



## GUIDELINE FOR NURSES ON ASSISTING WITH INTUBATION AND EXTUBATION OF INFANTS AND CHILDREN


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## 1. a) Intubation - Introduction

Intubation is the placement of an endotracheal tube in the trachea and is the gold standard and method of choice for establishment and maintenance of an airway (Chethan and Hughes 2008).

### Indications for Intubation / Ventilation

- Maintenance of patent airway / upper airway obstruction
- Worsening Respiratory Distress / Respiratory Failure
- Prolonged apnoea
- Inadequate ventilation
- Worsening hypoxia, despite oxygen therapy
- Elective Intubation, i.e. following neonatal surgery, cardiac surgery or prior to general anaesthesia
- Trauma i.e. facial injuries
- Neurological i.e. raised intracranial pressure (ICP), deteriorating Glasgow Coma Scale (GCS) i.e. < 8 with no gag reflex
- Inhalation Burns
- Resuscitation (NSCNS 2005, BCH 2012, Hazinski 2013).

### Equipment (Appendix I)

- Cardiac monitor with audible QRS tone
- Oxygen saturation monitor
- Blood pressure monitoring of patient
- Rebreathing circuit (bag), mask (appropriate size) and oxygen source
- Airway appropriate size
- Appropriate size ETT, one 0.5mm smaller and 0.5mm larger (internal diameter measurement mm ET tube)
- Appropriate sized laryngoscope i.e.
  - **Straight blade** (Miller)
    - Preterm Infant – Size 0
    - Infants - Size 0-1
    - Small Child - Size 1 or 2
  - **Curved blade** (Mackintosh) Child
    - Infant/ Child (<12kgs) Size 1
    - Child (< 22kgs) Size 2
    - Large Child (< 30kgs) Size 3
    - Adolescent Size 3-4
- Wall suction with yankauer
- Suction catheters, appropriate size
- Magill's forceps appropriate size
- Gauze and K-Y Jelly
- Nasogastric tube prn
- Elastoplast tape (cut in trouser legs x 2) and 3<sup>rd</sup> piece with 'eye hole' slit
- Embroidery cotton (6 strand)
- Duoderm
- Cavilon™ Swabs
- Ventilator with appropriate settings checked by anaesthetist
- Stethoscope
- Scissors
- Trolley or clear surface for equipment

#### **Optional:**

- Introducer / Stylet
- Artery forceps
- Gum elastic bougie (older child)
- End tidal CO2 detector

NB: (Attach blade and check light and have spare light, blades and batteries to hand)

## SOAPME (Quick Guide)


- **S**uction (Yankeur)
- **O**xygen and rebreathing / bag-mask circuit
- **A**irways (ETT, LMA, Guedel, NPA)
- **P**ositioning and **P**ersonnel (e.g. Shoulder roll, role allocation)
- **M**edication and **M**onitoring (Consider atropine for neonatal intubation, Saturation pulse volume on)
- **E**quipment –i.e. Ventilator working (Evans 2001, BCH 2012)

## Tracheal Tubes

Estimating Endotracheal Tube Size and Length	
<b>Size</b>	$\frac{(\text{Age years}) + 4}{4}$
<b>Length (cms)</b>	<b>Oral Tube</b> $\frac{(\text{Age years}) + 12}{2}$
	<b>Nasal Tube</b> $\frac{(\text{Age years}) + 15}{2}$
<p>* Formulas are appropriate for children &gt; 1 year.</p> <p>* Preterm Infants 2.5 ETT</p> <p>* Infant &lt; 6 months 3.0 – 3.5 ETT</p> <p>* Infant 6-12 months 3.5 – 4.0 ETT</p>	

(APLS 2011)

Microcuff Endotracheal Tubes - Recommended Sizes	
Tube Size (mm)	Age
3.0	Newborn (3kgs) – < 8 months
3.5	8 months - < 2 years
4.0	2 - < 4 years
4.5	4 - < 6 years
5.0	6 - < 8 years
5.5	8 - < 10 years
6.0	10 - < 12 years
6.5	12 - < 12 years

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7.0	14 - < 16 years
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(KimberlyClark 2006a)

<b>Tube Insertion Depth (cms) for Preterm Infants (Infants Wt (Kgs) + 6)</b>	
< 1kg	6-5 – 7cms
1-2kgs	7-8cms
2-3kgs	8-9cms
3-4kgs	>9cms

(Kattwinkel *et al.* 2000)

## Intubation Equipment (Appendix I and II)

### Endotracheal Tubes (*Cuffed or Uncuffed Tubes*)


All endotracheal tubes have a preformed curve which conforms to the child's anatomy of the airway, aiding insertion and preventing kinking whilst in situ. The tube is oval in cross section but the distal end is cut at an oblique angle (bevelled) so that the aperture opens on the left side. This facilitates visualisation of the tip of tube as it passes through the cords when introduced with the right hand by the anaesthetist. There is a hole at the bevelled end (Murphy's eye) which allows an alternative route for gas flow should the bevelled end become obstructed by blood, mucus or the tracheal wall. It is also believed that it allows ventilation to the other lung should inadvertent main stem intubation occur. Tubes have markings from top to bottom in cms and a radio-opaque longitudinal line. Sizes are in millimeters (mms) of internal diameter. Uncuffed endotracheal tubes have traditionally been used in infants / children < 8 years because their airway is funnel shaped and narrowest at the cricoid cartilage which acts as a physiological seal compared to a cylinder airway in the older child / adult. However there is evidence showing that using a cuffed tube on all age groups has no increased adverse effects and also reduces multiple intubations and reduces cost (Crankshaw *et al.* 2014).

### **Endotracheal Tubes (Mallinckrodt)**

Made from siliconized PVC, with black line ® (radioopaque) and come with standardised 15mm ISO connector. Cuffed tubes have high volume, low pressure (HVLP) Soft-Seal Profile ®. A spring loaded one way valve helps ensure the integrity of cuff inflation.

### **Microcuff® Tubes**

Microcuff ® paediatric endotracheal tubes (ETT) have been designed to be anatomically correct for the paediatric airway and have a thinner more distensible cuffed tube. The short cylindrical ultra-thin (10 micron) walled polyurethane, puncture resistant HVLP cuff is placed in the lower trachea, to allow

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expansion of cuff for 'tracheal sealing' instead of 'cricoid sealing'. They are capable of sealing at very low pressures (< 20 cms of water), average 11 cms of water compared to PVC ETT, which is almost half the pressure of conventional cuffed ETT. The cuff also fills the gap between tracheal wall and tube without folds and channels, clinging and draping to the wet mucosa almost like 'clingfilm' at lower pressures compared to PVC. There is maximum reduced airleak, improving the efficacy of ventilation. Anatomically based depth markings with 4 pre-glottic markings, ensures a cuff-free subglottic area, thus reducing the risk to the pressure sensitive larynx and the development of subglottic stenosis. There is also sufficient margin for preventing inadvertent tracheal extubation or endobronchial intubation. Microcuff tubes also reduce the risk of aspiration, need for re-intubations and lower pollution of environment and staff by gases. The microcuff endotracheal tube may be used by anaesthetists for specific situations i.e. facial / inhalation burns (Kimberley Clark 2006a, 2006b).

## Laryngoscopes

This is a rigid instrument that the anaesthetist uses to examine the larynx and facilitate endotracheal intubation. It consists of the handle containing the battery and the blade which is used to move tongue and soft tissues aside to ensure a good view of the larynx. At the blade tip is an incandescent bulb, which turns on when blade and handle are attached together and locked into a 90 degree angle.

***Straight Blade*** – Usually used for infants and enables anterior laryngeal placement. Epiglottis can be lifted to view vocal cords. However it can cause vagal stimulation resulting in bradycardia or laryngospasm.

***Curved Blade*** – Usually used in children > 1 year. Its curved blade flange is large enabling better control of the tongue and is able to move the epiglottis forward by lifting from the front. There is less need to exert leverage on the child's upper teeth which reduces the risk of dental damage. The tip of the blade is inserted into the vallecula (mucosal pocket) at base of tongue, anterior to the epiglottis and moved forward. Vocal cords can be visualised with less vagal stimulation as the mucosa of vallecula is innervated by the glossopharyngeal nerve.

## Magill Forceps

Used to grasp the endotracheal tube, especially when inserting through the nose and pass it through the vocal cords.

## Intubation Adjuncts

### Introducer / Stylet

This is a long bendable rod which can be inserted into the endotracheal tube and used to help facilitate a difficult intubation. It is placed into the endotracheal tube before the procedure. Care is necessary to ensure that the tip doesn't protrude beyond the end or side holes of the endotracheal tube during the procedure to avoid trauma to the tissues. Following successful placement of the tube the stylet is removed.

### Bougie

This is a straight semi-rigid stylet type device with a bent tip that can be used to facilitate intubation. It is carefully advanced through the cords into the larynx until the tip enters the main stem bronchus.

The endotracheal tube is then threaded into the larynx. Once correct placement has been achieved the bougie is removed.

## Laryngeal Mask Airway

The laryngeal mask airway (LMA) is a supra-glottic airway device. It consists of tube PVC (single use) or silicone (usually reusable). It fills the gap between face mask and endotracheal tube. In children a smaller size is used which makes it easy to position. However it may give a false sense of security because the mask is also easy to dislodge, therefore vigilance is essential. It may be used in the PICU in an emergency when failed intubation has occurred, where it helps establish and maintain the child's airway. Positive pressure ventilation can be applied. The LMA however does not protect against aspiration and is contraindicated where there is a risk of regurgitation.

(Chethan and Hughes 2008, Fine 2008, Gerber 2008a,2008b, Maxwell 2008, National Maternity Hospital 2008, APLS 2011, Mitchell and Patel 2011, University of Virginia 2011).

Mask Size	Patient Size	Maximum Cuff Volume (Air)
1	Neonates / Infants < 5 kgs	Up to 4 mls
1 ½	Infants 5-10 kgs	Up to 7 mls
2	Children 10-20 kgs	Up to 10 mls
2 ½	Children 20-30 kgs	Up to 14 mls
3	Children 30-50 kgs	Up to 20 mls
4	Adults 50 -70 kgs	Up to 30 mls
5	Adults 70-100 kgs	Up to 40 mls

Table 1: LMA Quick Guide (LMA 2010)

### Medication for Intubation (*Given by anaesthetist*)


- Atropine (0.01mg – 0.02 mg / kg). ( Usually minimum dose of 0.1 mg/kg to prevent paradoxical bradycardia)
- 0.9% Normal Saline flush (dated and timed)

### Induction Agents

- Thiopentone (3 – 5mgs / kg)
- Ketamine (2mgs / kg)
- Propofol (2-3mgs / kg) (Over 3 years, ensure no egg allergy) (Ghanta *et al* 2007)

### Muscle Relaxants

- Suxamethonium (1.5mg – 2mgs /kg)
- Pancuronium / Vecuronium (0.1 – 0.3mg /kg)
- Atracurium besylate (0.5mg / kg)

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**Rapid Induction Pack** (*Available in ward fridges for emergency use*)

- Suxamethonium (50mgs / ml) 2ml ampoule
- Thiopentone (25mgs/ ml) 20 ml ampoule
- Ketamine (10mg / ml) 20 ml vial
- Pancuronium (2mg / ml) 2 ml ampoule x 2


**1. b) Assisting with the Intubation of an Infant / Child.**

ACTION	RATIONALE EVIDENCE and REFERENCE
<p><b>Pre Procedure</b></p> <p><b>Patient Preparation</b> Prepare child and family where possible</p> <p>Gather all equipment.</p> <p>Test the cuff, pilot balloon and valve of each tube of cuffed endotracheal tube i.e. Microcuff tube, prior to use. Insert a luer tip syringe into cuff inflation valve and inject enough air to fully inflate the cuff. After test inflation, fully evacuate the air prior to use.</p> <p>The child should be nil by mouth (NPO) prior to the procedure, 4- 6 hours when possible, unless emergency. Insert nasogastric tube and aspirate nasogastric tube prior to procedure.</p> <p>Check IV access is patent (central or best peripheral).</p> <p>Record the child's heart rate (with audible QRS sound), B/P, oxygen saturations and respiratory rate.</p> <p>Ensure pulse tone is on and set to the correct source i.e. Oxygen saturations.</p> <p>Ensure suction working and attach appropriate size yankauer suction with catheters nearby.</p>	<p>To reassure parents and child, gain confidence and cooperation (Hockenberry and Wilson 2015).</p> <p>To facilitate completion of the procedure in a timely manner (Trivits-Verger and Lebet 2008).</p> <p>To ensure patient safety and equipment is working satisfactorily prior to use (Kimerley-Clark 2006b).</p> <p>To empty the stomach and prevent aspiration of contents during the procedure (Levin <i>et al</i> 1997).</p> <p>To be able to administer pharmacological agents.</p> <p>Attain base line vital signs (Hazinski 2013).</p> <p>Early detection of adverse effects of intubation i.e. bradycardia due to hypoxia or vagal stimulation.</p> <p>To be prepared for the procedure.</p>




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<p>In the neonate or preterm infant ensure infant is kept warm i.e. radiant warmer, giraffe incubator.</p> <p>Put on personal protective equipment (PPE) following risk assessment i.e. apron, goggles etc. Wash hands. ANTT Level 3.</p> <p><b>Procedure</b></p> <p><b>Rapid Sequence Induction (RSI)</b> is usually performed with any patient considered at risk of regurgitating their stomach contents. Muscle relaxant and sedative is administered in rapid sequence.</p> <p>Confirm with Anaesthetist that necessary equipment is readily available prior to procedure.</p> <p>Ensure infant / child is supine with head at side of incubator/ radiant warmer or the top of the cot / bed.</p> <p>The anaesthetist stands at the child's head which is positioned midline with minimal extension of the neck (infant neutral and child in sniffing position). A roll may be placed under shoulders.</p> <p><b>NB: Avoid:</b></p> <ul style="list-style-type: none"> <li>- Hyperextending or rotating the neck.</li> <li>- Flexing the head towards the chin.</li> </ul> <p>Anaesthetist will manually ventilate the child with 100% oxygen, using a rebreathing bag, mask, valve for a minimum of 3 minutes, prior to intubation.</p> <p><b>NB: Maintenance of oxygenation is a priority during the procedure</b></p> <p>Procedure should be limited to maximum of 20 seconds.</p> <p>Ensure yankauer and suction available to hand at infant / child's shoulder to allow easy access for the anaesthetist.</p> <p><b>Cricoid Pressure</b></p> <p>The anaesthetist may request the nurse to apply cricoid pressure (Sellick's manoeuvre).</p>	<p>To protect against cold stress and its detrimental effects (Karlsen 2014).</p> <p>Standard precautions (OLHSC 2007, OLCCH 2010, 2011)</p> <p>The aim is to minimise the risk of gastric aspiration during intubation. It also facilitates airway visualisation through muscle relaxation, control of agitation and prevention of involuntary reflexes i.e. gag reflex (Gardiner and Grindrod 2005, Zelicof-paul et al. 2005, Hazinski 2013).</p> <p>To ensure patient safety during the procedure.</p> <p>Opens airway fully and aligns the trachea which allows visualisation of glottis and larynx (APLS 2011, NSCNN 2005, National Maternity Hospital 2000). The glottis will be raised above the line of sight and narrow the trachea and under flexing will cause the posterior pharynx to be viewed but prevent direct visualisation of the glottis (National Maternity Hospital 2008).</p> <p>Fill the reserve lung volume with oxygen rather than room air to minimise the risk of desaturation or bradycardia (Levin <i>et al</i> 1997). To prevent hypoxia (APLS 2011, Henderson 2011).</p> <p>Bradycardia and oxygen desaturations can occur within 55 seconds (Bottor 2009).</p> <p>Pharyngeal suction may be required to ensure good visualisation of the cords.</p> <p>Cricoid pressure compresses the cricoid cartilage against the cervical vertebrae, closing the</p>
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<p>NB: Cricoid cartilage is just below the thyroid cartilage (Adam's Apple) which is the first complete cartilage ring of the trachea.</p> <p><b>Do not remove pressure until requested by the anaesthetist.</b></p> <p>Cricoid pressure should be applied before loss of consciousness.</p> <p>Observe the child's heart rate, blood pressure and oxygen saturations during the procedure and notify the doctor of any changes.</p> <p>Child is induced by the anaesthetist.</p> <p>Ensure intubation equipment is to hand for the anaesthetist i.e. laryngoscope, magill forceps, endotracheal tube, gauze with KY jelly.</p> <p>The anaesthetist may select as clinically indicated:</p> <p><b>Orotracheal</b> intubation for an emergency intubation</p> <p><b>Nasal</b> intubation for an elective intubation or following stabilisation with an oral endotracheal tube.</p> <p>When the anaesthetist is able to visualise the glottis the endotracheal tube is inserted whilst the vocal cords are open, until the vocal cord guide is at level of the vocal cords (black ring around tip of the tube).</p> <p>The procedure should be stopped if the infant / child deteriorates i.e. bradycardia and/ or desaturates. The anaesthetist will hand ventilate with 100% oxygen until the infant's cardiovascular and respiratory status stabilises.</p>	<p>oesophagus and thus preventing passive regurgitation and aspiration of gastric contents. It also may minimise gastric inflation during manual hand ventilation and it helps with visualisation of the vocal cords thereby facilitating the insertion of ETT (Jagim 2003, Jukes 2003, Gardiner and Grindrod 2005, Nolan <i>et al.</i> 2005, Walker <i>et al.</i> 2010, APLS 2011)</p> <p>The splinter effect of the oesophagus, preventing regurgitation is lower once the patient is unconscious (Brimacombe and Berry 1997).</p> <p>Early detection of significant changes in vital signs i.e. bradycardia which may be a sign of hypoxia and hypotension may result from medication administered or underlying cardiovascular instability (Tritis-Verger and Lebet 2008, Hazinski 2013).</p> <p>To aid the procedure.</p> <p>This should place the endotracheal tube midway between carina and vocal cords (National Maternity Hospital 2008).</p> <p>Bradycardia is a sign of hypoxia. To restore oxygenation (Henderson 2011).</p>
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<p><b>Post Procedure</b></p> <p><b>Confirmation of Endotracheal Tube Placement is MANDATORY.</b></p> <p>Observe chest wall movements, ensuring equal symmetrical chest expansion and listen with stethoscope for bilateral air entry to both lungs  <b>NB: Final confirmation is the responsibility of anaesthetist.</b></p> <p>Ensure no sounds i.e. gurgling noted over stomach or gastric distension.</p> <p>Ensure colour, oxygen saturations and heart rate are satisfactory.</p> <p>Anaesthetist may use an end tidal CO2 detector connected to ETT to confirm position if clinically indicated.</p> <p>Once the position of the endotracheal tube has been ascertained and the anaesthetist has confirmed placement at the nose / lips, formal securing of the tube can take place.</p> <p><b>Securing the Tube</b>  Assist with fixation of endotracheal tube and nasogastric tube (Appendix III).  This procedure <b>should</b> always be performed by 2 people.</p> <p>Children with burns or scalds to the face will require an alternative method for securing the endotracheal tube. The anaesthetist intubating the child will decide this at the time of intubation.</p> <p>Ensure skin is clean and dry.  Apply Cavilon skin protectant to cheeks followed by a colloid dressing strip i.e. duoderm is applied</p>	<p>To avoid mortality from hypoxaemia due to delay or failure to recognise oesophageal intubation. There is also a risk of morbidity due to accidental endobronchial and supra glottic positions (Henderson 2011).</p> <p>To confirm endotracheal tube is correctly positioned (Levin <i>et al.</i> 1997, Jagim 2003, NSCNN 2005, APLS 2011).</p> <p>(APLS 2011).</p> <p>(NSCNN 2005).</p> <p>Colour changes from purple to yellow in presence of exhaled carbon dioxide. The detector should also cycle between purple- yellow and purple to yellow during inflation – exhalation and inflation and exhalation (National Maternity Hospital 2008).</p> <p>To secure tubes and prevent accidental extubation.</p> <p>To protect skin from adhesive stripping and prevent skin breakdown (Lund and Tucker 2003, NSCNN 2005, Karlsen 2006). The routine use of bonding</p>
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<p>to cheeks as clinically indicated.</p> <p>Cut 2 pieces of elastoplast approx. 10 – 15 cms long into “trouser legs” as clinically indicated. Also a third piece of Elastoplast with ‘eye-hole’ (slit) in the middle. Follow procedure for strapping as per pictorial guideline (Appendix 1). NB: The ETT should be secure from both (right and left) directions of the face.</p> <p>Organise retaping of the ETT by anaesthetist if the ETT position is incorrect on chest x-ray or if the tapes become wet and loose i.e. (move &gt; 0.5cms)</p> <p><b>Following Securing of Endotracheal Tube.</b> Suction the infant /child post intubation.</p> <p>Obtain blood gas post intubation</p> <p>Ensure chest x-ray is requested by anaesthetist and obtained post intubation with head in midline position.</p> <p>When infant is stable the external part of the tube may be shortened if necessary by the anaesthetist.</p> <p><b>Air Leak</b> The endotracheal tube is checked for presence of air leak at 25-30 cms water using manometer, by the anaesthetist: <b>Appropriate tube size</b> – a small airleak is present when child is hand ventilated. <b>Tube too small</b> – Significant air leak present.</p>	<p>agents i.e. Compound Tincture of Benzoin is not recommended in neonates as it results in epidermal stripping because the epidermis becomes stronger than the cohesion of epidermis to dermis when it is removed (Lund and Tucker 2003). It is also not recommended in adults due to: drying of the skin; skin occluded and impaired function and local irritation / allergy especially in atopic patients (Lund and Tucker 2003, Scardamaglia <i>et al.</i> 2003).</p> <p>The tape may be placed onto transparent glossy paper prior to cutting as this facilitates straight cutting and the tape peels easily away for use. (ALSG 2008).</p> <p>To maintain satisfactory ventilation and prevent unplanned extubation which may result in a life threatening event. The infant &lt; 3 months is more at risk of an unplanned extubation due to shorter trachea.</p> <p>To maintain a clear airway.</p> <p>Evaluate respiratory status.</p> <p>To verify endotracheal tube position approximately 1-2cms above the carina and correct placement of nasogastric tube (NSCNN 2005).</p> <p>This reduces dead space and prevents kinking of the tube (National Maternity Hospital 2008).</p> <p>A tube that is too small may result in a large airleak which may contribute to under ventilation. This may be compensated for by increasing the tidal volume on the ventilator. However reintubation with a larger tube size may be required. An excessively large tube may contribute to the development of laryngeal oedema and sub glottis stenosis (Hazinski 2013).</p>
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<p><b>Tube too large</b> – Air leak not detected until inspiratory pressure &gt; 30cms water.</p> <p>Remove personal protective equipment (PPE) and wash hands.</p> <p>Document procedure in the nursing notes including size and type of endotracheal tube and length to nose or lips. Also insertion of nasogastric tube as appropriate.</p> <p>Ensure that all medication has been documented in the drug kardex by the anaesthetist.</p> <p>Discuss with the anaesthetist, the ventilation plan for the child i.e. ventilation mode / settings and need for sedation / analgesia.</p> <p>If intubation occurred on a ward organise safe transfer to PICU.</p>	<p>To reduce cross infection. (OLHSC 2007, OLCHC 2011).</p> <p>To maintain accountability and ensure continuity of care (NMBI 2015a).</p> <p>To ensure safe and effective management of the patient post intubation.</p>
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## 2. Cuffed Endotracheal Tube: Checking Cuff Pressure

### Nursing Considerations with Cuffed Endotracheal Tubes

NB: Always discuss with consultant anaesthetist regarding specific patient requirements and inflation pressures for cuffed endotracheal tube.

ACTION	RATIONALE EVIDENCE and REFERENCE
<p>Following endotracheal intubation an air leak should be present around the ETT at 20 cms water (positive) airway pressure with the cuff not inflated.</p> <p>Cuff should be carefully inflated using a cuff pressure manometer or syringe until air leak is no longer present. (Attach syringe to valve port). Cuff pressure should not exceed 20 cms water.</p>	<p>If no air leak is detected the tube may be too large and the anaesthetist may consider changing the tube (Kimberley-Clark 2006b, Microcuff 2011)</p> <p>(Kimberley-Clark 2006b, Microcuff 2011)</p>



Figure 1: Paediatric Cuff Pressure Gauge (VBM).

Remove syringe from valve after cuff inflation.

Monitor and record ETT cuff pressures routinely a minimum of every 4 hours, if inflated as clinically indicated.

Aim to keep ETT cuff pressures

- Malakroft Tube – Aim < 20cms water.
- Microcuff Tube – Aim 10 – 15cms water.

Reduce pressure if it exceeds 20cms water.

*NB: Manual compression of the pilot balloon should be avoided.*

Routine cuff deflation is not necessary if pressures are kept below 20cms water.

Cuff should not be routinely deflated except for extubation.

If cuff inflation is not required the cuff should be released with a cuff pressure manometer.

Keeping the syringe attached will keep valve open and allow the cuff to deflate (Kimberley-Clark 2006b).

(STRS 2007, Gerber 2008)

Deviation from selected seal pressures should be corrected (Kimberley-Clark 2006b, STRS 2007)

Sealing of the microcuff tube is superior within the trachea at pressures of 10 -15cms water, average 11cms water (Gerber 2008, Spiegel 2010).

Maximum pressure for ETT cuff and may predispose infant child to excessive pressure in the airway (Kimberley-Clark 2006b).


(STRS 2007)

To avoid creation of membrane folds (STRS 2007).

### 3. Extubation

#### Introduction

Extubation is the process of removing an oral or nasal endotracheal tube when it is no longer required (Urden *et al.* 2006, Scales and Pilsworth 2007). Extubation should be elective, planned and carried out in a controlled manner, as per anaesthetic consultant / team's orders.

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### Indications and Readiness for Extubation

- Child is not in respiratory distress with a good respiratory pattern.
- Minimal ventilation i.e. pressure support / CPAP 5 is required
- Satisfactory blood gas and oxygen saturations with oxygen requirements <40%
- Child is haemodynamically stable, peripherally warm and well perfused
- Apyrexial
- Heart rate normal / upper limits
- Chest clear with minimal secretions
- Child is awake and responsive and requiring minimal or no sedation
- Cough, swallow and gag reflexes present in child without a disability
- Satisfactory nutrition with adequate respiratory muscle strength and ventilator drive
- Child should have an audible leak at 20cms water prior to extubation.


NB: If no leak present Dexamethasone I.V. 6 hourly is charted for 24 hours prior to extubation to reduce the incidence of post extubation stidor (De 2004, Lancaster 2007, Scales and Pilsworth 2007, Wratney and Chieifetz, 2007, Karmarkar and Varshney 2008).

### Equipment

- Rebreathing circuit and mask (checked)
- Airway (appropriate size)
- Suction and catheters (checked)
- Yankauer
- Oxygen cannula / tube
- Bubble humidifier
- Duoderm tape
- Plaster removal swabs i.e. Appeel™
- Tegaderm dressing
- Scissors
- 5 / 10 ml syringe
- Stethoscope
- Emergency intubation trolley nearby
- Nebuliser circuit and mask
- Racemic Epinephrine
- Non-sterile gloves (Scales and Pilsworth 2007)


ACTION	RATIONALE, EVIDENCE and REFERENCE
<p><b>Pre Procedure</b> Prepare child and family.</p> <p>It is best for extubation to take place early in the morning if possible.</p>	<p>To reassure parents and child, gain confidence and cooperation (Hockenberry and Wilson 2015).</p> <p>There is more nursing and medical support available during the day post extubation to ensure timely intervention if necessary. This is important if the child's condition deteriorates, gets into</p>




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<p>Ensure physiotherapy is carried out prior to extubation, if requested by medical staff.</p> <p>Withhold feeds 2-4 hours prior to extubation. Prior to procedure aspirate nasogastric tube.</p> <p>NB: The neonate may require maintenance fluids whilst nil by mouth.</p> <p>Wean sedation as appropriate i.e. morphine infusion decreased to maximum 20 mcg/ kg/ hour.</p> <p>Ensure suction and oxygen equipment are functioning properly.</p> <p>An appropriate size bag, face mask and airway should be available at the child's bedside.</p> <p>Establish and set up oxygen therapy for post extubation.</p> <p>Ensure all necessary equipment is available including intubation equipment.</p> <p>Wash hands using an aseptic non-touch technique (ANNT) level 3.</p> <p>Put on personal protective equipment (PPE) i.e. goggles, glasses, apron, and gloves.</p> <p>Monitor child's vital signs and oxygen saturation.</p>	<p>respiratory distress / failure and requires reintubating or non-invasive ventilation (Lancaster 2007, Scales and Pilsworth 2007).</p> <p>To decrease the risk of aspiration during the procedure and ensure the stomach is empty should reintubation be required (De 2005, Parker 2007, Hazinski 2013).</p> <p>The neonate is more at risk of hypoglycaemia.</p> <p>To ensure the child will not have respiratory depression due to sedation on extubation.</p> <p>To ensure patient safety (Hazinski 2013).</p> <p>Airway problems are more common during extubation and recovery compared to intubation (Mitchell 2011).</p> <p>Most patients require 5-10% more inspired oxygen post extubation.</p> <p>To ensure the procedure is completed smoothly in a safe and coordinated manner (Cull 1999, Dougherty and Lister 2015).</p> <p>To prevent cross infection (Infection Control Association 2002, OLHSC 2007, OLCCH 2010)</p> <p>There is a high risk of droplet contamination of the eyes during the procedure as the child may cough / expectorate (Lancaster 2007).</p> <p>To ensure timely intervention should child's condition deteriorate.</p>
<p><b>Procedure</b> Inform anaesthetist immediately prior to procedure.</p>	<p>If reintubation is required, staff need to be prepared. Anaesthetist needs to be on the Paediatric Intensive Care Unit (PICU) and available to reintubate if the</p>




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<p>The procedure is performed by the anaesthetist assisted by nurse or 2 nurses, one of which is a senior PICU / recovery nurse who is deemed competent in the procedure and is working within her scope of practice.</p> <p>Elevate head of bed for infants or sit an older child in a comfortable upright position.</p> <p>Suction child prior to the procedure.</p> <p>Ensure infant / child awake, with stable vital signs and good motor responses</p> <p>Explain procedure to child as appropriate and reassure.</p> <p>Deflate the cuff using a 5-10 ml syringe, if a cuffed endotracheal tube is in situ.</p> <p>Gently remove tapes from the child's face using the appropriate adhesive remover. Secure nasogastric tube to child's forehead.</p> <p>Affix face mask to rebreathing circuit, in preparation for post extubation.</p> <p>Support and encourage child as appropriate.</p> <p>Encourage deep breathing and coughing during the procedure as appropriate.</p> <p>Give suction support prior to extubation.</p> <p>Remove the endotracheal tube in a swift motion on expiration whilst suctioning. An older child</p>	<p>child fails extubation (Lancaster 2007, Hazinski 2013).</p> <p>To ensure a safe and coordinated extubation by competent practitioners (NMBI 2015b).</p> <p>To facilitate spontaneous breathing, diaphragmatic expansion, maximises lung expansion and the work of breathing is decreased as gravity assists in lung expansion. Facilitates an effective cough (Lancaster 2007, Karmarkar and Varshney 2008).</p> <p>To clear the airway.</p> <p>To ensure patient is ready for extubation.</p> <p>To relieve anxiety and gain cooperation.</p> <p>This frees the endotracheal tube from child's face for easy removal (Trivits-Verger and Lebet 2008).</p> <p>To provide reassurance and support for the child prior to and during the procedure (Trivits-Verger and Lebet 2008).</p> <p>To ensure oxygenation is optimised and secretions are cleared (Lancaster 2007).</p> <p>Tracheal extubation has been demonstrated to greatly impair oxygenation (Karmarker and Varshney 2008).</p> <p>To free tube and remove any remaining secretions. Procedure is carried out on expiration when glottis is</p>
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<p>may be able to do this themselves with direction as appropriate.</p> <p><b>NB: Do not stop or reinsert the tube during the removal.</b></p> <p>Apply oxygen via re breathing circuit and mask.</p> <p>Suction the oropharynx under direct vision as clinically indicated.</p> <p>Assess respiratory status for signs of respiratory distress, desaturation and stridor.</p> <p>Note if there is an audible stridor report to anaesthetist immediately and document.</p> <p><b>Post Procedure</b></p> <p>Secure supplementary oxygen therapy via nasal cannula as clinically indicated.</p> <p>Minimal handling of patient initially.</p> <p>Observe child for:</p> <ul style="list-style-type: none"> <li>- drowsiness / lethargy</li> <li>- restlessness</li> </ul> <p>Close observation and continual reassessment of respiratory status over 24 hours (even following transfer out of PICU to the ward).</p> <ul style="list-style-type: none"> <li>o Monitor heart rate, respiratory rate and oxygen saturation.</li> <li>o Observe for signs of respiratory distress: intercostal, sternal and subcostal recession: tachypnoea; nasal flaring; tracheal tug; dyspnoea; pale / grey / mottled colour.</li> <li>o Arterial or venous blood gas post</li> </ul>	<p>fully open to prevent laryngospasm and trauma (Karmarkar and Varshney 2008, Hodd <i>et al</i> 2010).</p> <p>Extubation may result in vocal cord or tissue damage or cause laryngeal spasm which may occlude the patents airway (Lancaster 2007).</p> <p>To prevent Hypoxemia (Trivits-Verger and Lebet 2008).</p> <p>To maintain a clear airway and prevent secretion accumulation. Minimise aspirate of oral content with first breath after extubation (Parker 2007, Trivits-Verger and Lebet 2008, Mitchell 2011).</p> <p>There is a risk of trauma t the soft tissues if suction blindly (Mitchell 2011).</p> <p>Evaluate if patient can breathe without endotracheal tube.</p> <p>A stridor may indicate an obstructed airway and require timely intervention.</p> <p>To minimise metabolic requirements and prevent hypoxia (Hazinski 2013). Maximum 2 litres oxygen via nasal cannula.</p> <p>To evaluate respiratory status and early detection of upper airway obstruction or respiratory distress (Levin <i>et al.</i> 1997).</p> <p>NB: A drowsy child may be hypercapnoeic (high pCO<sub>2</sub>) whilst a restless child may be hypoxic.</p> <p>To ensure timely intervention should the child's condition deteriorates.</p> <p>To establish if child is able to maintain adequate</p>
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<p>extubation if access available (1 hour post extubation and repeated depending on the child's condition while in the PICU).</p> <ul style="list-style-type: none"> <li>○ Chest x-ray if ordered.</li> </ul> <p>The infant should be placed on an apnoea monitor (MR10) as clinically indicated.</p> <p>Observe for post extubation distress i.e. croupy cough with inspiratory stridor.</p> <ul style="list-style-type: none"> <li>○ If present administer Racemic Epinephrine nebulised as prescribed.</li> </ul> <p>Encourage child to cough and deep breath, suction as necessary.</p> <p>Ensure chest physiotherapy is performed as requested.</p> <p>Recommence feeds once respiratory status is stable, 2-4 hours post extubation.</p> <p>Dispose of clinical waste appropriately.</p> <p>Remove personal protective equipment (PPE) and wash hands.</p> <p>Document procedure and child's response in the nursing notes.</p>	<p>pulmonary perfusion and exchange of gases (Lancaster 2007).</p> <p>Early detection of further respiratory problems i.e. collapse / atelectasis.</p> <p>This may be due to laryngospasm, airway obstruction or laryngeal oedema. 1mm subglottic oedema in the infant de-creases cross-sectional by 35% (Karmarkar and Varshney 2008). To decrease vasoconstriction and bronchodilation and thereby treat upper airway oedema and stridor (Levin <i>et al</i> 1997, Karmarkar and Varshney 2008, Trivits-Verger and Lebet 2008).</p> <p>To promote hyperinflation of the lungs and helps remove secretions (Trivits-Verger and Lebet 2008).</p> <p>This allows the pharyngeal sensation to return to normal and reduce the risk of reintubation (Parker 2007).</p> <p>To promote safety and prevent cross infection (OLCHC 2008).</p> <p>To prevent cross infection (Infection Control Association 2002, OLHSC 2007, OLCHC 2010)</p> <p>Maintains continuity of care and accountability through accurate recording of medical and nursing intervention. (NMBI 2015a).</p>
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### 3. a) Accidental / Unplanned Extubation

Unplanned extubation (UE) is a serious airway complication in PICU, which may result in adverse patient deterioration leading to a potentially life threatening event. It is considered a quality of care indicator in the Paediatric Intensive Care Unit.

#### Recognition

- Actual witnessed ETT removal by the infant / child.
- Increased respiratory effort / respiratory distress

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- Desaturation, deterioration in patients' central colour
- Decreased chest movement
- Reduced air entry
- Any audible patient sound i.e. any sound at all – cry, whimper etc.
- Bradycardia

### Suspected Unplanned Extubation (*This is an emergency*)

- Call for assistance / alarm
- 2<sup>nd</sup> nurse
  - **Double bleeps anaesthetist bleep 652 (PICU 2) or bleep 468 (PICU 1)**
  - **Emergency Number 2222 if clinically indicated**
- Connect rebreathe circuit to ETT
- Manually ventilate patient for 2 breaths
- Second nurse listens and observes chest movement for equal and bilateral air entry
- Listen over stomach to exclude oesophageal intubation

#### If in doubt take it out

*(Decision is made in conjunction with most senior nurse present i.e. shift leader)*


### Confirmed Unplanned Extubation

- Contact anaesthetist immediately (as above)
- Swiftly remove endotracheal tube (deflate cuff if cuffed tube)
- Maintain Airway, Breathing and Circulation (ABC)
- Place infant / child flat on back, (infant neutral position / child sniffing position) to open airway
- Apply appropriate size mask to the rebreathing circuit and manually ventilate with 100% oxygen
- Observe chest movement for chest rise
- If no chest rise, reposition airway and ensure no leak around mask, until chest rise is observed
- Observe infant / child's colour, oxygen saturation and heart rate
- Prepare equipment for re-intubation and ensure availability of reintubation medication
- Aspirate stomach contents
- Reassess sedation level
  - Assess patients own respiratory effort as may not need to be manually ventilate if nearly ready for extubation i.e. on CPAP
- *NB: An incident and UE audit form must be completed once the child's condition is stable.*
- *Ensure 5-15 minute vital signs have been documented during any clinical deterioration as clinically indicated*


## 4. Care of an Infant with a Nasopharyngeal Tube

### Nursing Considerations with a Nasopharyngeal Tube

A nasopharyngeal tube may be used to deliver nasopharyngeal CPAP as an elective procedure post extubation in an infant < 6 months. This will assist the infant who has respiratory distress by reducing the work of breathing and minimise the need for reintubation.

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ACTION	RATIONALE, EVIDENCE and REFERENCE
<p><b>Size</b></p> <p>The length of tube is estimated by measuring from the tip of the infant's nostril to the tragus of the ear and taped at the nostril. Anaesthetist will make final decision regarding length.</p> <p>A Malakroft endotracheal tube (ETT) is usually used and shortened to correct length. Size of nasopharyngeal tube is same as for ETT. Length measured from flange of the infants' nostril to the tragus of the ear. Secured in place as for ETT (Appendix III)</p> <p>The tube is lubricated alongside of tube prior to insertion using K.Y jelly.</p> <p><b>Safety</b></p> <p>A spare approximately cut nasopharyngeal tube is kept by the infants' cot / radiant warmer.</p> <p>An oxygen face mask is attached to the rebreathing circuit.</p> <p><b>Monitoring of Infant</b></p> <p>Close observation of the infant for signs of respiratory distress / failure.</p> <p>Ensure apnoea, oxygen saturation and respiratory monitoring is on including alarms.</p> <p>The infant will be able to vocalise.</p> <p>Regular suctioning of the nasopharyngeal tube.</p> <p>Ensure infant is receiving humidity from a Fisher Paykel Humidifier set at 37 celius.</p>	<p>To ensure correct placement (Resuscitation Council UK 2008, APLS 2011).</p> <p>(Resuscitation Council UK 2008, APLS 2011).</p> <p>To aid insertion and prevent trauma to nasal mucosa which is very vascular.</p> <p>To be prepared for emergency reinsertion of a new nasopharyngeal tube, if tube becomes blocked. <b>NB: This can be done by the nurse</b></p> <p>The Nasopharyngeal tube needs to be removed should it block and be replaced. Airway suctioned and hand ventilation as clinically indicated.</p> <p>Early detection of any respiratory deterioration and to ensure timely intervention.</p> <p>To ensure patient safety.</p> <p>The nasopharyngeal tube does not pass the vocal cords.</p> <p>To maintain patent airway. Nasopharyngeal tubes are prone to blocking.</p> <p>Optimise humidity.</p>

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**5. APPENDICES**

**Appendix I - Endotracheal Tubes**



Figure 1: Portex Uncuffed Tube



Figure 2: Malekroft Cuffed Tubes

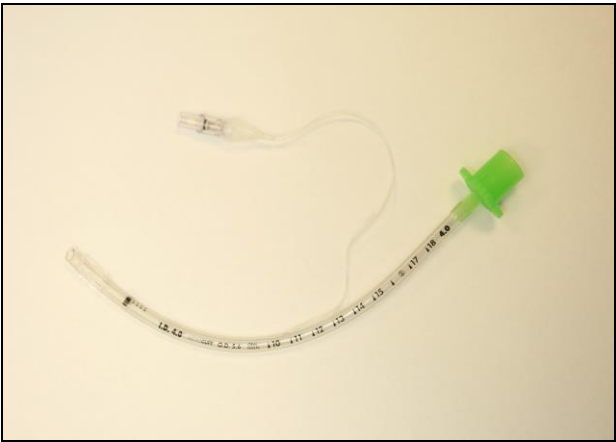



Figure 3: Microcuff Endotracheal Tube Tube



Figure 4: Cuff of Microcuff Endotracheal

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## Appendix II - Equipment for Intubation

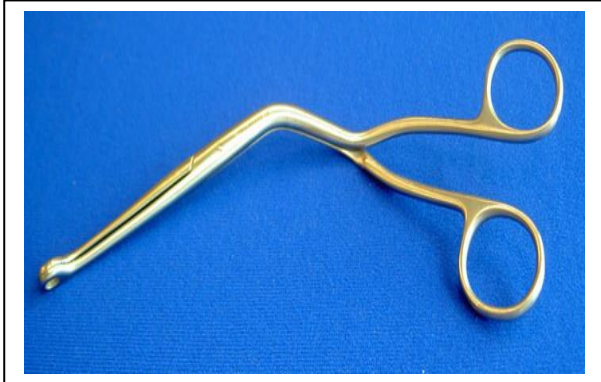


Figure 6: Magill Larngoscope and Straight Blades (OLCHC)



Figure 7: Miller Straight Laryngoscope Blades




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Figure 8: Mackintosh Laryngoscope and Blade (OLCHC)

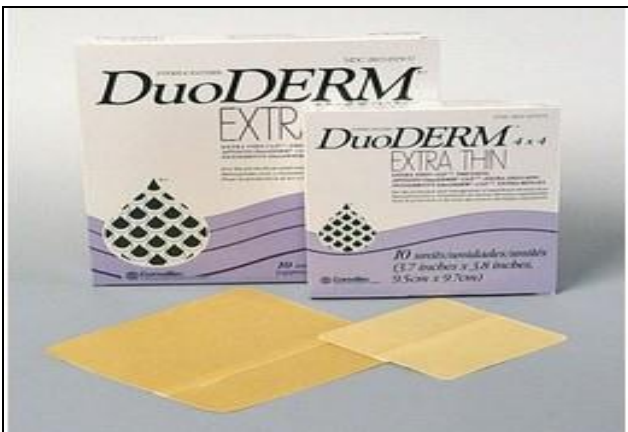



Figure 10: Duoderm Extra Thin



Figure 11: Cavilon Wipes



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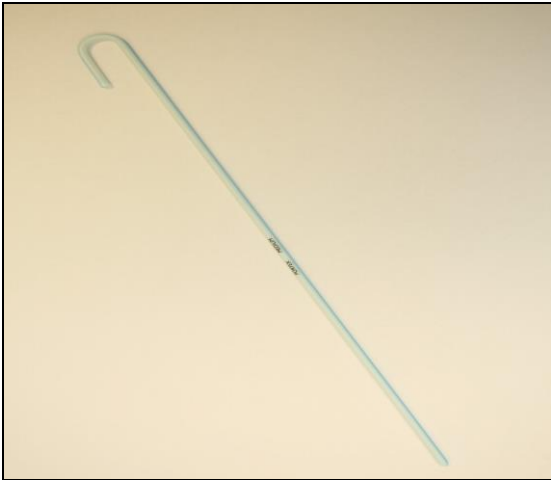


Figure 12: Gum Elastic Bougie (Intubation Adjunct) (OLCHC)

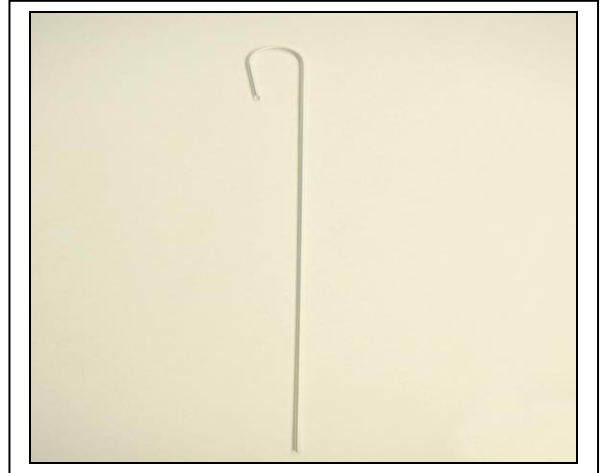


Figure 13: Stylet (Intubation Adjunct) (OLCHC)

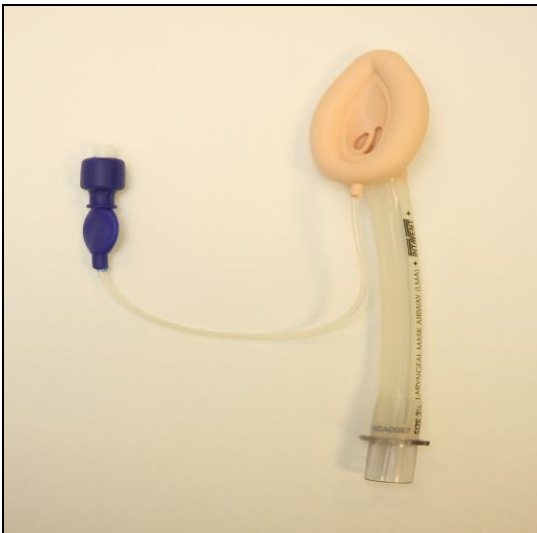



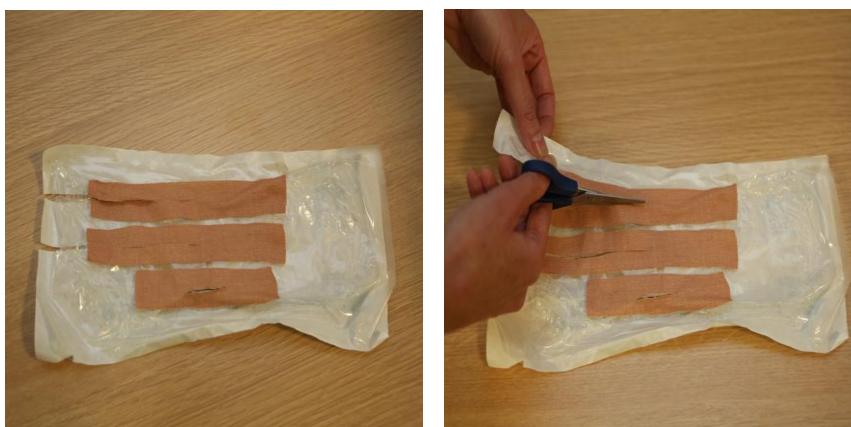
Figure 14: Laryngeal Mask (OLCHC)

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### **APPENDIX III – Securing a Nasal Endotracheal Tube (ETT) Using the Modified Melbourne Strapping Technique**

Patients with burns or scalds to the face will require an alternative method of securing the endotracheal tube (ETT). The PICU medical /anaesthetist intubating the patient will decide this at the time of intubation. The procedure should be performed by PICU medical /anaesthetist, assisted by a 2<sup>nd</sup> registered practitioner (medical / nursing).


- Ensure emergency equipment is available.
- Discuss need for sedation for procedure with PICU medical/ anaesthetist as clinically indicated.
- Check length of tube at nostril / mouth with PICU medical /anaesthetist and agree length to be taped at.
- The tube is held securely at the agreed length.



- (1) and (2) Cut two pieces of Elastoplast approximately 10 – 12 cms long into 'trouser legs' prior to intubation. Also a third piece of Elastoplast with 'eye-hole' (slit) in the middle.



- (3) Ensure skin is clean and dry. Apply cavilon swab to cheeks elastoplast and around nose as clinically indicated i.e. neonate.

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(4) and (5) Apply 2 strips of duoderm to either side of face from ear to nose and apply from edge of nose to ear.



(6) Cut a length of soft cotton string i.e. embroidery thread (slightly longer than distance around child's face from ear to ear). Tie the string around the ETT, ensuring knot is positioned on the underside of the ETT.



(7) Repeat knot (Reef knot, right over left, left over right).

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(8) The ETT may then be held in place by second practitioner holding the string.



(9) Align the first strip of the elastoplast over the string and duoderm to the **OPPOSITE** side of the face to the ETT. The inferior leg of the 'trouser leg' is applied under the nose and onto the duoderm and string on the other side of the face.



(10) The superior 'trouser leg' is stretched and applied **OVER** the nose and around the ETT at the lateral edge of the nares at least 2-3 times. Ensure it remains in situ.

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- (11) The procedure is repeated with the second 'trouser leg' from the **SAME SIDE** of the face as the ETT.



- (12) The superior 'trouser leg' is stretched and applied over the nose.



- (13) The inferior 'trouser leg' is stretched up from **UNDER** and around the ETT at least 2-3 times ensuring it remains in situ.

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(14) Ensure nostril is visible and ETT secure in position.  
The ETT should be pointed downwards and away from nasal rim to prevent pressure necrosis




(15) Pass a naso-gastric tube if not already in situ.



(16) and (17) Place ETT and naso-gastric tube through the 'eye-hole' strapping and apply over the previous tapes. Ensure maximum visibility is achieved around the nostril.  
Application will require the ETT connection to be temporarily removed.



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(18) On completion of the procedure, most of the circumference of the intubated nostril should remain visible



(19) Secure Naso-gastric tube with elastoplast to cheek.




(20) Trim elastoplast and string as clinically indicated.

(21) The ETT should be secure from both (right and left) directions of the face.

(22) Retape if the ETT position is incorrect on the chest X-ray or if the tapes become wet and loose.


*(Adapted from Advanced Life Support Group 2008)*

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