Neonatal Intubation

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Rationale & background

- To intubate the trachea for the purpose of providing an airway and/or assisted mechanical ventilation and surfactant administration.
- Drugs given to assist neonatal intubation provide analgesia and assistance in smooth passage of the tube. It is not truly a rapid sequence induction as you should allow time for the morphine to work prior to proceeding to muscle relaxation and intubation.
- As the risk of aspiration of stomach contents is less in neonates than in paediatric patients, more time is available to the intubator without the risk of reflux.
- Following assessment of the neonate, concerns regarding the airway and relative difficulty of the attempt at intubation should be predicted and the safest approach taken eg micrognathia. Anaesthetic support should be sought where appropriate.

Equipment

- Appropriate sized (straight) laryngoscope blade (size 0 for preterm; size 1 for term)
- Neonatal Magills forceps (if necessary)
- ETT (non-cuffed) of appropriate estimated size:
  - size 2.5mm <1kg
  - size 3.0mm 1kg-3kg
  - size 3.5-4.0mm >3kg
- Other sizes should be readily accessible. Lengths – see NETS calculator
- Endotracheal tube introducer
- Water soluble lubricating gel
- Short FG 12 suction catheter
- Working suction outlet
- 8FG intragastric tube (IGT) with 20mL syringe connected to distal end.
- Leucoplast trouser leg tapes to secure the ETT
- Syringes
- Drug labels
- Access to Neopuff® or anaesthetic bag with manometer connected and/or self inflating bag
- Appropriate sized clear silicone face mask
- Neonatal stethoscope
- Atropine / Morphine / Suxamethonium
- Drug calculation sheet
- NETS' ventilator with circuit ready to go
- Humidifier – fill with water set temp at 39°C
- Oxygen flow meter, if available oxygen/air blender
- Exhaled CO₂ detector e.g. Pedicap®
Procedure
In general, it may be safer to perform oral intubation prior to nasal intubation. A nasal tube may be more secure for transport purposes, but a secure oral ETT is adequate (depends on skill/experience of intubator).

Before intubation:
- Monitor heart rate, respiratory rate and oxygen saturation
- Check Neopuff® and anaesthetic bag function, operating laryngoscope and set suction at 100 mmHg (13-14 Kpa)
- Set ventilator so that hand bagging of the neonatal lungs is limited
- Calculate and order medication
- Draw up and label drugs
- Check patency of IV line
- Check availability of radiographer to anticipate need for x-ray
- Empty the stomach using 8FG IGT
- If surfactant is required, have this warmed and drawn up ready for administration once ETT is placed
- Arrange the team that will be supporting the intubation and intubator – a supportive team is very important to the success of this critical procedure. Define roles during the process eg. individual assigned to each of the following:
  - Scribe of events
  - Drug administration
  - Suction
  - Intubation
  - Pedicap and ventilator circuit
- Discuss management plan with all team members before proceeding.
- Have an escape plan should the first attempt at intubation be unsuccessful.

Intubation:
- Allow the infant to breath spontaneously and target saturations’ appropriate for gestational age
- If you need to support breathing prior to intubation use CPAP initially and PPV if required – keeping saturations appropriate for gestation. Do not hyper-oxygenate the preterm infant.
- Give Morphine followed by a saline flush 5 minutes prior to planned intubation to allow time for analgesic effect. Some infants will require more respiratory support following this. This is a good time to establish nasal patency with your ETT if nasal intubation is planned.
- If required you may also give Atropine, flushing after with saline. Be aware that atropine in the septic neonate may increase the heart rate and critically decrease the cardiac filling time.
- Cricoid pressure may be required to assist in viewing the larynx. Use an experienced assistant.
- Position infant so that head and neck are in neutral alignment; this may be enhanced by placing a roll under the infant’s shoulders (See figure).
**Oral intubation**

- Administer Suxamethonium; followed by normal saline flush
- Open mouth gently with gloved finger
- Place laryngoscope blade (largest which fits in the mouth) in the mouth to the right of centre; moving the whole tongue and lift the tongue and jaw to view the posterior larynx and cords
- Suction may or may not be required
- Place the endotracheal tube (using an introducer if preferred) in the mouth and advance through the cords to 2 – 4 cm at the cords
- Careful securing of the oral ETT is the key to minimising the risk of inadvertent extubation

**Nasal intubation**

- A nasal tube may be more secure especially in the transport setting.
- The intubator checks the patency of the nares with the ETT. Passing the turbinates may best be achieved by gently manipulating the bevel of the ETT tip. Move the tube so its 'curve' points to the 9 o'clock, 12 o'clock, and 3 o'clock direction. If unable to insert the tube at least 3-4cm, remove and attempt to pass 6Fg IGT, (6Fg may also be used as an introducer). Once satisfied the nares are patent, suxamethonium would normally be given followed by saline flush.
- Suction may or may not be required
- Visualise the larynx using laryngoscope and pass ETT through the cords either by pushing the ETT through or by lifting and placing ETT with Magill's forceps
- If changing from oral to nasal ETT, partially remove oral ETT strapping.
- If changing from oral to nasal ETT, position the nasal ETT near larynx prior to removing oral ETT. The ETT is passed through the cords under direct vision using the Magills forceps, if necessary (See figure). Cricoid pressure may be useful in visualising the glottis.

- A guide to the depth of insertion is that the number of centimetres through the cords is about the same as the number of mm internal diameter of the ETT being used. In many brands of ETT this measurement is the ETT “vocal cord guide” (the black marker near the tip of the ETT) which is placed at the level of the vocal cords (See figure).
• The ETT connector should be connected to the ventilator circuit and pressures adjusted as required to achieve adequate chest movement.

• Should the ventilator fail for any reason then you should attach the Neopuff® or the resuscitation bag with manometer to the ETT and ventilate. Be careful to regulate the pressures and volume delivered to the neonatal lung.

• Check that the tube is in the right position:
  o View the ETT passing through the larynx.
  o Use an end tidal CO₂ detector attached to the ETT for verification of correct tube placement. Devices to detect exhaled CO₂ after endotracheal tube placement in infants have good sensitivity and specificity within 2 or 3 inflations (check manufacturer’s specifications as Pedicap® reading is recommended after 6 breaths). In the presence of cardiovascular collapse, the Pedicap® may be of limited use.
  o Listen to both axillae with a stethoscope. The sounds of positive-pressure inflation should be similar on each side and should not be heard in the stomach. This may be difficult to assess in very immature infants. In some special circumstances (e.g pneumothorax diaphragmatic hernia) there may be asymmetrical breath sounds.
  o If ETT tip is in the trachea, mist will condense on the inside of the endotracheal tube during expiration.

• Minimise hypoxia during intubation by:
  o Limiting the intubation attempt to prevent excess fall in oxygen saturation and/or heart rate – a supportive team member should be available to determine when the attempt should cease and re-oxygenation be implemented.
  o There is no need for the support person to count or worry the intubator unnecessarily whilst they are attempting to pass an ETT. Supportive comments aid in the success of intubation.
  o The experienced support person may be able to assist the intubator if the laryngoscope is clearly too deep in the larynx or the neck too extended.
  o Providing appropriate ventilation before and between intubation attempts.

**After intubation:**

• Strap the ETT according to NETS guidelines
• After placing the first piece of strapping, you may need to reconfirm ETT position at vocal cords under direct laryngoscopy. Auscultate chest before completing strapping procedures to make sure that the ETT is still in the correct position.
• If there is any doubt of the position of the tube, reuse the exhaled CO₂ detector (PediCap®)
• Secure ventilator circuit to eliminate tension or torsion on the circuit and possible dislodgment of the ETT.

**Recommended drug doses** - see NETS calculator
- Morphine: 100 - 200 micrograms/kg – lower dose in sepsis
- Atropine: 10-20 micrograms/kg – beware in sepsis
- Suxamethonium: 1-2mg/kg – beware in suspected neuromuscular disease
  o Suxamethonium can be repeated at a dose of 1mg/kg up to a maximum total dose of 4mg/kg in a 5 minute period.

**Documentation**
- Indication for intubation
- Whether oral or nasal and which nostril used
- ETT size as well as position at cords and nares/lips
- Radiological position of tip of ETT (aiming for T2-T3)
- Medication chart completed
- Infant’s tolerance of procedure and any adverse events
## Complications

<table>
<thead>
<tr>
<th>Complication</th>
<th>Causes</th>
<th>Preventive/corrective actions</th>
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</thead>
<tbody>
<tr>
<td>Hypoxia</td>
<td>Prolonged attempt to intubate</td>
<td>Shorten intubation attempt&lt;br&gt;Neopuff® or Bag-mask ventilation with oxygen&lt;br&gt;Proper positioning of the ETT</td>
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<tr>
<td></td>
<td>Incorrect placement of ETT</td>
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<tr>
<td>Bradycardia/Apnoea</td>
<td>Hypoxia</td>
<td>Bag-mask, bag-ETT ventilation with oxygen&lt;br&gt;Atropine in the induction</td>
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<td></td>
<td>Vagal response due to the laryngoscope blade, ETT, or suction catheter stimulating the posterior pharynx</td>
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<td>Contusions or lacerations of tongue, gum, pharynx, epiglottis, trachea, vocal cords, or oesophagus</td>
<td>Rough handling of laryngoscope or ETT&lt;br&gt;Laryngoscope blade too long or too short</td>
<td>Additional practice/skills&lt;br&gt;More appropriately sized equipment</td>
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<tr>
<td>Pneumothorax</td>
<td>Over-ventilation of one lung due to placement of ETT in a main bronchus (usually the right)</td>
<td>Proper positioning of ETT&lt;br&gt;Appropriate ventilating pressures using the ventilator or Neopuff®&lt;br&gt;Avoid hand bagging where possible</td>
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<tr>
<td>Right main bronchial intubation</td>
<td>Incorrect placement of ETT</td>
<td>Confirm correct ETT position clinically and by X-ray</td>
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<tr>
<td>Oesophageal intubation</td>
<td>Obstructed view of the glottis and other landmarks&lt;br&gt;Inexperience</td>
<td>Correct placement and lifting technique of the laryngoscope blade to obtain clear visualization of the cords&lt;br&gt;Additional practice/skills</td>
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<tr>
<td>Perforation of trachea or oesophagus</td>
<td>Insertion of ETT or introducer is too vigorous, or introducer protrudes beyond end of tube</td>
<td>Proper placement and curvature of introducer&lt;br&gt;Gentle handling</td>
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<tr>
<td>Infection</td>
<td>Introduction of organisms via equipment or hands</td>
<td>Universal precautions</td>
</tr>
<tr>
<td>Change of position between procedure and completion of securing and/or chest x-ray</td>
<td>Insecure ETT strapping</td>
<td>After placing the first piece of strapping, confirm the position of ETT clinically before completing strapping</td>
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## Educational Notes

- Indications for endotracheal intubation include but are not limited to:
  a) RDS where surfactant is required
  b) When bag mask ventilation is ineffective
  c) To effect tracheal suctioning
  d) Congenital diaphragmatic hernia is suspected
  e) Perinatal asphyxia with metabolic acidosis
  f) Sepsis
  g) Moderate to severe respiratory distress
  h) Apnoea
  i) Extreme prematurity
  j) Suspected pulmonary hypertension
Congenital heart disease, especially where a Prostin infusion of 20ng/kg/min or greater is given

- Use of laryngoscope with straight blade size 0/00 (7.5 cm) for premature infants and size 1 (10 cm) for term infants is preferred.
- Intubation without analgesia (cold intubation) is only warranted in arrest situation or in an emergency situation at delivery
- Site long 8FG IGT prior to chest X-ray being taken where possible
- Positioning infant for CXR is most important. To prevent ‘rotation’ the head and torso must be supported on both sides with sand bags or nappy rolls for smaller or muscle relaxed infants. Where suitable sandbags are not available, use 2 x 1 L IV fluid packs each wrapped in a nappy.
- If an introducing stylet is used (only in oral intubation), care must be taken to prevent the stylet from protruding beyond the tip of the tube and damaging the trachea.
- Exhaled colorimetric CO2 detector (PediCap®) is one of the recommendations for tube verification (See figure). This device has been shown to have a good sensitivity and specificity after 6 inflations. A positive test (detection of exhaled CO2) confirms tracheal placement of the tube, whereas a negative test strongly suggests esophageal intubation. Poor or absent pulmonary blood flow (e.g. cardiac anomalies) and severe airway obstruction (e.g. meconium) may give false negative results while contamination with gastric contents and drugs such as adrenalin also give false positive results.

![Exhaled colorimetric CO2 detector](Image)

**Colour change after 6 positive pressure breath**

<table>
<thead>
<tr>
<th>Intubation</th>
<th>Inspiration</th>
<th>Expiration</th>
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<tbody>
<tr>
<td>Tracheal: gold yellow</td>
<td><img src="Image" alt="Image" /></td>
<td><img src="Image" alt="Image" /></td>
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<tr>
<td>Oesophageal: beige colour</td>
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</table>
Tracheal or oesophageal in case of poor or absent pulmonary blood flow &/or cardiac output: no colour change

- There are several common problems experienced during neonatal intubation:
  - If the laryngoscope is initially advanced too far the tip will be in the lower pharynx and the larynx will not be seen
  - If the blade of the laryngoscope does not support the tongue it will obscure the view of the larynx
  - If the laryngoscope is not held slightly towards the left side of the mouth there will be inadequate space to see the larynx or pass the ETT past the tongue
  - If the neck is flexed or over-extended the larynx may not be seen
- Correct blade lifting is obtained by raising the entire blade by pulling up in the direction the handle is pointing (See figure). Lifting the tip of the blade by using a rocking motion and pulling the handle towards the operator will not produce a clear view of the glottis and will leads to pressure on the alveolar ridge and possibly harm future tooth formation.

- Premedication is indicated in controlled situations. At delivery or in "arrest" situations intubation without sedation is warranted.
- Morphine is a sedative agent that provides pain relief within one minute when given intravenously that deepens over 5 to 10 mins. The half-life is inversely related to gestational age, being between 6 and 12 hours (mean 8.75 hours) in the very preterm infant. It may cause hypotension.
- Suxamethonium is a short-acting depolarizing muscle relaxant. It may cause potentially serious side-effects such as hyperkalemia, profound vagotonia, malignant hyperthermia, masseter spasm and systemic and ocular hypertension. Reactive bradycardia can occur especially with repeated doses and atropine can be given before to prevent this. Muscle relaxants are contraindicated in situations known to be associated with difficult intubation (e.g. Pierre Robin sequence), severe hyperkalaemia and myopathies.
- Propofol (2.5 mg/kg IV), a hypnotic agent with no analgesic properties, has been shown to be an effective induction agent for neonatal endotracheal intubation. It facilitates intubation and allows recovery twice as fast as the combination of morphine, atropine and suxamethonium. Hypoxemia is less severe probably because of continued spontaneous breathing. Propofol is known to cause hypotension, especially in preterm infants, and its routine use is not recommended in the newborn and should only be used when the receiving neonatologist has requested it.

**Bibliography**


Acknowledgements

- All images within the guideline were obtained from the internet