for 7 days
- **AND/OR** Roxithromycin if Mycoplasma/ Chlamydophila pneumonia proven or suspected.
- Early clinic review at 1 week
- If lobar consolidation, repeat CXR at 4-6 weeks and LMO review. If abnormal urgent General Medical OPD review.

**YES**

ADD Roxithromycin

- Consider Outpatient Management
- All patients under 6 months must be seen by senior doctor before discharge
The Febrile Child

Temp >38°C is a normal response to infection

Fever >39°C
With appearance of “toxic” child
- The child’s general state of alertness and well being
- Vital signs, PR and RR (both increases in early sepsis)
- Peripheral perfusion assessment by capillary return

Focus evident on history, examination and urine collection
- Viral fever (NPA)
- DHF (Platelet count & Hess’s test)
- UTI
- Pneumonia
- Septicaemia
- Meningitis

Admit to hospital
Septic screen
(FBC, CRP, Blood picture, Blood culture, Urine culture, CXR, CSF culture)
IV antibiotics

Risk of a pneumococcal bacteriæmia
WBC > 15,000 – 17%
WBC > 30,000 – 40%

Treat focus accordingly
Admit as necessary

Admit to Emergency Department / PCU
Consider empirical antibiotic therapy
Systaemic Inflammatory Response Signs (SIRS)

The inflammatory triad of fever, tachycardia & abnormal perfusion is very common in children with benign infections. Septic shock should be considered in children who manifest this triad with additional features such as tachypnoea, reduced urine output, irritability & lethargy / drowsiness.

1. Systemic Inflammatory Response Syndrome (SIRS)
   Suspected infection
   • Hypo or hyperthermia (temp <36° or >38.5°)
   • Tachycardia
   • Tachypnoea
   • Altered mental status
   • Decreased urine output (<1 ml/kg/min)
   • Other end organ dysfunction
   • Signs of either cold or warm shock

2. Signs of shock

3. Types of shock

4. Compensated vs Uncompensated shock
**Anti-infective guidelines for febrile neutropenic patients-17.16**

<table>
<thead>
<tr>
<th>Central line in-situ</th>
<th>Central line absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cefepime &amp; Tobramycin</td>
<td></td>
</tr>
</tbody>
</table>

**Negative culture after 48hrs**

- **Low risk neutropenic patient**
  - Discharge home on augmentin
- **Fever persists >3-7 days**
  - Consider antifungal

**Positive culture**

- **High risk neutropenic patient**
  - Continue antibiotics

- **Gram negative organism**
  - Psedomonas
  - Add ceftazidime
  - Cease cefepime

- **Gram positive organism**
  - Clinical response
  - Continue same antibiotics

- **Lack of clinical response**
  - Add vancomycin
Febrile Convulsions

A convulsion in infancy or childhood usually occurring between 3 months and 5 years associated with fever but without evidence of intra cranial or defined cause.
Affect 4% of children
Damage from fits are rare
Need for prophylactic anticonvulsants is uncommon
Risk of latter epilepsy is same as in general population
< 1 year has greater risk of severe FC & repeated convulsions within 24-48hrs and FC with subsequent febrile episodes.

Simple FC
Complex FC
Last longer than 15 minutes
Have focal features
Recur within 24 hours

Management
- Terminate fit if necessary (se status epilepticus) (Don’t Ever Forget RBS)
- Find and treat cause of fever (Exclude bacterial meningitis)
- Treat with paracetamol and physical measures
- Admit
  - First fit
  - Prolonged or focal fit or slow recovery
  - Young child < 2 years of age
  - Two or more fits within 24 hours
- Prophylactic anticonvulsants
  - Oral diazepam 0.5mg/kg/day in divided doses with fever or intra nasal midazolam 0.25mg/kg/ or rectal diazepam (0.5mg/kg/dose) with the onset of convulsion may be prescribed.

First afebrile seizure
- Look carefully for precipitating cause(s)
- Full examination including – blood pressure, head circumference, urinalysis, blood glucose and electrolytes including calcium and magnesium.
- Avoid
  - Falls from unprotected heights
  - Unsupervised swimming pools and bathing
  - Bike riding on busy roads
- Consider Paediatric Neurologist’s opinion
Diarrhoea and Dehydration

1. Assessment of dehydration
   It is important to assess the degree of dehydration in children. Infants and small children are at a higher risk of dehydration. Weight loss is useful in estimating the degree of dehydration if weight prior to admission is known.

<table>
<thead>
<tr>
<th>Fluid deficit in ml/kg body weight</th>
<th>No dehydration 5%</th>
<th>Some dehydration 5-10%</th>
<th>Severe dehydration &gt;10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Condition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eyes</td>
<td>Well, alert</td>
<td>Restless, Irritable</td>
<td>Lethargic or unconscious or floppy</td>
</tr>
<tr>
<td>Tears</td>
<td>Normal</td>
<td>Sunken</td>
<td>Very sunken and dry</td>
</tr>
<tr>
<td>Mouth &amp; tongue</td>
<td>Present</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Thirst</td>
<td>Moist, thirsty</td>
<td>Dry</td>
<td>Very dry</td>
</tr>
<tr>
<td>Skin pinch</td>
<td>Goes back quickly</td>
<td>Thirsty, drinks eagerly</td>
<td>Drinks poorly or not able to drink</td>
</tr>
</tbody>
</table>

2. Management of Dehydration
   - Correction of the existing water and electrolyte deficit
   - Replacement of ongoing losses.
   - Provision of normal daily fluid requirement

3. No dehydration
   a. Give the child more fluids than usual to prevent dehydration
   b. Home based fluids and ORS solutions such as kanjee should be used.
   c. Give as much fluid as the child wants.
   d. As a guide approximately 50 ml of fluid should be given after each stool.
   e. Watch for signs of dehydration.

4. Some dehydration (5 – 10%)
   a. Approximate amount of ORS solution to be given in the first four hours is 75ml/kg in first 4 hours

5. Severe dehydration >10% dehydration
   a. Children with severe dehydration need intra venous fluids, as there is a risk of impending shock
   b. Start IV Ringer’s Lactate fluid immediately. If the patient can drink, ORS should be given while the drip is set up.
   c. Normal saline could be used if Ringer’s Lactate solution is not available.
   d. If intra venous access is impossible attempt intra osseous administration or give ORS through naso-gastric tube
   e. Reassess the patient every 1-2 hours. If hydration is not improving, give the IV drip more rapidly.

Guidelines for intravenous treatment of children and with severe dehydration
Start IV fluids immediately. If the patient can drink, give ORS by mouth until the drip is set up. Give 100 ml/kg. Ringer’s Lactate Solution a divided as follows:

<table>
<thead>
<tr>
<th>Age</th>
<th>First give 30ml/kg in</th>
<th>Then give 70ml/kg in</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infants &lt;12 months</td>
<td>1 hour</td>
<td>5 hours</td>
</tr>
<tr>
<td>&gt;1 year</td>
<td>30 minutes</td>
<td>2 ½ hours</td>
</tr>
</tbody>
</table>
# Child in shock

## Aetiology of the shock

<table>
<thead>
<tr>
<th>Hypovolaemic</th>
<th>Distributive</th>
<th>Cardiogenic</th>
<th>Obstructive</th>
<th>Dissociative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haemorrhagic</td>
<td>Sepsis</td>
<td>Arrhythmias</td>
<td>Tension pneumothorax</td>
<td>Severe anaemia</td>
</tr>
<tr>
<td>Gastroenteritis</td>
<td>Anaphylaxis</td>
<td>Cardiomyopathy</td>
<td>Haemo-pneumothorax</td>
<td>CO poisoning</td>
</tr>
<tr>
<td>Intussusceptions</td>
<td>Vasodilatory drugs</td>
<td>Heart failure</td>
<td>Flail chest</td>
<td>Methaemoglobinemia</td>
</tr>
<tr>
<td>Volvulus</td>
<td>Spinal injury</td>
<td>Valvular disease</td>
<td>Cardiac tamponade</td>
<td></td>
</tr>
<tr>
<td>Peritonitis</td>
<td>DSS/DHF</td>
<td></td>
<td>Pulmonary embolism</td>
<td></td>
</tr>
<tr>
<td>Burns</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## A sick child- hypovolaemic shock

<table>
<thead>
<tr>
<th></th>
<th>Compensated</th>
<th>Uncompensated</th>
<th>Preterminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood volume loss</td>
<td>&lt;25%</td>
<td>25-40%</td>
<td>&gt;40%</td>
</tr>
<tr>
<td>Heart rate / Pulse rate</td>
<td>↑</td>
<td>↑↑</td>
<td>↑↑↑/↓</td>
</tr>
<tr>
<td>Systolic BP</td>
<td>Normal</td>
<td>↓</td>
<td>Unrecordable</td>
</tr>
<tr>
<td>Diastolic BP</td>
<td>May be elevated</td>
<td>Falling,</td>
<td>Very Low / Un-recordable</td>
</tr>
<tr>
<td>Central pulses</td>
<td>Normal</td>
<td>Weak,</td>
<td>Absent</td>
</tr>
<tr>
<td>Cap. refill</td>
<td>&gt;2 secs</td>
<td>&gt;2 secs</td>
<td>&gt;5 secs</td>
</tr>
<tr>
<td>Extremities - Temperature</td>
<td>Cold,</td>
<td>Cold,</td>
<td>Cold</td>
</tr>
<tr>
<td>Skin colour</td>
<td>Cool / pink</td>
<td>Cold / mottled</td>
<td>Cold / grey</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>↑</td>
<td>↑↑</td>
<td>Sighing</td>
</tr>
<tr>
<td>Mental state</td>
<td>Mild agitation</td>
<td>Uncooperative</td>
<td>Unresponsive</td>
</tr>
<tr>
<td>Breathing Pattern</td>
<td>Normal,</td>
<td>↑↓</td>
<td>Acidotic</td>
</tr>
<tr>
<td>Urine output</td>
<td>Reduced</td>
<td>Nil</td>
<td>Nil</td>
</tr>
</tbody>
</table>

## Irreversible shock (Pre-terminal)

- Diagnosis is retrospective one
- Death of the patient is inevitable despite therapeutic intervention
- Sever damage to vital organs such as heart and brain
- Pathophysiologicaly the high energy phosphate reserves in cells (especially liver and heart) are greatly diminished.
- Hence early recognition and effective treatment of shock are vital.
Septic Shock Protocol

Recognised decreased mental status & perfusion
Begin high flow Oxygen
Establish IV/IO access in 5 min or 3 attempts
– RBS, BC, FBC, Grouping Rh

Initial Resuscitation
Push boluses of 20ml/kg 0.9% N Saline IV bolus over 5 up to & over 60ml/kg until perfusion improves OR hepatomegaly / crackles develop
Correct Hypoglycaemia
IV antibiotics – Cefotaxime 80mg/kg IV

Fluid Refractory Shock
Start dopamine up to 15 mcg/kg/min IV/IO
Intubate and gain central access

COLD SHOCK
• CRFT >3 seconds
• Reduced peripheral pulses
• Cold mottled extremities
• Narrow pulse pressure

Add in central adrenaline if dopamine resistant

WARM SHOCK
• Flash CRFT
• Bounding peripheral pulses
• Warm to edge
• Wide pulse pressures

Add in central noradrenaline

Catecholamine resistant shock
Begin hydrocortisone If at risk for absolute adrenal insufficiency

Cold shock with normal BP
1. Titrate volume & adrenaline ScvO₂>70%, Hb>10g/dl
2. If SCVO₂ remains <70% add vasodilator with volume loading(eg-milrinone)

Cold shock with low BP
1. Titrate volume & adrenaline ScvO₂>70%, Hb>10g/dl
2. If remains hypotensive consider noradrenaline
3. If SCVO₂ remains <70% add milrinone

Warm shock with low blood inotropes
4. Titrate volume & noradrenaline ScvO₂>70%,
5. If remains hypotensive consider vasopressin, trilipressin or methylene blue
6. If SCVO₂ remains <70% consider low dose adrenaline

Persistent Catecholamine resistant shock
Rule out & correct pericardial effusion, pneumothorax & intra abdominal pressure >12mmHg. Consider cardiac output monitoring to guide fluid, inotropes, vasopressor, vasodilator & hormonal therapies.
GOAL cardiac index >3.3 & < 6.0 l/min/m²
Refractory Shock – ECMO
### Inatropes

- **Properties**

- **Doses - Rule of 3s**

<table>
<thead>
<tr>
<th>Drug</th>
<th>Infusion</th>
<th>Dose Adrenaline / Noradrenaline</th>
<th>Dose – Isoprenaline</th>
<th>Dose – Salbutamol</th>
<th>Dopamine</th>
<th>Dose - Dopamine</th>
<th>Dose e- Dobutamine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adrenaline</td>
<td>3mg in 50 ml of 5% dextrose</td>
<td>= 1 -10+ mcg/min</td>
<td>= 1 -20 mcg / min</td>
<td>= 5 – 20 mcg / min</td>
<td>3mg / kg in 50 ml of 5% dextrose ≈ 60 mcg / kg ml</td>
<td>= &gt;5 mcg / kg /min (Inotropic)</td>
<td>= 1 – 20 mcg / kg /min</td>
</tr>
<tr>
<td>Noradrenaline</td>
<td>1ml / hr</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isoprenaline</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salbutamol</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Cardiac Enzyme time sequence**

<table>
<thead>
<tr>
<th></th>
<th>Earliest rise (hours)</th>
<th>Peal (hours)</th>
<th>Normalize (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CK</td>
<td>6-8</td>
<td>24-30</td>
<td>3-4</td>
</tr>
<tr>
<td>CKMB</td>
<td>3-4</td>
<td>18-24</td>
<td>2</td>
</tr>
<tr>
<td>LDH</td>
<td>12-24</td>
<td>48-96</td>
<td>7-10</td>
</tr>
</tbody>
</table>
Anaphylactic algorithm

Anaphylactic reaction?

Airway, Breathing, Circulation, Disability, Exposure

Look for Signs & symptoms of anaphylactic reactions
- Acute onset of illness
- Life threatening Airway, and/or Breathing and/or Circulation problems
- And usually skin changes

When skills and equipment available:
- Establish airway
- High flow oxygen
- IV Fluid challenge
- Adrenaline
- Chlorphenamine
- Hydrocortisone

Monitor:
- Pulse oximetry
- ECG
- Blood Pressure

Nebulised salbutamol or Nebulised adrenaline 0.5ml/kg of 1:1000 to a maximum of 5ml as for croup

IV Crystalloid 20ml/kg
Repeat as necessary – if >40ml/kg fluid is needed

IM Adrenaline 1:1000;
(May be repeated every 5 minutes)
- 0.01ml/kg IM
- <6 years – 0.15ml
- 6 – 12 years – 0.3ml
- >12 years - 0.5ml

Age
- Chlorpheniramine IM or slow IV
- Hydrocortisone IM or slow IV

<table>
<thead>
<tr>
<th>Age</th>
<th>Chlorpheniramine IM or slow IV</th>
<th>Hydrocortisone IM or slow IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 months</td>
<td>250mcg/kg</td>
<td>25mg</td>
</tr>
<tr>
<td>6 months-6 year</td>
<td>2.5mg</td>
<td>50mg</td>
</tr>
<tr>
<td>6 years – 12 years</td>
<td>5mg</td>
<td>100mg</td>
</tr>
<tr>
<td>&gt;12 years</td>
<td>10mg</td>
<td>200mg</td>
</tr>
</tbody>
</table>

Airway & Breathing
Hoarseness, Stridor
Wheezing, Cyanosis, SpO2 <92%
Respiratory distress

Circulation
Compensated or Uncompensated shock

Call for help
Lie patient flat
Raise patient’s legs

Resolution
Observe
Monitor ABC re-assessment

No resolution
Contact PICU
**Dengue Shock Syndrome**

- Check the ideal body weight
- IV cannula (FBC, PCV, Grouping & Rh, SGPT/SGOT, SE)
- Serum albumin level, Serum cholesterol level, Clotting profile
- USS scan
- 0.9% N Saline IV fluid (10ml/kg/hr for compensated shock and 20ml/kg rapid bolus [free flow of fluid] for uncompensated shock until pulse and BP is palpable)

**Indications for 40% dextran infusion (document the pre & post bolus PCV values)**
- Uncompensated or compensated shock after two normal saline boluses were given and no improvement noted.
- 10ml/kg infusion over 1 hour

**Indications for 40% dextran infusion with frusemide**
- Compensated shock with fluid overload
- Definite signs of fluid over load

**A maximum of 3 dextran infusions per 24 hours**

**If child does not improve always look for**
- Acidosis
- Hypoglycaemia
- Low inosided Calcium
- Bleeding
- Low serum Sodium

**Signs of fluid overload**
- Increasing breathing rate;
- Wheezing
- Large pleural effusions and tense ascites;
- Increased jugular venous pressure
- Poor peripheral circulation
- Narrow pulse pressure

**Maintenance fluid M+5% over 48 hours**

<table>
<thead>
<tr>
<th>Child (ml/kg/hr)</th>
<th>Adult (ml/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>M/2</td>
<td>1.5</td>
</tr>
<tr>
<td>M</td>
<td>3</td>
</tr>
<tr>
<td>M+5%</td>
<td>5</td>
</tr>
<tr>
<td>M+7.5%</td>
<td>7</td>
</tr>
<tr>
<td>M+10%</td>
<td>10</td>
</tr>
</tbody>
</table>

**↑ Rate of IV fluid depends on**
- Urine output <0.5ml/kg/hr
- Pulse pressure <20mmHg
- Tachycardia and thready pulse
- Line of cold line
- Rising PCV

**Critical phase**

- Ill looking child
- Temperature may be settling
- ↑ PCV from 10% to ↑20%
- Ascitis & Pleural Effusion – clinically or by USS scan
- Dropping serum albumin level & Serum cholesterol

- WBC < 5000
- Platelets -- < 100,000 (higher tendency to leak)
- Hess test – positive
- Base line PCV above the average value

**Indications for blood transfusions**
- With severe metabolic acidosis and end organ dysfunction despite adequate fluid replacement.
- With HCT is not as high as expected for the degree of shock
- Drop in HCT (PCV of < 40-45) without clinical improvement despite adequate fluid replacement (40-60ml/kg).
- Drop of HCT by >10% after colloid transfusion
- Early liver failure with abnormal coagulation profile
- 10ml/kg whole blood or 5ml/kg pack cells – 1ml/kg pack cell transfusion will increase the Hb by 5points
<table>
<thead>
<tr>
<th>Glasgow Coma Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>&gt;4year</td>
</tr>
<tr>
<td>Eye Opening</td>
</tr>
<tr>
<td>Spontaneously</td>
</tr>
<tr>
<td>To Speech</td>
</tr>
<tr>
<td>To Pain</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Best Verbal Response</td>
</tr>
<tr>
<td>Orientated</td>
</tr>
<tr>
<td>Confused</td>
</tr>
<tr>
<td>Inappropriate words</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
</tr>
<tr>
<td>None</td>
</tr>
<tr>
<td>Best Motor Response</td>
</tr>
<tr>
<td>Obeys commands</td>
</tr>
<tr>
<td>Localizes (pain)</td>
</tr>
<tr>
<td>Withdraws from (pain)</td>
</tr>
<tr>
<td>Abnormal flexion (pain)</td>
</tr>
<tr>
<td>Abnormal Extension(pain)</td>
</tr>
<tr>
<td>None</td>
</tr>
</tbody>
</table>
Status Epilepticus Algorithm

Airway
High flow oxygen
Don’t ever forget glucose

Vascular access IV/IO

Yes

Midazolam or Diazepam or Lorazepam

5 minutes

Midazolam or Diazepam or Lorazepam

5 minutes

Phenytoin (IV/IO) or Phenobarbitone (IV/IO)

20 minutes

Midazolam infusion / 30-200 microgm / kg / hr
Diazepam infusion 100-400 microgm / kg / hr
(use intraosseous if no IV access)

No

Midazolam IM, buccal or Intranasal
If not available – Diazepam PR

10 minutes

Midazolam IM, Buccal or Intranasal
If not available – Diazepam PR

10 minutes

Paraldehyde PR

10 minutes

Contact PICU
Rapid Sequence Induction
With Thiopentone or Propofol
Prolonged Tonic / Clonic Seizure

Any such seizure of more than 5 minutes duration is considered unusually prolonged and along with frequently recurring seizures warrants drug therapy. Old definition of “status” are impractical guide to therapy, though within 30 minutes the risk of brain damage is considered low.

Emergency Management Aims

- Secure Airway, Ventilation, Oxygenation, Circulation
- Optimal drug therapy
- Identify and treat precipitant(s) – Hypoglycaemia, Electrolyte abnormality, Hypertension, Low anti-epileptic drug levels, Febrile, CNS disease, etc.
- Treat complications – Acidosis, Hypertension, Cerebral oedema, Avoid excess IV fluids
- Avoid seizure recurrence. Always do urgent blood glucose and take plasma drug level(s) if on AED(s)
- Prevent systemic complications
- Further evaluate and treat the causes (infection, bleeding).

Medications used in management of status epilepticus

<table>
<thead>
<tr>
<th>STEP 1 and 2</th>
<th>Drug</th>
<th>Route</th>
<th>Dose</th>
<th>Maximum dose</th>
<th>Repeat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Midazolam</td>
<td>Buccal</td>
<td>0.5 mg/Kg</td>
<td>10mg</td>
<td>Every 10 min ×2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nasal, IM</td>
<td>0.2 mg/Kg</td>
<td>5mg per nostril</td>
<td>Every 10 min ×2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IM</td>
<td>0.2 mg/Kg</td>
<td></td>
<td>Every 10 min ×2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>0.1 mg/Kg</td>
<td></td>
<td>Every 5 min ×2</td>
<td></td>
</tr>
<tr>
<td>Lorazepam</td>
<td>IV, buccal, PR</td>
<td>0.1 mg/kg</td>
<td>4 mg</td>
<td>Every 5 min ×2</td>
<td></td>
</tr>
<tr>
<td>Diazepam</td>
<td>Rectal</td>
<td>0.5 mg/Kg</td>
<td>20 mg</td>
<td>Every 10 minute ×2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>IV</td>
<td>mg/Kg</td>
<td>&lt; 5 yrs 5 mg, &gt;5 yrs 10 mg</td>
<td>Every 5 minutes ×2</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>STEP 3</th>
<th>Drugs</th>
<th>Route</th>
<th>Dose and Rate</th>
<th>Maximum dose</th>
<th>Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenytoin</td>
<td>IV/IO</td>
<td>20 mg/Kg</td>
<td>Over 20 min (1 mg/kg/min)</td>
<td>1000 mg</td>
<td>Watch for arrhythmias and hypotension Avoid dextrose containing fluids If already on phenytoin use phenobarbitone or lower dose phenytoin : 5 mg/kg</td>
</tr>
<tr>
<td>Phenobarbitone</td>
<td>IV/IO</td>
<td>20 mg/Kg</td>
<td>Over 5 minutes</td>
<td>1000 mg</td>
<td>Watch for Respiratory depression hypotension and sedation</td>
</tr>
<tr>
<td>Paraldehyde</td>
<td>PR</td>
<td>400 mg (0.4ml)/Kg</td>
<td>10 g, 10 ml</td>
<td>Mucosal irritation</td>
<td></td>
</tr>
</tbody>
</table>
**STEP 4**

<table>
<thead>
<tr>
<th>Medicine</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thiopentone</td>
<td>4 mg/kg bolus followed by 2-4 mg/kg/h. Increases of 1 mg/kg/h can be used every 30 min as needed, with a 2 mg/kg bolus with each increase. Maximum of 6 mg/kg/h. If midazolam and phenobarbital are currently being used, they should be discontinued, whereas phenytoin should be maintained.</td>
</tr>
<tr>
<td>Propofol</td>
<td>Propofol 1–2 mg/kg boluses up to 10 mg Then 2–10 mg/kg/hour, titrated to effect</td>
</tr>
<tr>
<td>Midazolam</td>
<td>Loading dose of 0.15 mg/kg (maximum 8 mg) followed by an infusion rate of 2 µg/kg/min. Can be titrated up by increasing by 2 µg/kg/min every 5 min until seizure control is achieved. Maximum 24 µg/kg/min</td>
</tr>
<tr>
<td>Diazepam</td>
<td>IV infusion 100-400 mcg/Kg/h</td>
</tr>
</tbody>
</table>

Watch for Respiratory depression, hypotension and sedation in all step 3 drugs.
Management of children aged >4 weeks with suspected acute bacterial meningitis

**AIM** to start antibiotics within 30 minute of suspecting meningitis.

**Immediate actions**
- Screen for critical complications: Airway and breathing, circulation, raised Intracranial pressure
- Send blood culture
- Also send blood for FBC, CRP, Electrolytes, glucose, urea
- Perform lumbar puncture whenever possible (if no contra indications)
- Inform consultant pediatrician

**Contra indications for lumbar puncture present**: see below

**YES**
- Defer Lumbar Puncture
  - Start steroids and antibiotics
  - Manage as for raised ICP
  - Discuss and arrange PICU admission
  - Urgent neuroimaging

**No**
- Perform Lumbar puncture
  - Collect at least 30 drops of CSF
  - Arrange urgent transport to microbiology and request urgent microscopy (gram stain also antigen testing when available)
  - Also Protein and Glucose
  - Start steroids and antibiotics

- IV dexamethasone 0.15 mg/kg
- Followed by IV ceftriaxone 100 mg/kg (max. 4 g) or IM if no IV access (1 g per site) (Alternative: cefotaxime 50 mg/kg: max 2 g)
- Add Vancomycin 15 mg/kg (max 500 mg) in those with: Trauma, surgery, shunt, immune deficiency, critical illness, suspected antibiotic resistance

**Contra indications for lumbar puncture**
- **Signs of raised ICP**
  - Depressed level of consciousness (GCS< 12)
  - Papilloedema
  - Pupillary or eye movement disorder
  - Abnormal breathing
  - Decorticate or decerebrate posturing
  - Slow pulse and/or rising blood pressure
  - Hemiplegia
  - Focal seizures
  - Focal neurological signs
  - Rash suggestive of meningococcal septicemia
- **During or immediately after seizure**
- **Circulatory or respiratory insufficiency**
- **Coagulopathy**
- **Local skin sepsis**

**Avoid**
- Hypoglycemia
- Hyperthermia
- Seizures
- Acidosis
- Anemia
- Coagulopathy
- Abnormal electrolytes: Ca, Mg, K

**Avoid hypotension**: Maintain normal mean arterial pressure (use inotropes when needed)

**Fluid management**: see page X
- Carry out appropriate volume resuscitation
- **Do not restrict fluids**
- Always use isotonic (0.9% saline) solutions
- Use Hypertonic saline if signs of raised ICP present
Decreased Level of consciousness (Non-traumatic coma)

<table>
<thead>
<tr>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Febrile encephalopathy</td>
</tr>
<tr>
<td>• Seizure(s)</td>
</tr>
<tr>
<td>• Focal deficit</td>
</tr>
<tr>
<td>• Confusion / reduced conscious state</td>
</tr>
<tr>
<td>• Acute headache</td>
</tr>
<tr>
<td>• In early infancy – poor feeding, lethargy, vomiting, hypotonia</td>
</tr>
</tbody>
</table>

1. Airway & Breathing
   a. Ensure patent airway
   b. Give 100% oxygen via re-breathing bag
   c. Consider intubation
      i. GCS <8 or AVPU < P
      ii. Loss of airway reflexes
      iii. Ventilator insufficiency (hypercarbia PaCO2 >6; Hypoxia PaO2 <13 in high flow oxygen)
      iv. Obtunded / agitated
      v. Consider intubation when CT scan cannot be performed safely otherwise
      vi. Status epilepticus unresponsive to APLS algorithm
   d. Management of the child requiring intubation
      i. Rapid sequence induction with thiopentone and suxamethonium
      ii. Sedate with morphine and midazolam infusions
      iii. Insert OGT and place on free drainage

2. Maintain cerebral perfusion pressure
   a. Give 20l/kg fluid bolus if signs of shock and re-assess
   b. Normal requirement of Fluids
   c. Consider adding inotropes
   d. Consider achieving target Mean arterial pressure
   e. Catheterize the patient and check urine output.

3. Disability
   a. Check for hypoglycaemia and correct it (if glucose <3mmol/l, treat with 2ml/kg of 10% dextrose) and regularly check for hypoglycaemia
   b. Check Urea, Electrolytes, Calcium, Magnesium
   c. Lumbar puncture should never be done in a child with decreased level of consciousness

4. Assess the neurological functions
   a. Coma score – GCS
   b. Posture & tone
   c. Pupils size and reactivity
   d. Fundal changes – haemorrhage / Papilloedema
   e. Ophthalmoplegia
   f. Reflexes
   g. Evidence of fitting.

Treat urgently
1) Seizures
2) Critical ICP coning
3) Hypoglycaemia
5. **Assess for signs of raised ICP**
   a. Pupillary dilatation or asymmetry
   b. Abnormal posture
   c. Abnormal breathing pattern
   d. Bradycardia & Hypertension

6. **Critically raised ICP (“coning”)** – signs imply brain distortion or shift with or without reduced cerebral blood floor especially to brainstem. Can be mistaken for seizure (coma before posturing and bradycardia suggest coning)
   - Rapid decrease in conscious state
   - Dilated poorly reactive pupil(s)
   - Eye deviation (especially downward) and no doll’s eye movements
   - Abnormal respiration especially depression
   - Extensor posturing
   - Bradycardia ± raised BP
   - Any combination of above signs

7. **Management of raised intra cranial pressure**
   a. Consider mannitol 0.5g/kg IV
   b. 3-5ml of 3% Normal saline (aim Na 145mmol/l)
   c. Urgent CT scan (+/- Contrast)

8. **Urgent Treatment (without waiting for CT scan)**
   - Mild hyperventilation (usually after intubation). Effect on ICP is immediate. Do this first if any doubt about respiration
   - IV Mannitol 0.25 – 0.5g /kg (2-4ml/kg of 12.5% solution ) as rapid infusion. Effect in 10-15 minutes and for 3 – 5 hours.
   - Subdural, shunt or ventricular taps or emergency craniotomy rarely required – consult an neurosurgeon.

9. **Assess for treatable causes**
   a. Bacterial Meningitis – Cefotaxime 50mg/kg/dose x tds
   b. Meningoencephalitis (Herpes ) – Acyclovir
   c. Meningoencephalitis (Mycoplasma) – Clarythromycine
   d. Krait bite – signs of envenomation
   e. Poisoning – serum and urine for toxicology screen
   f. Cerebral malaria – IV quinine

10. **Other causes**
    a. Trauma (including neglectful or inflicted injury in infancy [shaking, direct trauma, asphyxiation])
    b. Infectious / Inflammatory CNS disease – refer above
    c. Severe seizure(s)
    d. Hypoxia / Hypotension – asphyxia, drowning etc.
    e. Metabolic – hypoglycaemia, electrolyte abnormality, genetic disease (especially infancy)
    f. Neurotoxic i.e drug, venom, toxin (Refer above)
    g. Systemic diseases
    h. Vascular i.e Hypertension, ICH, CVA, migraine
    i. Acute hydrocephalus i.e shunt blockage
11. Transport Consideration
   a. Manage as for raised ICP (ventilate to normocarbia, maintain CPP, normothermia, nurse head up and midline, etc)
   b. Monitor pupils
   c. Consider mannitol or 3% saline if signs of raised ICP (take pre-prepared bolus)
   d. Monitor glucose
   e. Take copies of CT scan if these have been done

12. A

Traumatic Brain Injury (TBI)

1. Assessment
2. Initial Management
3. Indication for intubation
4. Management of post intubation
Normal Fluid & Electrolytes

Physiology:

Tonicity: is normally maintained between 280 – 295 mosmol/L by ADH and thirst control mechanisms. EVolume regulation of water is via ADH, thirst and renin-angitnesin-adosternoe system. Note that volume regulation overrides the osmotic regulation.

Urine output:
The minimal urine output that maintain homeostasis varies with e.g. being 1.4ml/kg/hr at 4 weeks, 1ml/kg/hr at 6 months and 0.5ml/kg/hr at 1 year.

Compartments:

<table>
<thead>
<tr>
<th></th>
<th>Newborn</th>
<th>Infant</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>TBW</td>
<td>75%</td>
<td>60%</td>
<td>60%</td>
</tr>
<tr>
<td>ICV</td>
<td>35%</td>
<td>35%</td>
<td>40%</td>
</tr>
<tr>
<td>ECV</td>
<td>40%</td>
<td>25%</td>
<td>20%</td>
</tr>
<tr>
<td>Blood Volume</td>
<td>8%</td>
<td>7.5%</td>
<td>7.5%</td>
</tr>
</tbody>
</table>

Measured parameters that aid assessment are

- Weight
- Haematocrit
- Serum and urinary osmolality
- Acid base balance

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

Body Weight Serum Na mmol/kg/day Serum K mmol/kg/day
First 10kg 2-4 1.5-2.5
Second 10kg 1-2 0.5-1.5
Subsequent kg 0.5-1 0.2-0.7

- Actual volume of insensible loss is related to:
  - Caloric content of feeds, ambient temperature, humidity of inspired air, presence of pyrexia and the quality of the skin.
  - Usually between 0 and 10 ml/kg/day are lost in stools
  - (may exceed 300 ml/kg/day in diarrhoea)
  - Urinary losses are usually between 1-2 ml/kg/day
  - (approx 30ml/kg/day)
• How to calculate the percentage of dehydration
  o Percentage dehydration x weight x 10
  o Percentage dehydration means the number of grams of fluid lost per 100 gm of body weight.
  o Percentage x 10 converts this volume into ml/kg

• Shock occurs as a result of rapid loss of 20ml/kg from the intravascular space. If the intravascular volume is maintained, clinical dehydration is only evident after losses > 25ml/kg of total body water.

• It is possible to be shocked and not dehydrated, dehydrated and not shocked, or dehydrated and shocked.
HyperKalaemia Management

**Aetiology of Hyperkalaemia**
- Inadequate excretion of $K^+$ by the kidneys e.g. Renal failure
- Excessive potassium administration
- Shift of $K^+$ from the cellular to the vascular space associated with metabolic acidosis
- $K^+$ release from injured cells e.g. burns, severe dehydration, shock, sepsis, transfusion reaction

| Hyperkalaemia = serum potassium >5.5 mEq/L |
| Effects – Cardiac arrhythmias and Cardiac arrest |

**ECG diagnosis**
- Tall T waves
- Widening of QRS complexes
- Decreased P wave amplitude
- Increased PR interval

**Factitious? – Repeat serum $K^+$ levels**
- Traumatic venipuncture
- Leukocytosis or thrombocytosis
- Blood sample from vein or IV in which $K$ is infusing
- Lab error

Treat the cause
- Stop all exogenous potassium (infusions)
- Avoid the diet and drugs causing high $K$ levels
- Monitor vital signs and continuous ECG monitoring
- Reduce serum $K^+$ levels
- Check pH

**Remove excess $K^+$ from the body**
- Frusemide 1-4mg/kg IV
- Peritoneal dialysis

Nebulised Salbutamol 0.15mg/kg 4 hourly
IV bolus dose of salbutamol 4mcg/kg

**Stabilize the myocardium**
- 10% Calcium Gluconate 0.6 – 1ml/kg diluted 1:1 IV over 5-10 minutes give slowly (effect lasts over 30-60 minutes)
- Calcium Chloride 0.2-0.25ml/kg (10-20mg/kg) central IV of 10% solution. Give slowly. Infusion should be stopped if the fall in heart rate is >20/min.
- Give under cardiac monitor

**Move $K^+$ into the cellular space**
- Insulin and glucose Insulin 0.1 unit/kg in 2ml/kg 25% dextrose(glucose 0.5g/kg) IV infusion over 15-20 minutes followed by 10% Glucose 5ml/kg/hr with insulin 0.05 / 0.1 units/kg/hr IV
- Sodium bicarbonate 1mEq/kg IV

**Chronic hyperkalaemia**
- Binding resin – Kayaxelate 1g/kg, 6hourly orally or through NG tube. Retention enema (20% sorbitol) can also be given.
- CAH – Hydrocortisone (25mg/m3) and fludrocortisone (hypoaldosteronism) 0.1-0.2 mg/m2.
Hypokalaemia

Causes of hypokalaemia

- Hypokalaemia without potassium deficit
  - Metabolic alkalosis
  - Leukaemia (high white cell count – this is a spurious hypokalaemia, it occurs when blood sample is left in room temperature, when plasma potassium is shifted to the white cells).
  - B agonists drugs

- Hypokalaemia without potassium deficit
  - GIT loss (vomiting, diarrhea)
  - Renal loss (diuretics, RTA, osmotic diuresis such as DKA)
  - Hyperaldosteronism
  - Drugs

Investigations

- Urine microscopy
- ECG
- RBS
- ABG and anion gap
- Renal profile
- Liver profile

Pointers to specific conditions

| Diarrhoea | h/o diarrhea + Dehydration + metabolic acidosis, |
| Diuretic therapy | Metabolic alkalosis + diuretic therapy |
| RTA | h/o FTT, Rickets + Metabolic acidosis + positive net charges bicarbonate administration 0.5 – 1 mmol/kg/day orally. |
| Bartter syndrome | Metabolic alkalosis + low serum Mg + normal BP + high fractional excretion of Mg. Treatment is indomethacin and potassium supplementation. |
| Hyperaldosteronism | Metabolic alkalosis + high BP |
| Malnutrition | Features of PEM + metabolic alkalosis + low serum Mg + low fractional excretion of Mg + Normal BP. |
| Cystic fibrosis | FTT + malabsorption + recurrent chest infection + alkalosis + positive sweat chloride test |
| Mg deficiency | add magnesium sulfate 0.2ml/kg of 50% injection IM 12 hourly for 2-3 days followed by oral Mg SO4. |

Management

Aim should be to maintain the serum potassium level in between 3.5 to 5.5 mEq/L. Daily supplementation of potassium should be 5 – 6 mEq/L/kg day.

IV route

- Hypokalaemia should best replaced enterally in non-emergent situations.
- Dose of KCl (2mEq/ml) is 0.25 mEq/kg/hr to 1 mEq/kg/hr.
- Maximum up to 40 mEq/L KCl can be given through the peripheral vein.
- More than this level will require central line access. Up to 60 mEq/L can be given by central line.
- The rate of the infusion should not exceed 20 mmol/hr unless malignant arrhythmia are present.
- For magnesium deficiency, For Bartter syndrome.
- For RTA,
Potassium infusion in hypokalemic patients

**Indications**
- If the serum potassium is less than 4.0 mmol/l on a serum electrolyte sample
- Symptomatic hyokalaemia particularly with ECG changes
- Higher doses up to 1 mEq/kg/hr are required if hypokalaemia is associated with the life threatening conditions like cardiac arrhythmias, respiratory arrest, DKA and quadripareisis.

**Patient <20kg**
- 10 mmols Potassium Chloride (5ml KCl solution), dilute with 5mls Normal Saline. Total volume of solution =10 mls

**Patient >20kg**
- 40 mmols Potassium Chloride (20ml KCl solution), dilute with 20mls Normal Saline. Total volume of solution =40 mls

Dextrose solutions can initially exacerbate hypokalaemia due to insulin mediated intracellular shift of the potassium

- Monitor the patient with continuous ECG monitoring
- Potassium infusion should always be given by a syringe pump and if possible be given through a central vein
- Run the infusion at 0.3mmol/kg/hour for 3 hours only
- Discard the solution after 24 hours
- The maximum infusion rate is 0.5mmol/kg/hour; faster infusion can cause cardiac arrhythmias. Replacement should not exceed 0.5 mEq/kg/hr in most cases because of following.
  - Risk of hyperkalemia particularly with acidosis or renal disease.
  - KCl is irritant and can cause phlebitis. Use a large, well-functioning IV, such as a central line or well flowing ante cubital vein.
- Infusion rate = (weight x 0.3)mls / hour
- Recheck serum potassium level after 3 hours
- If potassium >4.0 – stop infusion
- If potassium >5.5 – inform doctor
- If potassium <4.0 continue infusion for 3 more hours then recheck serum levels
Hyponatraemia (serum sodium <130 mmol/L)

Osmolality

Normal

Pseudohypo-Na

Hyperlipidaemia
Hyperviscosity
Hyperproteinaemia

Hyponatraemia (serum sodium <130 mmol/L)

Osmolality

Low

Hypotonic Hypo-Na

URINARY Na

>20 mmol/l

Hypovolaemia

Diuretics
Addisons
Salt loosing nephritis

Euvolaemic
(Chronic water load)

SIADH
Drugs
Carbamazepine
Endocrine
Chronic renal failure

URINARY Na

<20 mmol/l

Hypertonic HypoNa

Hyperglycaemia

Hyperpigmentation

URINARY Na

>20 mmol/l

Hypovolaemia

Extra renal losses
Vomiting
Diarrhea
Third space losses etc

Euvolaemic

Acute water overload
↑ water intake
Renal failure
Endocrine

Oedema

End stage Cardiac failure
Nephrotic syndrome
Cirrhosis
Protein loosing enteropathy

Treatment –
Fluid restriction (50% of daily requirement)

Treatment
• Fluid restriction (50% of daily requirement)
• Sodium restriction (no additives)
• Diuretic (Frusemide)
Hyponatremia can be isotonic, hypertonic or hypotonic depending on the measured serum osmolality.

**Dilutional hyponatremia (no oedema) i.e total body water excess**
- Increase intake – IV, Polydipsia
- Inappropriate ADH – Meningitis, CNS Trauma, Pneumonia
- Osmotic – glucose, mannitol

**Treatment**
- Fluid restriction (50% daily requirement)

**Dilutional hyponatremia (with oedema) i.e total body water and sodium excess**
- End stage Cardiac failure
- Renal failure
- Hepatic failure
- Protein losing enteropathy
- Nephrotic syndrome

**Treatment**
- Fluid restriction (50% of daily requirement)
- Sodium restriction (no additives)
- Diuretic (Furosemide)

**Hyponatraemia associated with sodium and water loss i.e.total body water and sodium deficit**
- Renal disease with salt wasting or renal tubular acidosis
- Adrenocortical failure (salt wasting congenital adrenal hyperplasia (CAH) or mineralcorticoid deficiency
- Post surgery, trauma, or burns
- GIT losses (diarrhea, vomiting, or third space)
- Diuretics

**Treatment**
- Replace sodium and water deficit.
- Correct to 125 mmol/L if symptomatic
- Initial treatment should correct hypovolaemic shock with normal saline using aliquots of 20ml/kg
- In symptomatic hyponatraemic patients sodium should be acutely raised to 120-125 mEq/l.
- Serum sodium level should not be increased by >12mEq/24hrs or >18mq/48hrs.
- Monitoring vital sings, intake output, should be checked during correction
- Serum sodium and serum glucose levels during correction should be measured hourly.
- 3% sodium chloride should be given for correction in the largest IV line available or through central line.
- Formula for correction is = ( 125- serum Na level (mEq/l) x 1.2ml/kg x body weight in kg
- Psuedo-hyponatramia
  - Extreme hyperglycaemia
  - Extreme hyperlipaemia
  - Extreme hyperprotemia
- Overhydrated
  - Cirrhosis
  - Nephrotic syndrome
  - End stage CCF
- Dehydrated
  - Renal loss
    - diuretic use or abuse
    - ATN
    - Prematurity
    - Cerebral salt wasting
    - Addison
  - GIT loss
  - Capillary leak syndrome
- Euvolaemic
  - SIADH
  - CNS
  - CVS
  - Drugs
  - Severe anaemia
- Miscellaneous
- Treatment

**SIADH**

### Features
- Serum sodium <130 mEq/L
- Serum sodium <280 mOsm/kg
- Urine osmolality >100 mOsm/kg (usually 300 mOsm/kg)
  - The urine osmolality is inappropriately elevated (relative to low serum osmolality) reflecting the inability to dilute the urine maximally.
- Urine Na >20 to 40 mEq/l
- Low blood urea nitrogen (BUN) level

1. Asymptomatic mild hyponatraemia (130-125mEq/L) – 2/3 maintenance
2. Symptomatic patients with seizures or coma increase the Sodium level to 120-125mEq/l with 3% NaCl3 solution
3. Fluid administration of 1/3 maintenance (400ml/m3/day) replaces only the insensible fluid loss.
4. Hyponatraemia should be corrected slowly over 48-72hrs.
**Hypernatraemia (serum sodium > 150mmol/L)**

Hypernatraemia is always associated with hypertonicity

Hypocalcaemia

**DHF / DSS**

Results in leaking of albumin into pleural and peritoneal cavity

- 10% Calcium Gluconate 0.5-1ml/kg (maximum dose 10ml) diluted 1:1 IV over 5-10 minutes give slowly (effect lasts over 30-60 minutes) x 6 hourly
- No indication for Ca in asymptomatic and uncomplicated DHF cases grade 1, 111, 11 patients.
Diabetic Keto Acidosis (DKA) Algorithm

## Clinical History
- Polyuria
- Polydipsia
- Weight loss
- Abdominal pain
- Weakness
- Vomiting
- Confusion

## Clinical Signs
- Assess dehydration
- Deep sighing respiration (kussmaul)
- Smell of ketones
- Lethargy, drowsiness

## Biochemistry
- Elevated blood glucose (>11mmol/l)
- Acidaemia (pH<7.3)
- Ketones in urine or blood
- Take blood also for electrolytes,
  - Dehydration <5%
  - Clinically well
  - Tolerating fluid orally

## Dehydration >5%
- Clinically acidicotic
- Vomiting

## Clinical Signs
- Shock
  - Reduced peripheral pulse volume
  - Reduced conscious level
  - Coma

## Resuscitation
- Airway ± N/G tube
- Breathing (100%FiO₂)
- Circulation (10ml/kg of 0.9% Saline repeated until circulation restored, max 3 doses)

## Observations
- Hourly blood glucose
- Neurological status at least hourly
- Hurly fluid input : output
- Electrolytes 2 hourly after start of IV therapy, then 4 hourly
- 1-2 hourly blood ketone levels

## Intravenous therapy
- Calculate fluid requirement
- Correct over 48hours
- 0.9% saline for at least 12 hours
- Add KCL 20 mmol every 500ml
- Insulin 0.1U/kg/hour by infusion after first hour of fluids

## Therapy
- Start with s.c insulin
- Give oral fluids

## No Improvement
- Blood ketones rising
  - Looks unwell
  - Starts vomiting

## Neurological deterioration: warning signs
- Headache, irritability, slowing heart rate, reduced conscious level, specific signs of raised ICP

## Exclude
- Hypoglycaemia
  - Is it Cerebral oedema

## Management
- Give 5ml/kg 3% saline or mannitol 0.5-1.0g/kg
- Call senior staff
- Restrict IV fluids by ½
- Move to ITU
- CT scan when stabilized

## Re-evaluate
- Fluid balance+IV therapy
- If continued acidosis, may require further resuscitation fluid
- Check insulin dose & correct
- Consider sepsis

## Insulin
- Start subcutaneous insulin then stop IV insulin hour latter

## Resolution of DKA
- Clinically well, drinking well, tolerating food
- Blood ketones <1.0 mmol/l or pH normal
- Urine ketones may still be positive

## Dehydration <5%
- Clinically well
- Tolerating fluid orally
SEDATION FOR CRITICALLY ILL CHILDREN

Aims of sedation

- Reduced anxiety and distress
- Facilitation of mechanical ventilation and avoidance of inadvertent self-extubation
- Reduced metabolic rate and oxygen demand
- Enhanced analgesia
- Less disrupted sleep
- Reduced patient recall
- To allow tolerance of diagnostic and therapeutic procedures

Usual intravenous sedative/analgesic combination in children is midazolam and morphine

**MIDAZOLAM**
- Intravenous infusion; 2-8 micrograms/kg/min
- Intravenous bolus; 100-200 micrograms/kg/min (Adult dose 5mg)
- Repeat bolus doses as necessary
- For patients >50kg give 5-15mg/hr (not per kg) as infusion
- Do not use routinely in infants below 6 months
- Consider reduced dose in renal and hepatic impairment

**Morphine**
- Intravenous infusion; 10-60micrograms/kg/hr
- Intravenous bolus; 100-200 micrograms/kg/dose (Adult dose 5-10mg)
- Start neonates at 5–20micrograms/kg/hr as infusion
- For patients >50 kg give 0.8-3mg/hr (not per kg) as infusion
- Consider reduced dose in renal and hepatic impairment
- Use with caution in asthmatic patients

**COMPLICATIONS OF SEDATION**

- Tolerance
- Withdrawal phenomenon
- Inadvertent hypotension
- Increased protein breakdown
- Immunosuppression
- Renal dysfunction
- Hepatotoxicity
- Increased financial cost
- Prolonged duration of mechanical ventilation and intensive care admission

Where possible use ENTERAL SEDATION; chloral hydrate with or without a sedative antihistamine such as alimemazine

**CHLORAL HYDRATE**
- NG; 25-50mg/kg/dose 4-6 hrly
Maximum 2g per dose  
Can cause gastric irritation  
Avoid in severe renal and hepatic failure  

**SEDATION SCORING**  
Sedation scores should be formally assessed and documented every hour.

<table>
<thead>
<tr>
<th>VENTILATION</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>No respiratory effort</td>
<td>0</td>
<td>Triggering respiration</td>
<td>Fighting ventilator</td>
</tr>
<tr>
<td>(apnoea)</td>
<td></td>
<td>Synchrony with ventilator</td>
<td>Asynchrony with ventilator</td>
</tr>
<tr>
<td>10% &lt;Baseline</td>
<td>1</td>
<td>0-10% &gt; Baseline</td>
<td>20% &gt; Baseline</td>
</tr>
<tr>
<td>FACIAL EXPRESSION</td>
<td>No Movement or asleep</td>
<td>Quietly alert with relaxed expression</td>
<td>Anxious/Anguished expression</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Frown</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Facial Grimace</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Silent cry</td>
</tr>
<tr>
<td>BODY MOVEMENT</td>
<td>No Movement or asleep</td>
<td>Some body movement but posture/position relaxed &amp; comfortable</td>
<td>Jerky / startled movements</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Uncoordinated movements of limbs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Arching of back</td>
</tr>
<tr>
<td>AGITATION</td>
<td>No movement or asleep</td>
<td>Some agitation but can be comforted</td>
<td>Major agitation &amp; cannot be comforted</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Crying/silent cry</td>
</tr>
</tbody>
</table>

**SCORE**  
SCORE 0-3 = Child is over sedated. Action: Review Sedation  
SCORE 4-6 = Child is adequately sedated. Action: None  
SCORE 7-10 = Child is under sedated. Action: Review Sedation  
If child is paralysed document as = P  

**WITHDRAWAL**  
Withdrawal may occur following the discontinuation of sedative agents, particularly the benzodiazepines. The incidence of midazolam withdrawal has been estimated at between 17% and 30% and may be related to the total drug dose received. Features of withdrawal usually occur within a few hours of stopping the drug.  
Features of withdrawal

<table>
<thead>
<tr>
<th>CNS FEATURES</th>
<th>SOMATIC FEATURES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agitation</td>
<td>Vomiting</td>
</tr>
<tr>
<td>Seizures</td>
<td>Tachycardia</td>
</tr>
<tr>
<td>Hallucinations</td>
<td>Fever</td>
</tr>
<tr>
<td>Psychosis</td>
<td>Respiratory distress</td>
</tr>
</tbody>
</table>

When intravenous sedative agents have been used for longer than seven days, withdrawal can be anticipated and the doses of sedative agents should be reduced by 10% increments of the original dose at eight hourly intervals; allowing for withdrawal of the agents over three days. Any signs of withdrawal should prompt a return to the previous increment and a slower weaning regime.
Additional agents that may be useful in the management of withdrawal include clonidine, methadone and lorazepam.

**CLONIDINE**
Intravenous infusion; 0.1-2 micrograms/kg/hr
NG; 1-5 micrograms/kg/dose 6 hrly
Start infusions at 1 microgram/kg/hr

**LORAZEPAM**
Intravenous bolus; 50-100 micrograms/kg/dose (max 4mg)
NG; 20-60 micrograms/kg/dose 8-24 hrly (max 1-3mg)
Reduce doses in severe renal and hepatic impairment
IV preparation may be given via NGT

**METHADONE**
Divide total daily dose of morphine by 5 for conversion to methadone dose and administer in two divided doses enterally

**OTHER AGENTS**

**KETAMINE**
Intravenous infusion; 5-20 micrograms/kg/min
Intravenous bolus; 1-2 mg/kg/dose
May be useful in status asthmaticus
Use with caution in systemic hypertension
Avoid in raised intracranial pressure
Concentrations exceeding 10 mg/ml should be infused centrally

**FENTANYL**
Intravenous infusion;
5-10 micrograms/kg/hr
Intravenous bolus; 1-2 micrograms/kg/dose
May be more effective than morphine
Less histamine response so potential benefit in status asthmaticus
Reduce dose in hepatic impairment
Beware hypotension and bradycardia
Transdermal patches may be of use in treating withdrawal

**PROPOFOL**
**PROPOFOL SHOULD NOT BE USED FOR LONG-TERM SEDATION IN CHILDREN UNDER THE AGE OF 16 YEARS**
Intravenous bolus dose; 1-3 mg/kg/dose
BLOOD COMPONENT ADMINISTRATION (NEONATES, INFANTS AND CHILDREN)

All Blood Components. All blood components should be administered using a blood component administration set which incorporates a 170 – 200 micron filter. A paediatric blood administration set may be used.

Whole blood is not used anymore, availability is very limited since more than 90% of blood collection is used to prepare packed red cells and other blood components.

However can be used in acute blood loss in DHF in shock and acute severe blood loss in trauma

Packed Red Cells - for neonates and infants

- Indication: Acute and chronic symptomatic anaemia
- Volume: depends on size of paedipak split
- Storage: designated temperature controlled refrigerator 4±2 oC
- All red cell units should be transfused within 4 hours of removal from designated temperature controlled storage (4 ±2 oC)

Neonatal Exchange transfusion:

- Plasma reduced whole blood in citrate phosphate dextrose (CPD) anticoagulant
- Haematocrit 0.5-0.6 (NHSBT, England 0.5-0.55)
- Irradiated (unless this would unduly delay transfusion and there has been no prior intrauterine transfusion)
- < 5 days old, 24 hrs post-irradiation
- Typical dose: 80-100ml/kg (for anaemia), 160-200ml/kg (for hyperbilirubinaemia)
- Administration rate: depends on stability of baby, discuss with Neonatal consultant
- Local units should have their own exchange transfusion guidelines

Large-volume transfusion:

- Red cells in additive solution (SAG-M) Hct 0.5-0.6,
- < 5 days old
- Typical dose: emergency neonatal transfusion: 10-20ml/kg

Top-up transfusions

- Red cells in additive solution (SAG-M),
- Hct 0.5-0.7, shelf-life 35 days
- Use of ‘Paedipaks’ should be discussed with the hospital transfusion laboratory.
• Typical dose - 10-20ml/kg, or Vol (mls) = desired Hb rise (g/dl) x weight (kgs) x 3
• -Typical administration rate: 5ml/kg/h

**Packed Red Cell transfusion for children**

• Typical dose: Vol (mls) = desired Hb rise (g/dl) x weight (kgs) x 3
• Typical administration rate 5 ml/kg/h (usual max rate: 150ml/hr)

**Platelets**

• Indications: Prevention and treatment of haemorrhage in patients with thrombocytopenia or platelet function defects. Platelet transfusions are not indicated in all causes of thrombocytopenia and may indeed be contraindicated in certain conditions (TTP, HIT and ITP unless life threatening). Thus, the cause of the thrombocytopenia should be established before a decision about the use of platelet transfusion is made. Any decision must also be based on an assessment of risk versus benefit
• Storage: temperature controlled 22 ±2o C – with continuous gentle agitation. Platelets must not be refrigerated. Shelf life: 5 days (In certain controlled circumstances 7 day platelets may be supplied)
• Apheresis platelets should be used for all children < 16 yrs where possible to reduce donor exposure
• Typical dose: Children < 15 kg: 10-20 mls/kg
• Children > 15 kg: single apheresis concentrate (approx 300mls; actual volume recorded on pack label)
• Typical administration rate 10-20ml/kg/h

**FFP (Fresh Frozen Plasma)**

• Indications: Multiple coagulation factor deficiencies, Reversal of warfarin effect if APCC is not available, DIC with bleeding, Massive blood transfusion.
• Storage: designated temperature controlled freezer. Core temperature -30 oC, Shelf life: 24 months (frozen)
• Typical dose: 10-20 mls/kg, Typical administration rate 10-20ml/kg/h

**Cryoprecipitate**

• Indications: Haemophilia A, Von willebrand disease & factor XIII deficiency if specific factor concentrates are not available. Hypo and dysfibrinogenaemia.
- Storage: designated temperature controlled freezer. Core temperature -30 °C. Shelf life: 24 months (frozen)
- Once thawed, cryoprecipitate must not be re-frozen and should be used immediately. If delay is unavoidable, the component must be stored at ambient temperature and used within 4 hours
- Typical dose is 5-10ml/kg. Typical administration rate 10-20 ml/kg/h.

**Granulocytes**

- Indications: Very severe febrile neutropenia (recovery is possible) not responding to antibiotics and antifungal.
- Storage: should be administered as soon as possible after their preparation. If storage is unavoidable, the component must be stored, without agitation, at a core temperature of 22 ±2 °C
- Shelf life: 24 hours
- Must be irradiated
- Administration rate: dependant on volume of the component and the weight of the child.

**Factor VIII concentrates**

- Indication: Haemophilia A prophylactic and on demand treatment, Von Willebrand disease Type III with bleeding, Rare bleeding disorders-combined factor V & VIII deficiency.

**Factor IX concentrates**


**Activated prothrombin complex concentrates(APCC) or Prothrombin complex Concentrates(PCC)**

- Indications: Haemophilia A & B with inhibitors and warfarin reversal with bleeding.
- Dosage: 25U/Kg

**Recombinant Factor VIIa**

- Indications: Factor VII deficiency, Haemophilia A & B with inhibitors to exogenous factor concentrates, Very severe uncontrollable haemorrhage not responding to other measures (Controversial).
- Dosage: 90 μg kg(-1)/dose

**Reference:**

**Blood Products**

1) **Whole blood**
   - Indications – acute blood loss in DHF with shock, surgical procedures, acute haemolysis
   - Volume to be given (ml) = 0.6 x weight (kg) x desired increase in Hb (g/dl)
   - 450mls pack, HCT - 33%, stored at 5 ± 1°C <28 days.
   - Not considered clinical source of viable platelets or labile coagulation Factors FV and F V111

2) **Packed red cells**
   a. Indications – acute blood loss in DHF with shock, surgical procedures, acute haemolysis
   - Volume to be given (ml) = 0.4 x weight (kg) x desired increase in Hb(g/dl)
   - It is almost always preferable to use packed cells in children over 12 months of age.
   - Hct 66%
   - One unit = 375 ± 75ml
   - Stored at 5 ± 1°C <35 days

3) **Platelet concentration**
   - 5.5 x 10^10 platelets suspended in 40-70 ml of plasma, stored at 20-24°C and agitated.
   - 1 unit should raise platelet count by 5 x 10^9
   - Indications – count < 10 or 50 with bleeding

4) **FFP**
   - Contain all coagulation factors including – 200 units of Factor V111 + also FV
   - Patients preferably ABO compatible
   - Volume – 300ml, stored –ve 30°C / <12 months
   - Usual dose 10-30ml/kg

5) **Cryoprecipitate**
   - Indications – von Willebrands Syndrome, Haemophilia A
   - One bag 15-20ml
   - Factoe V
   - It must be infused within 6 hours of thawing
   - Stored –ve 300C/ <12 months
   - Contains ~ 100u of Factor V111, 150 units of Fibrinogen, F V11, VWF, in <15 plasma ABO antibodies present

6) **Prothrombinex**
   - Contains ~ 200 units F 1X / 10ml, also F 11 and F X,
   - Stored –ve 30°C /<12 months
Acid Base Balance

Normal blood gas values:

<table>
<thead>
<tr>
<th>pH</th>
<th>pCO₂</th>
<th>HCO₃</th>
<th>BE</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.36–7.44</td>
<td>35–45 mmHg (4.7–6 kPa)</td>
<td>-2–+2 mmol/L</td>
<td>&gt;80 mmHg in air (&gt;10.6 kPa)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>pH</th>
<th>pCO₂</th>
<th>HCO₃</th>
<th>BE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metabolic acidosis</td>
<td>↓</td>
<td>↓</td>
<td>↓</td>
</tr>
<tr>
<td>Metabolic Alkalosis</td>
<td>↑</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Respiratory acidoisis</td>
<td>↓</td>
<td>↑</td>
<td>↑</td>
</tr>
<tr>
<td>Respiratory Alkalosis</td>
<td>↑</td>
<td>↓</td>
<td>↓</td>
</tr>
</tbody>
</table>

Look for associated abnormalities

If a primary metabolic acidosis

Expected $pCO₂ = (1.5 \times HCO₃) + 8$  
$pCO₂ = \text{decimal digit of pH} \pm 5 \text{ mmHg}$ or  
$↓ pCO₂ 1.3 \text{mmHg per 1 mmol} ↓ \text{ in HCO₃ (limit 10)}$

If a primary metabolic alkalosis

Expected $pCO₂ (0.9 \times HCO₃) + 9$  
$pCO₂ = \text{decimal digits of pH} \pm 5 \text{ mmHg}$ or  
$↑ pCO₂ 0.7 \text{mmHg per 1 mmol} ↑ \text{ in HCO₃ (limit 60)}$

If a primary respiratory acidoisis

Acute: $HCO₃ ↑1 \text{ mmol pe}$  
Chronic: $HCO₃ ↑4 \text{ mmol per 10mmHg} ↑ \text{ in CO₂ (max 36)}$

If a primary respiratory alkalosis

Acute: $HCO₃ ↓2 \text{ mmol per 10mmHg} ↓ \text{ in CO₂ (min 18)}$  
Chronic: $HCO₃ ↓5 \text{ mmol per 10mmHg} ↓ \text{ in CO₂ (min 12)}$

Metabolic Equations

<table>
<thead>
<tr>
<th>Equation</th>
<th>Formula</th>
<th>Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anion gap</td>
<td>$Na⁺ - (HCO₃ + Cl⁻)$</td>
<td>7-12 ± 2</td>
</tr>
<tr>
<td>Calculated Osmolarity</td>
<td>$2 \times Na + \text{urea + glucose}$</td>
<td>275-295 mosmol</td>
</tr>
<tr>
<td>Osmolar gap</td>
<td>measured osmolality – calculated osmolality</td>
<td>≤10</td>
</tr>
<tr>
<td>Corrected Na for glucose</td>
<td>$(glucose /3) \ \text{apparent Na}$</td>
<td></td>
</tr>
<tr>
<td>Corrected Ca for albumin</td>
<td>$\uparrow 0.2 \text{ per mmol/l per 1g} ↓ \text{ in albumin}$</td>
<td></td>
</tr>
<tr>
<td>Corrected K for pH</td>
<td>$0.5 \text{ mmol/l} \ \uparrow \text{ in K per 0.1} ↓ \text{ in pH}$</td>
<td></td>
</tr>
<tr>
<td>Alveolar gas equation</td>
<td>$PAO₂ = (710 \times FiO₂) – (PaCO₂/0.8) \ \text{mmHg}$</td>
<td></td>
</tr>
<tr>
<td>Aa gradient</td>
<td>$PAO₂ – PaO₂ \ \text{(Age + 3)} – 3 \text{ mmHg}$</td>
<td></td>
</tr>
</tbody>
</table>
| Water deficit/excess            | $\text{TBW} \times (1- (Na₂ + Na₁))$  
$\text{TBW} = \text{total body water} = 60\% \ \text{weight}$  
$Na₂ = \text{desired Na}$  
$Na₁ = \text{actual Na}$ |        |
| Renal failure index             | $(\text{urine Na} \times \text{serum Cr}) ÷ \text{urine Cr}$ |        |
| Fractional excretion of Na      | $((\text{UNa ÷ SNa}) × (\text{SCr ÷ UCr})) \times 100$ |        |
| Cl:PO4 ratio                    | If >33:1 consider $\uparrow \text{PT hormone}$ |        |
**Lactic Acidosis**

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type A</strong></td>
<td>Hypoxia &amp; ↓ perfusion</td>
</tr>
<tr>
<td>B&lt;sub&gt;1&lt;/sub&gt; “Lukes”</td>
<td>Leukamia, lymphoma</td>
</tr>
<tr>
<td>B&lt;sub&gt;1&lt;/sub&gt; “TIPS”</td>
<td>Thiamine deficiency, infection, pancreatitis, short bowel syndrome</td>
</tr>
<tr>
<td>B&lt;sub&gt;1&lt;/sub&gt; “FAILURES”</td>
<td>Hepatic/renal/diabetic failures</td>
</tr>
<tr>
<td>B&lt;sub&gt;2&lt;/sub&gt; Drugs</td>
<td>Metformin, salisylates, methanol, ethylin glycol, IV fructose</td>
</tr>
<tr>
<td>B&lt;sub&gt;3&lt;/sub&gt; Hereditary</td>
<td>G6PD deficiency</td>
</tr>
</tbody>
</table>

**Metabolic Alkalosis with Saline responsiveness (Urinary Chloride <10 mmol/l) (35)**

<table>
<thead>
<tr>
<th>Alkalosis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal Alkalosis</td>
<td>Diuretic</td>
</tr>
<tr>
<td>Poorly reabsorbable anion therapy: Carbenicillin/penicillin/phosphate/sulphates Post hypercapnia</td>
<td></td>
</tr>
<tr>
<td>GI Alkalosis</td>
<td>Gastric alk, intestinal alk, Cl diarrhoea</td>
</tr>
<tr>
<td>Exogenous alkali</td>
<td>Citrate, lactate, antacids, transfusion, NaHCO3, gluconate, acetate</td>
</tr>
<tr>
<td>Contraction alkalosis</td>
<td></td>
</tr>
</tbody>
</table>

**Metabolic Acidosis with high anion gap**

- **M** – Methanol, Metformin
- **U** – Uraemia
- **D** – Diabetic Ketoacidosis
- **P** – Phenformin, paraldehyde, Propylene glycol, pyroglutamic acidosis
- **I** – Iron, isoniazid
- **L** – Lactic acidosis
- **E** – Ethanol ketoacidosis, ethylene glycol,
- **S** – Salicylate, starvation, ketoacidosis, solvents (tolune)

**Metabolic Acidosis with normal anion gap**

- **U** – Ureteroenterostomy
- **S** – Small bowel fistula
- **E** – Extra chloride
- **D** – Diarrhoea
- **C** – Carbonic anhydrase deficiency
- **A** – Addison’s disease
- **R** – Ranal Tubular acidosis
- **P** – Pancreatic fistula

<table>
<thead>
<tr>
<th>Anion gap</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>K&lt;sup&gt;+&lt;/sup&gt; ↓</td>
<td></td>
</tr>
<tr>
<td>K&lt;sup&gt;+&lt;/sup&gt; ↑</td>
<td></td>
</tr>
<tr>
<td>K&lt;sup&gt;+&lt;/sup&gt; ↓ (Type 1)</td>
<td></td>
</tr>
<tr>
<td>K&lt;sup&gt;+&lt;/sup&gt; ↓</td>
<td></td>
</tr>
<tr>
<td>K&lt;sup&gt;+&lt;/sup&gt; ↓</td>
<td></td>
</tr>
<tr>
<td>K&lt;sup&gt;+&lt;/sup&gt; ↓</td>
<td></td>
</tr>
</tbody>
</table>

**Metabolic Alkalosis with Saline responsiveness (Urinary Chloride <10 mmol/l) (35)**

<table>
<thead>
<tr>
<th>Alkalosis</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renal Alkalosis</td>
<td>Diuretic</td>
</tr>
<tr>
<td>Poorly reabsorbable anion therapy: Carbenicillin/penicillin/phosphate/sulphates Post hypercapnia</td>
<td></td>
</tr>
<tr>
<td>GI Alkalosis</td>
<td>Gastric alk, intestinal alk, Cl diarrhoea</td>
</tr>
<tr>
<td>Exogenous alkali</td>
<td>Citrate, lactate, antacids, transfusion, NaHCO3, gluconate, acetate</td>
</tr>
<tr>
<td>Contraction alkalosis</td>
<td></td>
</tr>
</tbody>
</table>
Metabolic Alkalosis with Saline unresponsiveness (Urinary Chloride >10 mmol/l) (35)

<table>
<thead>
<tr>
<th>BP normal</th>
<th>BP high</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bartter’s syndrome</td>
<td>Conn’s</td>
</tr>
<tr>
<td>Severe hypokalemia</td>
<td>Hypereninism</td>
</tr>
<tr>
<td>↑calcium</td>
<td>Liddle’s syndrome</td>
</tr>
<tr>
<td>↓PTH</td>
<td>Adrenal enzyme ↓: (11+17 hydroxylase)</td>
</tr>
<tr>
<td>Refeeding alkolosis</td>
<td>Liquorice</td>
</tr>
<tr>
<td></td>
<td>carbenoxolone</td>
</tr>
<tr>
<td></td>
<td>Chewing tobacco</td>
</tr>
</tbody>
</table>

Acute Renal Failure

<table>
<thead>
<tr>
<th></th>
<th>Pre-renal</th>
<th>Renal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urine Na+ mmol/l</td>
<td>&lt;20</td>
<td>&gt;40</td>
</tr>
<tr>
<td>Urine osmolality</td>
<td>&gt;500</td>
<td>&lt;350</td>
</tr>
<tr>
<td>Urine specific gravity</td>
<td>&gt;1.040</td>
<td>1.010 – 1.016</td>
</tr>
<tr>
<td>Urine: Serum creatinine</td>
<td>&gt;40</td>
<td>&lt;20</td>
</tr>
<tr>
<td>Renal failure Index (more reliable)</td>
<td>&lt;1</td>
<td>&gt;1</td>
</tr>
<tr>
<td>Fractional excretion Na⁺ (more reliable)</td>
<td>&lt;1</td>
<td>&gt;1</td>
</tr>
</tbody>
</table>
MANAGEMENT OF CHILDHOOD URINARY TRACT INFECTIONS

Acute management of the symptomatic child

- **Voiding symptoms only**
  - UFR & urine culture are suggestive of UTI
    - Is the collection accurate?
      - Yes
        - Repeat UFR and urine culture, Re-assess the clinical status & act accordingly
      - No
        - Repeat UFR and *urine culture and start AB, if clinical status prevails

- **Febrile (Otherwise well)**
  - UFR, *Urine culture
    - Positive UFR with **prevailing clinical status** OR features of APN
      - Start AB pending culture

- **Febrile (Moderately ill)**
  - Immediate IV AB preferably after septic screening
    - *Preferably a catheter or a SPA sample for infants and young child

- **Febrile (Very ill)**
  - **Repeat UFR 48 hours after starting treatment and assess clinical improvement; If no improvement re-evaluate, repeat urine culture and consider urgent RBUS ±nephrology / urology opinion**
  - **RBUS is also indicated in the acute phase for those with atypical/complex UTI**
  - **Ensure hydration and good passage of urination**
  - **Use nephrotoxic drugs cautiously; Avoid in atypical/complex UTI**

Long term follow up of the first attack of simple febrile UTI in a child without urological / voiding problems:

- RBUS within 6 weeks of the acute attack
- Counsel and ensure early identification of future attacks and prompt treatment
- Ensure proper collection of urine samples for culture
- **Infants and young children** RBUS may be repeated to ensure renal growth and to further exclude any structural anomalies
- **Prophylactic antibiotics** Not routinely recommended

**Indications for second line imaging** Only indicated if there are clear changes in the management based on its findings; and also consider the opinion of a nephrologist/urologist as appropriate.

<table>
<thead>
<tr>
<th>Indications for DMSA scan:</th>
<th>Indications for MCUG scan:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• RBUS evidence of duplex, ectopic, scarred or absent kidney/s or poor renal growth</td>
<td>• Suspected BOO or neurogenic bladder</td>
</tr>
<tr>
<td>• Selected patients with recurrent UTI</td>
<td>• <strong>&lt;3 years with</strong> Persistence RBUS evidence of high grade VUR, atypical or complex clinical circumstances, and selected patients with recurrent UTI</td>
</tr>
<tr>
<td>• <strong>&lt;3 years with</strong> Atypical or complex clinical circumstances</td>
<td></td>
</tr>
</tbody>
</table>

**Management of children with recurrent UTI:**

- Re-evaluate clinical symptoms and lab reports for accuracy of diagnosis
- Evaluate bowel, voiding and drinking habits
- **Dysfunctional voiding and constipation** are the commonest causes
  
  *These children need a well structured long-term management plan*
- Evaluate for **structural BOO and neurogenic bladder**
- Ensure personal and perineal hygiene
- Treat labial adhesions / phimosis
- Advice double voiding for reflux
- Explore the availability of health care facilities during an acute attack
- **Do not treat asymptomatic bacteriuria**
- Consider **2nd line imaging ± prophylactic antibiotics/ surgery only** after carefully analysing risks Vs. Benefits; consider parents’ preferences
- Consider **expert second opinion**
**Atypical UTI (NICE 2007)**

1. Seriously ill or septic child  
2. Evidence of obstructive uropathy  
3. Rising serum creatinine  
4. Failure to respond to appropriate AB therapy with in 48 hrs  
5. Non E-coli UTI  
6. Any prenatal urinary tract finding

**References**


**Abbreviations**

- UFR = urine full report  
- AB = antibiotics  
- APN= acute pyelo-nephritis  
- SPA = supra pubic aspiration  
- RBUS = renal bladder ultra sound scan  
- BOO = bladder outlet obstruction
## Hypertension

Hypertension is defined as a blood pressure reading higher than two standard deviation above the mean for age.

The cuff bladder should be large enough to totally encircle the upper arm and its width should be at least two-thirds the length of the upper arm and its width should be at least two-thirds the length of the upper arm. The child should be relaxed and quite during the measurement, either sitting or lying.

Always use the biggest cuff that will fit comfortably on the upper arm.

Small cuff will give erroneously high reading

The systolic BP may give a more reliable reading than diastolic BP

If using an electronic device and the result is unexpected re-check it manually

Raised BP in a child who is fitting, in pain or screaming must be re-checked when the child is calm.

If the child is very small or uncooperative use a Doppler device. Approximate SBP may be obtained by palpation method.

BP increases with age, the reading should be checked against normal ranges for the child’s age.

Any BP >95% centile should be repeated.

### Acute hypertensive emergency:

Systolic blood pressure more than 25mmHg greater than the upper range of normal for age and/or diastolic more than 20mmHg greater.

<table>
<thead>
<tr>
<th>Drug</th>
<th>Dose</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Labetalol</td>
<td>16-50 microgram/kg/minute</td>
<td>Alpha and beta-blocker.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Titratable infusion.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Do not use in patients with fluid overload.</td>
</tr>
<tr>
<td>Captopril</td>
<td>0.5mg/kg (maximum 1mg/kg)</td>
<td></td>
</tr>
<tr>
<td>Sodium Nitroprusside (for the PICU use only)</td>
<td>0.2 – 0.6 microgram/kg/minute</td>
<td>Vasodilator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Very easy to adjust the dose</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Protect form light</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Monitor cyanide levels</td>
</tr>
<tr>
<td>Hydralazine</td>
<td>(oral) – 1mg/kg/dose</td>
<td></td>
</tr>
<tr>
<td>Hydralazine</td>
<td>0.2 – 1 microgram/kg/minute</td>
<td>Vasodilator</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Titratable infusion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Adjust as required (give slowly over 2minutes)</td>
</tr>
<tr>
<td>Nifedipine</td>
<td>0.25 mg/kg</td>
<td>Vasodilator</td>
</tr>
<tr>
<td></td>
<td>0.25mg/kg (first dose) up to 0.5mg/kg/dose</td>
<td>Fluid can be drawn up from capsule and squirted into mouth sublingually. Better to bite the capsule and swallow. May be difficult to control BP drop because it is given as a bolus.</td>
</tr>
<tr>
<td>Frusemide</td>
<td>(IV) 1-2mg/kg,</td>
<td>can use more if renal function significantly reduced. Loop diuretic only used when salt overload expands the intravascular volume. e.g acute nephritis</td>
</tr>
</tbody>
</table>
Management guidelines on paediatric hypertension

Hypertension (HTN)

- Blood pressure more than the 95th percentile for age, gender and height on 3 or more separate occasions
- Refer blood pressure tables in the fourth report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents
Evaluation of a hypertensive child

Hypertension

Stage 1 HTN
Sustained or episodic

Stage 2 HTN
Control with antihypertensive treatment

Acute or Chronic

Screening

History/Examination/BMI
SE/Creatinine/Urinalysis
Renal U/S ± Doppler

Abnormal

Normal ± Obesity
Positive family history

Specific evaluation

1. Renovascular or Cardiovascular
   - Renal angiogram
   - Captopril DMSA
   - Renal vein renin
2. Renal parenchymal
   - Complement/ANA
   - Renal biopsy
3. Congenital anomaly
   - DMSA
4. Endocrine
   - Specific hormone assays
   - MIBG/Imaging
5. Monogenic
   - Hormone assays
   - Genetic mutation analysis
6. other

1. Primary hypertension
   - Uric acid/fasting lipids/glucose
2. Renovascular hypertension
   - Captopril DMSA
   - Renal angiography
Asymptomatic hypertension

Goal of therapy in asymptomatic children

- <95th centile if no coexisting disorder
- <90th centile if cardiovascular risk factors, diabetes, end organ damage, progressive renal disorders or proteinuria

Management

- Life style measures and non-pharmacological management
  - Diet-salt restriction
  - Weight loss
  - Exercise
  - Behavioral modifications
- Pharmacological therapy

Indications for pharmacological treatment

- Stage 1 HTN unresponsive to life style changers/ stage 2 HTN
- Secondary HTN
- Evidence of end organ damage
- Coexisting diabetes / additional cardiovascular risk factors

General approach to pharmacotherapy

- Start with one medication at low dose range and increase to mid-range
- If not achieving the target within 2-3 days

Choice of antihypertensive medication

- ‘ABCD’ groups
  - Angiotensin converting enzyme inhibitors and Angiotensin receptor blockers
  - Beta-blockers
- Calcium channel blockers
- Diuretics

- Choice depend on the aetiology of HTN
- Children generally respond better to drugs that block renin (A and B)
- If combination necessary
  - A or B with C or D
  - Triple therapy A+C+D or B+C+D
- Avoid A group when there is acute kidney injury (risk of further deterioration in function)
Hypertensive emergencies

- Severe symptomatic hypertension with decompensation
- Medical emergency
- If of known short duration (<72h) can be brought down quickly otherwise gradual reduction
  - First ⅓ of total BP - aim over first 12h
  - Next ⅓ of total BP - aim over next 12h
  - Final ⅓ of total BP – aim over next 24h

Reference - The fourth report on the Diagnosis, Evaluation, and Treatment of High blood Pressure in Children and Adolescents
Guideline on the Management of Acute Kidney Injury

Presentation
Oliguria (UOP < 0.5ml/kg/hr) or anuria (UOP<1ml/kg/day)
Polyuria
With elevation of serum creatinine

Assessment
Hydration (under/over)
UOP
Weight
Blood pressure, JVP
Neurological examination

Investigations

Basic Investigations
Urine for - proteins, pus cells, red cells, casts, culture, Na, osmolality, creatinine

\[
\text{Calculate Fe Na\%} = \frac{\text{UNa}}{\text{Pcreatinine}} \times 100
\]

Blood - FBC & blood picture, BU & SE Creatinine, Ca, Phosphate, VBG, LFT
US scan KUB

Consider the following on clinical grounds
Stool culture, Blood culture
ASOT, ANA, DsDNA, ANCA, anti- GBM
C3, C4, Immunoglobulins
Ophthalmology opinion
MCUG, DMSA/DTPA
Alkaline phosphatase

Urinary electrolytes in AKI

<table>
<thead>
<tr>
<th></th>
<th>Pre - renal</th>
<th>Intrinsic Renal</th>
<th>Post - Renal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Osmolality mosm/l</td>
<td>&gt;500</td>
<td>&lt;300</td>
<td>&lt;350</td>
</tr>
<tr>
<td>UNa mmol/l</td>
<td>&lt;10</td>
<td>&gt;40</td>
<td>&lt;40</td>
</tr>
<tr>
<td>FeNa%</td>
<td>&lt;1</td>
<td>&gt;2</td>
<td>&lt;2</td>
</tr>
</tbody>
</table>
Management

- Assess the patient
- Identify & treat any life threatening conditions first – hydration status, oxygenation, electrolyte derangements
- Identify the cause(s) & treat the treatable
- Avoid nephrotoxins
- Maintain adequate nutrition

Initial fluid management

<table>
<thead>
<tr>
<th>Hypovolaemic</th>
<th>Volume overloaded</th>
<th>Euvolaemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.9% saline 10-20ml/kg over 30mints.</td>
<td>Give frusemide 1-4mg/kg IV bolus over 10 mints</td>
<td>Fluid challenge with 10-20ml/kg 0.9% saline with frusemide 1mg/kg IV bolus</td>
</tr>
<tr>
<td>If no UOP in 30 mints, re-assess &amp; if still hypovolaemic repeat same.</td>
<td>If no UOP in 1-2 hrs, restrict fluids to IL + part of previous UOP &amp; is.</td>
<td>bolus over 10mints</td>
</tr>
<tr>
<td>Once UOP improves. give maintenance fluids + any ongoing losses</td>
<td>If diuresis is established with frusemide, minimise fluids as above to allow</td>
<td>If no UOP in 1-2 hrs, restrict intake to insensible loss + previous UOP +</td>
</tr>
<tr>
<td></td>
<td>a negative balance till euvolaemic.</td>
<td>other losses.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>IL- insensible loss, UOP- urine out put</td>
</tr>
</tbody>
</table>

Management of Hyperkalaemia

- Definition:
  - $K^+ > 5.5$mmol/l in children
  - 6.5$mmol/l in neonates

- ECG monitoring if $K^+ > 6$mmol/l for evidence of hyperkaemia.
  - Prolongation of PR interval and/or peaked T waves as toxicity worsens p wave is lost, QRS widens and ST depression occurs

- Restrict potassium intake unless serum $K^+ < 3.5$mmol/l or there are ongoing losses.

- If hyperkalaemic ECG changes are present, give calcium gluconate as bellow & take the following holding up measures while dialysis is set up
Emergency drug treatment of hyperkalaemia

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Dose</th>
<th>Onset</th>
</tr>
</thead>
<tbody>
<tr>
<td>Salbutamol nebulizer</td>
<td>2.5-5mg as a single dose</td>
<td>5 mints</td>
</tr>
<tr>
<td>10% Calcium gluconate</td>
<td>0.5ml/kg IV over 10 mints. Monitor ECG</td>
<td>5mints</td>
</tr>
<tr>
<td>8.4% Sodium bicarbonate</td>
<td>1-2mmol/kg IV over 30 mints</td>
<td>5 mints</td>
</tr>
<tr>
<td>( if ph &lt;7.3)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glucose /Insulin infusion</td>
<td>10% dextrose 5ml/kg over 30mints &amp; insulin 0.1unit/kg over 30 mints</td>
<td>30mints. Check RBS frequently</td>
</tr>
<tr>
<td>Calcium resonium</td>
<td>250mg/kg 6hrly PO/PR</td>
<td>PO- 2hrs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>PR- 1/2hr</td>
</tr>
</tbody>
</table>

Subsequent Management

- Fluid intake
- Once euvoalaemia is restored, give only the insensible loss + UOP + other losses

**Calculation of Insensible fluid loss**

<table>
<thead>
<tr>
<th>Weight Range</th>
<th>Insensible Fluid Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10 kg</td>
<td>25ml/kg</td>
</tr>
<tr>
<td>10-20kg</td>
<td>12.5ml/kg</td>
</tr>
<tr>
<td>&gt;20kg</td>
<td>5ml/kg</td>
</tr>
</tbody>
</table>

- Increase the fluid intake promptly if urine volume increases with fall in BU and creatinine to prevent prolonged oliguria.
- Once diuresis begins, increase electrolyte replacement including potassium.
- Once stable, reduce fluid intake gradually to avoid prolonged diuretic phase.
- Management of Hyponatraemia
- Patients are likely to be symptomatic if Na level is <120mmol/l
- If Na is > 120mmol/l, and no neurological symptoms or ongoing salt loss, fluid restriction +/- dialysis will be sufficient.
- If < 120mmol/l or if symptomatic, correct to 125mmol/l according to following formula to alleviate symptoms

\[
Na \ dose \ (mmol) = (125-\text{measured \ PNa}) \times \text{weight (kg)} \times 0.6 \ \text{as 3\% saline over 2-4hrs}
\]

Further correction over 24-36 hrs by fluid restriction & fluid replacement with 0.9\% saline

- Management of Hypocalcaemia
- If associated with hyperkalaemia, connect
- patient to ECG monitor
- If symptomatic, 10% Calcium gluconate 0.5ml/kg (0.1mg/kg) IV over 30-60mins with ECG monitoring
- Hypocalcaemia will improve if hyperphosphataemia is treated.

**Management of Hyperphosphataemia**

Treat by dietary phosphate restriction and giving phosphate binders (eg: calciumcarbonate)
Metabolic Acidosis
Treatment is only indicated if there is profound acidosis (Ph <7.3) &/or Hyperkalaemia.
• If unwell, correct with 8.4% NaHCO$_3$ IV calculated as below

\[
\text{NaHCO}_3 \text{ as mmol} = 0.3 \times \text{weight (kg)} \times \text{BE}
\]

• Replace half the deficit initially over 1hr & do further corrections slowly orally or IV
• If well, give oral NaHCO$_3$1-2mmol/kg/day in 2-3 divided dose

Hypertension
• Often due to fluid overload
• Use diuretics if responsive
• Others – vasodilators are preferred

Medication
• Avoid all nephrotoxic medications
• Adjust doses according to GFR as instructed in Paediatric BNF

\[
\text{GFR} = \text{Ht (cm)} \times 40
\]

Nutrition
• Aim for a high energy, low protein, potassium restricted diet initially
• Once urea starts falling, introduce proteins and gradually increase the amount.
• Replace vitamins and micronutrients

Monitoring
• Maintain accurate fluid balance chart
• Reassess fluid intake 12hrly
• Check weight twice daily
• Hourly BP, PR, RR
• Urea, electrolytes
• Creatinine, Ca, PO$_4$, VBG daily

Indications for dialysis
• Hyperkalaemia > 6.5 mmol/l
• ECG changes irrespective of K$^+$ value
• Severe fluid over load
• Urea > 40 mmol/l (>30 mmol/l in neonate)
• Severe acidosis pH <7.2 despite HCO3
• Multiorgan failure
• Severe hypo/hypernatraemia
• To create space for nutritional intake
Management of snake bites in children

1. Evidence of snake bite
   - Yes
   - No

2. Snake identified?
   - Yes
   - No

   - Identified as following bites:
     - Cobra
     - Russell’s Viper
     - Krait
     - Saw scaled viper

   - Systemic envenomation +/- Local envenomation
     - Or
     - Local envenomation only with witnessed cobra bite

   - Specific features:
     - Coagulopathy
     - Neuropathy
     - Rhabdomyolysis

   - Early non specific features:
     - Nausea / Vomiting
     - Abdominal pain
     - Neutrophilia

3. Antivenom is not indicated

4. Clinical assessment of snakebite and pattern of envenomation
   - Local envenomation only without witnessed cobra bite
   - High clinical suspicion of following bites with Systemic envenomation +/- Local envenomation
     - Cobra
     - Russell’s Viper
     - Krait
     - Saw scaled viper

5. Polyvalent snake antivenom is indicated

Antivenum a total of 10 vials is given as a single dose for all ages. Each vial is reconstituted in 10 ml of Normal Saline. In infants and small children this can be given directly with an infusion pump.

In older children the reconstituted antivenom can be further diluted to make total of 400 ml with normal saline.
Management of acute poison ingestion in children

Poison ingestion

Significant amount of toxin ingested?

Presented within 01 hr?

Airway Protection and safety good?

Gastric Lavage

Presented within 02 hr?

Airway Protection and safety good?

Single dose Activated Charcoal

Specific Antidote +/- Observation and supportive care
<table>
<thead>
<tr>
<th>Drug</th>
<th>Antidote</th>
<th>Drug</th>
<th>Antidote</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beta Blocker</td>
<td>Glucagon</td>
<td>Heparin</td>
<td>Protamine</td>
</tr>
<tr>
<td>Benzodiazepines</td>
<td>Flumazenil</td>
<td>Iron</td>
<td>Dexteroxamine</td>
</tr>
<tr>
<td>Calcium chan blockers</td>
<td>CaCl₂</td>
<td>Isoniazid</td>
<td>Pyridoxine</td>
</tr>
<tr>
<td>Carbon Monoxide</td>
<td>Oxygen</td>
<td>MetHb</td>
<td>Methylene Blue</td>
</tr>
<tr>
<td>Cholinergics</td>
<td>Atropine</td>
<td>Methanol</td>
<td>Ethanol</td>
</tr>
<tr>
<td>Chloroquine</td>
<td>Diazepam</td>
<td>Methotrexate</td>
<td></td>
</tr>
<tr>
<td>Clonidine</td>
<td>Naloxone</td>
<td>Narcotics</td>
<td></td>
</tr>
<tr>
<td>Cyanide</td>
<td>Hydroxycodalin, Kelocyanor</td>
<td>Organophosphate</td>
<td></td>
</tr>
<tr>
<td>Digoxine</td>
<td>Specific Fabs</td>
<td>Paracetamol</td>
<td></td>
</tr>
<tr>
<td>Ethylene Glycol</td>
<td>Ethanol</td>
<td>TCS</td>
<td></td>
</tr>
<tr>
<td>Fluoride</td>
<td>Calcium gluconate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrofluoric acid</td>
<td>Calcium gluconate</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Substances not well bound by charcoal
SRUCTURED APPROACH TO THE SERIOULSELY INJURED CHILD

Structured approach

<table>
<thead>
<tr>
<th>Immediate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary survey</td>
</tr>
<tr>
<td>Resuscitation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Focussed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secondary survey</td>
</tr>
<tr>
<td>(key features)</td>
</tr>
<tr>
<td>Emergency management</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Detailed Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reassessment</td>
</tr>
<tr>
<td>(system control)</td>
</tr>
<tr>
<td>Continue stabilization and definitive care</td>
</tr>
</tbody>
</table>

Primary Survey

- Airway with cervical spine control
- Breathing with ventilatory support
- Circulation with haemorrhage control
- Disability with prevention of secondary insult
- Exposure with temperature control

Objective of the primary survey

- Airway obstruction
- Tension pneumothorax
- Open pneumothorax
- Massive haemothorax
- Flail chest
- Cardiac tamponade
- Shock (Haemorrhage or otherwise)
- Decompensating head injury

If breath sounds are unequal

- Pneumothorax
- Haemo-pneumothorax
- Misplaced tracheal tube
- Blocked main bronchus
- Pulmonary collapse
- Diaphragmatic rupture
- Pulmonary contusion
- Aspiration of vomit or blood

Table – Recognition of clinical signs indicating blood loss requiring urgent treatment

<table>
<thead>
<tr>
<th>Signs</th>
<th>Marked or increased tachycardia or relative bradycardia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart rate</td>
<td>Systolic BP</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
 Fluid therapy in hypovolaemic shock after trauma

- Crystalloid
  - 10ml/kg + 10ml/kg

Assess response after each 10ml/kg aliquot

- Crystalloid
  - 10ml/kg + 10ml/kg
  - Surgical Option

Assess response after each 10ml/kg aliquot

- Blood

Table – Cross match time

<table>
<thead>
<tr>
<th>Blood type</th>
<th>Cross-match</th>
<th>Time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>O-negative</td>
<td>Nil</td>
<td>0</td>
</tr>
<tr>
<td>Type-specific ABO</td>
<td>ABO</td>
<td>10-15</td>
</tr>
<tr>
<td>Full cross match</td>
<td>Full</td>
<td>45-60</td>
</tr>
</tbody>
</table>

Summary

- Primary Survey
  - Airway
  - Breathing
  - Circulation
  - Disability
  - Exposure
- Resuscitation
  - A
  - B
  - C
  - D
- Secondary Survey
  - Head
  - Face
  - Neck
  - Chest
  - Abdomen
  - Pelvis
  - Spine
  - Extremities
    - Upper
    - Lower
PRINCIPLES OF SAFE TRANSFER AND RETRIVALS

Assessment
Child’s history and examination findings
Current local clinical team (consultant in charge, doctor at bed side, referring doctor/nurse)
Transfer Team (Consultant in charge, clinician undertaking the transfer, ambulance or vehicle providers)
Receiving team (Consulting accepting the referral and other consultants of different specialties-PICU, Anaesthesits, surgical team, receiving doctor, receiving nurse etc)

Control
(Retrieval team)
Identification of clinical team leader
Identification of the tasks to be carried out
Allocation of tasks to individuals and teams
Liaise with referring and receiving consultants

Communications – Key Elements
Who you are
What is needed? (form the listener)
Relevant details about the child
What the problem is?
What has been done to address the problem?
What happened?
What need to be done next?

Evaluation
Transport appropriate for this child? (risk involved In transport must be balance against the risk of staying and benefit of care that can be given only by the receiving unit)
What clinical urgency does this child have?
Mode and speed of transport
**Preparation & Package**

Child’s preparation
- Proper stabilization by referring hospital A-B-C-D

Equipment preparation
- Tested and adequate power reserves
- Drugs and fluid sufficient for the journey
- Airway / Breathing / circulation equipment

Personal preparation
- Number and nature of staff during the transport
- All staff to practice within their competencies
- To familiar with equipment during the transport
- Team to be covered accident insurance

Packaging
- All lines and drains must be secured to the child
- Child must be secured to the trolley and trolley must be secured to ambulance
- Chest drain secured and unclamped
- Cover the child to prevent fluid loss
- Easy access to lines, drains etc

Check list prior to transfer

**Transportation**

Mode of transport
- Nature of illness
- Urgency of transfer
- Mobilisation time
- Geographical factors
- Weather
- Traffic conditions
- Cost

Care during transport
- Monitoring (SpO2, ECG, HR, IABP, etCO2, core & ambulance temp)

Hand over
VENESECTION WITH BROKEN NEEDLES

- **Indications:**
  - Neonates for investigations
  - Infants for investigations
  - Sometimes in Children

- **Procedure:**
  - You should have a good picture of the venous plexus of the hands / feet
  - IV needle (black or Blue colour)
  - Take the needle out
  - Break the needle cleanly
  - Hold the hand or feet with your grip
  - Get the veins distended
  - Attacks the small veins in the distal venous plexus
  - Sharp end in to the vein
  - Blunt end to the bottle
  - Gradually squeeze and release the grip
  - If needle gets dislodged – re site the needle
  - Collect the U&E first because EDTA contaminate K

- **Advantages**
  - No wasting of bigger veins which are suitable for IV cannulation
  - Puncture the veins which are not suitable for cannulations
  - With good skills one should be able to collect necessary volume of blood.
  - Minimal damage to veins

- **Complications:**
  - Whole of the needle can get lost inside the vein
  - Tight squeezing can cause fracture of the metacarpals
  - Osteomyelitis
INTRAOSSEOUS ACCESS

- **Why choose this route:**
  - Largely a life saving resuscitative measure for a short term as gaining peripheral venous access for initial resuscitation fluids and drugs can waste valuable minutes or hours.
  - The venous drainage from the marrow rapidly accesses the main venous system.
  - Refilling the circulation via this route may make peripheral cannulation more possible.

- **Indications:**
  - Patients less than 6 years of age.
  - For administration of fluids, drugs
  - Can be inserted through burnt skin if no alternative.

- **Sites:**
  - Proximal tibia
    - Flat anterior-medial surface
    - 1cm inferior to and 1 cm medial to the tibial tubercle
  - Femur
    - Distal femur – anterolateral surface 3cm above lateral condyle.
    - Avoid fractured limb or those with proximal fractures.

- **Equipment**
  - Alcohol solutions
  - Cleaning solutions
  - 18 gauge with a trocha at least 1.5cm in length
  - Bone Marrow needle with stylet
  - Blood needle
  - A 5ml syringe
  - A 20ml Syringe
  - Infusion fluids

- **Procedure:**
  - Prepare the skin sites with antiseptic
  - Administer local Anaesthesia
  - Use bone narrow needle with a stylet gauge 13 or 18
  - Introduce the needle with a rotating or screwing motion in the bone with pressure at 90 degrees to skin.
  - Needle should be pointing a way from the joint
  - Advance the needle until a give is felt – this may take one minute of patience.
  - Needle has now entered the marrow cavity
- **Confirmation of the site of entry:**
  - Then connect a 5cc empty syringe and withdraw the marrow
  - Ability to aspirate marrow OR
  - Ability to inject without extravasations
  - Marrow contains should be sent for cultures CRP and Full Blood Count.

- **Fixation:**
  - Use line extension and 3-way tap (not direct syringe application onto the needle) or the wiggling of the syringe enlarges entry hole into bone and extravasations will occur.
  - Splint the limb securely.

- **Rate of fluid entry:**
  - Start giving bolus solutions
  - 10mls / minute when under gravity
  - 40mls / minute when syringed in.

- **Type of fluid:**
  - Anything that can be given intravenously

- **Complications:**
  - Incorrect placement leading to extravasations and skin infiltration around the needle (needle is too superficial or too deep)
  - The limb should be observed and not covered in dressings. Excess extravasated fluid could lead to a compartment syndrome.
  - Cellulitis / Osteomyelitis
  - Damage to growth plate.
  - Rarely fractures

- **Contraindications**
  - Fractures of the bone
  - Bone diseases like bone tumour or osteogenesis imperfecta
PERIPHERAL INTRAVENOUS ACCESS

Clinical indicators of Peripheral cannulations are:

- To maintain hydration and or correct dehydration in children who are unable to tolerate sufficient volumes of oral fluids
- To maintain hydration / transfusion of IV fluids
- Transfusion of blood or blood products
- Administration of drugs/medication

1. Use with caution:
   a. Administration of irritant drugs
      - Sodium bicarbonate therapy
      - Dopamine
      - Some of the antibiotics as boluses e.g. Vancomycin / Clarithromycin, Cloxacillin
      - Thiopentone
   b. Large blood transfusions
   c. A high flow rates
      i. Peripheral Cannulation
         a) Preparation
         b) Equipments
         c) The Patient
         d) Operator
      ii. Selecting a suitable vein
      iii. Selecting appropriate cannula
      iv. Prepare the puncture site
      v. Getting the vein prominent
      vi. Insertion and advancement of the cannula
      vii. How to make sure the cannula is in situ.
      viii. Common problems with IV cannulation
      ix. Securing the IV cannula
      x. Care of IV cannula
      XI. Complications

PRINCIPLES OF IV CANNULATIONS
Preparation of IV cannulation
Equipment
- Correct cannula size 20 –pink, 22- blue, 24- yellow
- Cleaning agents – alcohol swab
- Sterile Cotton wool/ guaze-1 packet
- Flushing solution – 0.9% normal saline in 2cc syringe
- Fresh syringe – 5cc-to withdraw blood for essential investigations
- Blood collecting bottles – FBC, U&E, Capillary tubes
- Splints, bandages, Sticking tapes / tegederms, Scissors
- Connection for cannula –L.S-connection- [T]
The Patient
- Explain in simple terms the procedure to the patient and parents and make the child comfortable.
- Check patient’s identification
- Get the patient to inhale deeply during the actual venepunctures to relieve possible anxiety

Operator
- Organize correct lightening
- Wash hands thoroughly with antiseptic soap according to Hand washing policy
- This prevents
  - Nosocomial infection
  - Cross contamination
- Wearing protective gloves is optional – Remember in high risk patients that gloves will not protect against needle stick injuries

Selecting a suitable vein
- Have a good knowledge of venous plexus of both hands and feet
- Avoid bigger veins as far as possible. E.g. veins in antecubital fossa and greater saphenous vein.
- Use a patient’s non-dominant side
- First use distal veins of both dorsum of hands and feet
- Subsequently moves proximally
- Always allow adequate time on inspection and palpation of veins in the dorsum of hands and feet.
- Avoid very small veins – rarely successful.
- Cannula must never totally occlude a vein.
- The cannula length should correspond approximately to the length of straight vein to be used.
- If in doubt always call a more experienced colleague or a senior colleague

Avoid:
- Areas of joint flexion
- Veins close to arteries and deeper lying vessels.
- Median cubital vein – Reserved for difficult blood sampling
- Small visible but impalpable veins – this is rarely successful.
- Veins that may be irritated from previous attempts.
- Distal veins where proximal vein have been punctured

Selecting appropriate cannula
- Expiry date is not lapsed
- Be easy to insert
- Permit optimal flow rates
- Causes minimum discomfort to patient
- Always should give high consistent and reliable performance
- Should have a side injection port
- Have minimal complications
- Type of the infusion – Potent drugs and or irritant solution will require a large blood flow to assist haemodilution.
- Cannula life – a smaller size cannula will minimize venous irritation.
- Make sure package and its content are intact
Prepare the puncture site
- Apply local anaesthetic cream
- E.g.; Emla or Ametop and leave it for ½ hour
- Clean the puncture site and surrounding area thoroughly with iodine or alcohol swabs.
- Allow antiseptic to dry
- Do not re-palpate the area – it can be done if your hands are sterile.

Getting the vein prominent
- Create an adequate venous pressure by applying a tight tourniquet or with your handgrip avoid using a tourniquet in neonates as much as possible.
- Apply enough pressure to obstruct venous flow but not arterial flow
- To encourage venous filling adopt one or more of the following manoeuvres.
- Instruct the patient to clench or pump fist.
- Tap vein lightly
- Warm the extremities. (by wrapping with warm towels / gauze or dipping in warm water)
- Allow the arm to hang over bedside.

Insertion and advancement of the cannula
- Put on protective gloves- optional
- Fold down the wings
- Hold the Veinflown firmly with a three point grip-using-thumb & index finger
- This minimizes the risk of touch contaminating the lure connection.
- Ensure the correct positioning between the needle point and the catheter tip

Insertion & advancement of the Cannula
- Select the straight section of the vein close to or at a confluence of two tributaries
- Insert the cannula at 20-30 degrees or very low angle to the skin...
- Puncture the vein few mm away from the vein (cannulation through the skin layers act as a barrier and prevent leakage)
- Do not puncture the vein from the top.
- Maintain the grip to make the veins prominent
- Avoid if vein is moving or sliding.
- Entry of needlepoint to vein is indicated by the presence of blood in the flash back chamber.
- Insert the cannula slightly in order to make sure cannula tip is well within the vein. Make sure needle tip has not pierced the posterior wall of the vein.
- Release the tourniquet and advance the cannula
- Connect a 2cc syringe filled with normal saline and push the fluid in. make sure the cannula is well within the vein.
- It is essential to record the time and date of insertion and person who did it in the nurses’ flow chart and over the sticking plaster.
- Check the peripheral circulation after splinting.
Advancing the Catheter

- Advance the cannula a few millimetres further into the vein. This ensures that the catheter tip also enters the vein.
- Entry of the needle tip into the vein is indicated by the presence of blood in the flash back chamber.
- Withdraw the needle partially (about 5mm) to avoid exit through the posterior vein wall.
- Advance the catheter of the cannula into the vein gently.
- Release the tourniquet.
- The needle must never be reinserted while the catheter is in the vein.
- This may sever the catheter.
- Avoid blood spillage by pressing a finger on the vein on or above the catheter tip.
- Withdraw the needle completely.
- Fix 2cc syringe, which is filled with N-saline, and inject a small amount to make sure that there is no extravasations/resistance.

How to make sure the cannula is in situ.
If there is a resistance to the flushing solution, flush it again and see whether cannula is in situ. If the resistance is still there consider resiting.

Common problems with IV cannulation

- Initially blood flow now stopped
- Blood flow stopped while advancing
- No blood flowing to flash back chamber
- Not piercing the vein
- Try deep veins

Securing the IV cannula

- The method you use should fix the cannula securely so that it can be neither pulled nor kinked.
- With your cannula in place, have your assistance pass a piece of tape (¼”-2”) under the hub, stick side up.
- Take one side of the tape & bend it over the hub to wrap around it to stick to the skin at an angle of 45 degree to the line of the catheter.
- Do the same with opposite wing of tape.
- Take your other piece of 1/4”x2” tape & lay out it across the hub of the cannula close to the end.
- Attach the extension set – so that weight of the IV lines is not put on the cannula.
- Place a soft splint beneath the area to be fixed.
- Wrap one piece of tape around the distal end of the cannula, securing the limb to the splint below.
- The injection port of the cannula should be left exposed and a small piece of cotton wool can be placed underneath it to protect the skin below.
- Do not put the plasters right round the limb so that proximal vein may be totally or partially occluded.
- Wrap a second piece of tape around the proximal end of the splint, catching the extension tube below it.
- This piece of the tape should not be too tight, as it may occlude the venous flow.
- Allow the thumb to be free in case of cannula in the dorsum of the hand.
- Leave the fingertips free. So that you can detect early cyanosis.
Care of the cannula:

- **Idea is to prevent infections**
- Site inspection - daily basis for signs of infection
- Dressing Change – Wet or soiled dressing should be changed, this predisposed to bacterial colonization.
- Venous tenderness (Pain)
- Local venous reaction
- Redness, Tenderness, Swelling
- Syringe pumps—3 indicator pressure bulbs to show the level of resistance to the flow are present in new pumps.
  - P1 – Very minimal resistance to the flow
  - P2 – Moderate resistance
  - P3 – Severe resistance
- If one of the bulbs is indicated, flush the line with heparinized solution to make sure the line is blocked or not
- If the line is not working, re-site the cannula.
- Careful handling
- Do not contaminate. Wash your hand before handling the cannula. Leave a sterile towel under the IV cannula.
- Cannula Change
  - Record time & Date of insertion
  - Re-site the cannula after 48-72 hours
  - Change IV giving sets every 24-48 hours

Complications:

- Phlebitis and infection.
- Haematoma.
- Venospasm.
- Embolization of veins with blood clots during forced flushing.
- Air embolism. – Common in neonates with open foreman ovale.
- Infiltration of subcutaneous tissues with IV solutions.
- Accidental injection or infusion into an artery.
- Ischaemia or gangrene of the distal extremity

**EXTERNAL JUGULAR VEIN**

- A very useful site
- Position the child as for internal jugular access.
- Assistant can stretch the skin and position their finger to occlude the vein, just above the clavicle.
- Puncture the vein few millimetres away from the vein. (Do not puncture the vein from the top).
- Anchor the vein well.
ARTERIAL CANNULATIONS

➢ **Indications:**
  - Patients needing continuous intra arterial blood pressure monitoring
  - Frequent blood gas determinations
  - Frequent blood sampling

➢ **Sites:**
  - Radial
  - Posterior Tibial
  - Dorsalis Pedis
  - Femoral
  - Axillary artery
  - Neonates:
    - Umbilical arterial cannulation
    - Radial arterial cannulation
  - Avoid Brachial artery cannulation – poor collateral circulation

➢ **Procedure for Radial artery cannulation:**
  - IV cannula 22 /24 G
  - Perform Allen’s test
    - Occlude both ulnar and Radial artery for 30 seconds
    - Ulnar artery site is released
    - In less than 3-4 seconds palm should show signs of circulation by the return of pink colour
    - If palms remain pale – ulnar collateral circulation insufficient and radial artery cannulation should not be performed
  - Clean the site
  - Administer local anaesthetic
  - Extend the wrist
  - Catheter inserted at 30 degrees angle at the site of maximum radial pulsation with wrist extended
  - Catheter is advanced with the needle until blood return is obtained
  - Needle is removed half way through and catheter is advanced in the artery
  - If needle is difficult to advance although there is blood spurting at the end of catheter (artery has gone in to spasm)
  - Do not push the catheter
    Connect the flush and while flushing the line, advance the catheter

➢ **Problems with procedure**
  - Arterial spasm
    - Occur after repeated unsuccessful attempts
    - Arterial Pulse can become weak
    - Leave for 10-15 minutes
    - Spasm should ease out
Failed arterial cannulation
- After multiple attempts
- Do a arterial cut down similar to venous cut down

Arterial Line fluid
- Heparin saline 1 unit / 1 cc at a rate of 2 cc / hour – continuous flush via transducer

Complications
- Infections – Handle the line carefully
- Distal ischaemia and necrosis

Monitor – distal to the line placement
- Capillary circulation CRFT
- Peripheral pulses
- Temperature
- Look for blanching / Ischaemia

Peripheral Arterial Puncture

Procedure
- Get the correct size butterfly needle
- Leave the distal end open
- Clean the area well with antiseptic and dry with sterile gauze
- Get the light source from below
  - Pen torch
  - Fibro-optic light source
- Judge the size and the depth of the artery
- Puncture the artery
- Moment it puncture blood will flow backwards
- Connect a 1 cc empty pre-heparinised syringe and collect the blood
- Remove the butterfly needle
- Apply pressure with gauze until bleeding stops
- Use hypoallergenic plasters

Uses
- Blood gas
- Fungal blood cultures

Complications
- Haematoma formation
- Damage to deeper structures
CAPILLARY BLOOD SAMPLING

- CATEGORAY
  - Neonates / Infants

- INDICATIONS
  Microsample for laboratory analysis eg: SBR, Capillary blood-gas analysis, Blood glucose, Micro – haematocrit

- CONTRAINDICATIONS
  - Infant in shock
  - Compromised peripheral blood flow
  - Local oedema
  - Local infection
  - Severe polycythaemia (haematocrit > 70%)
  - Monitoring oxygen concentration

- PRECAUTIONS
  - Avoid anteromedial surface of the heel
  - The heel should be warm – do not use temperatures >40 C to warm it
  - Use a lancet specifically designed for the purpose with a Pint no longer than 2.5mm and preferably shorter
  - Do not apply an adhesive dressing to the wound after sampling – it will allow the tissue to become damp and may lead to maceration
  - Venous stasis in the hours after birth may give misleading values for both gases and haematocrit.
  - Use of alcohol skin wipes may alter blood glucose measurements made with Dextrostix using an optical electrical method
  - PO2 does not correlate with arterial oxygen concentrations.

- EQUIPMENT
  - Lancet – tip no longer than 2.5 mm
  - IV Needle (Pink or Brown)
  - Alcohol swab
  - Containers for blood samples
  - Capillary tube
  - Cotton wool ball
  - Warm compress if heel needs warming
  - Vaseline / paraffin jelly

- TECHNIQUE
  - Warm heel if necessary by wrapping in wet towel a 39C to 40C
  - Select puncture site. Do repeatedly use the same sites.
  - Cleanse site with alcohol and allow to dry
  - Wipe a small amount of paraffin jelly over the area to be punctured – this will allow the blood to accumulate as smooth droplets, which are easier to collect.
• Grasp ankle firmly with the index finger and thumb forming a circle through which the heel protrudes
• Puncture the heel with a single continuous motion
• Introducing the lancet perpendicular to the skin and to a depth of no more than 2.5 mm
• Apply gentle pressure as far away from the site as possible by squeezing the ring made by your thumb and index finger
• Draw blood into the appropriate collection pots with a scooper or into capillary tube
• Stop bleeding by gentle pressure with a cotton wool ball.
• Do not apply an adhesive dressing

• COMPLICATIONS
  • Inaccuracy of blood gas estimation
  • Cellulitis
  • Osteomyelitis of the calcaneus
  • Abscess formation
  • Calcified nodules
  • Tissue loss and scarring of the heel
  • Erroneously high Dextrostix values
  • Over estimating potassium concentration
  • Underestimating pO2