

Airway Patency and Ventilation

Key Teaching Objectives

Each candidate should receive practical instruction on the following:

1. Basic airway opening manoeuvres and clearance / Oxygen delivery / Oropharyngeal airway insertion / Nasopharyngeal airway insertion / Bag-mask ventilation – one & two person techniques. Emphasise the use of the 2 person techniques and HME-viral filters (with BVM, LMA, ETT) to minimize potential infective aerosol
2. LMA insertion in an infant
3. Orotracheal intubation of an infant and an older child / Ventilation with bag through tracheal tube
4. Allow time for questions. There may be issues raised regarding the implications of Covid 19. Laminated guidelines will be available. There will not be time for an extensive discussion.

Note: This is a skill station and does not require a detailed discussion of the decision making.

Equipment Required

Mannequins – for intubation & nasal airways

3x infant

2x child

Antibacterial wipes x 2

Hudson Face Masks

Paediatric with and without reservoirs

Adult with and without reservoirs

LMAs:

LMA Supreme (or Ambu Auragain or Aura-i)

6x #1.0

6x #1.5

Endotracheal tube stylet introducers:

1x 14Fr (adult)

1x 10Fr (paediatric)

Endotracheal tubes:

2.5 - 9.0 mm uncuffed (in 0.5 increments) x 1

3.5 mm uncuffed x 2

7.5 cuffed x 2

Eschmann Tracheal tube introducer – “Bougie”

1x 14Fr adult

1x 10Fr paediatric

infant - circular 01, 1, 2.

Laryngoscope handles x 2:

Miller Straight Laryngoscope blades:

1x size 0, 1, 2
Macintosh curved laryngoscope blades
1x size 1, 2,3
Nasopharyngeal airways 6 x 2
Size range: 3.5mm – 6mm in 0.5mm increments
Oropharyngeal airways:
(000, 00, 0, 1, 2, 3, 4, 5, 6) x 2
Paediatric Magills forceps x2
Paediatric yankauer suckers x 2
Y-suction catheters
14Fr x1
10Fr x1
Self-inflating bags with reservoir and oxygen tubing:
240 mL x 1
500 mL x 1
Face masks for bag ventilation
Round 4cm, 5cm, 6cm
Moulded paediatric & small adult
Spare batteries for laryngoscopes
Stethoscopes x 2
Stop Clock & Batteries
Syringe 10 mL
Tape to tie in endotracheal tube
Tongue depressors x 4
HME/Viral filters by 4

Environment

There will be three instructors to 6 candidates, so that the hands-on aspect of each station is taught by one instructor to two candidates. The manikins and equipment should be arranged into three separate stations.

- A child & infant for 1st & 3rd teaching stations
 - one group with one of each manikin size
 - and 2 groups sharing one of each, so that one group uses the infant while the other uses the child manikin & then swap
- An infant manikin for each of the 3 LMA teaching stations

Plan

The sequence & timing:

- Set (by one instructor to the whole group) **(5 mins)**
- Airway opening, BVM & adjuncts **(20 mins)**
 - Demo (whole group)
 - Split into the 3 groups for hands-on
- LMA insertion and Oro-tracheal intubation **(30 mins)**
 - Demo (whole group)
 - Split into the 3 groups for hands-on
 - LMA on infant only

- Closure done within small groups (**5 minutes**)

Set

"In this session there are 3 skill sets to learn. Firstly, we are going to revise the airway opening techniques used in basic life support and then teach you how to use simple airway adjuncts to help clear and maintain an airway. You will then be taught how to ventilate a patient using the bag-valve-mask with both the one and two-person techniques. **This is the foundation skill of advanced airway management and ventilation.**

Secondly, you will be taught techniques for insertion of a laryngeal mask airway in an infant to demonstrate the generic principles involved in the insertion of a supraglottic airway device.

Thirdly, we will teach you how to prepare for and then successfully carry out oral intubation in both the small and larger child. In this station one candidate will be doing the intubation while the second candidate will have an active role assisting by maintaining situational awareness so as to protect the patient from the task focused intubator who isn't aware of how much time has passed or how low the sats may have fallen. The roles will then be reversed."

Dialogue

This station is taught using the 4 part technique as described previously in the Pocket Guide to Teaching for Medical Instructors. The following sequence/methods should be taught:

Teaching station 1:

Basic airway positioning and clearance

Head Tilt & Chin lift

1. Place the hand nearest to the child's head onto the forehead
2. Apply pressure to gently tilt the head back to achieve the following degrees of tilt

Infant

Neutral

Child

Sniffing

3. Place the fingers of the other hand under the chin and lift gently upwards.
4. Positioning – briefly discuss positioning of infant /small child on flat surface, whereas older child (and adult) would have pillow under head. A rolled pillow case or small towel may be useful in younger patients under neck to help stabilise head. This may also be of use during intubation (see below)

Jaw Thrust

1. Place two or three fingers under the angle of the mandible bilaterally.
2. Lift the jaw upwards.

Suctioning

1. Apply basic airway positioning (as above)
2. Use a tongue depressor, or laryngoscope blade with light, to visualise the oro-pharynx
3. Maintaining direct vision of the tip of the device, insert a suction device into the oro-pharynx and suction the airway
4. Device selection:

| Infant | Child |
|--|----------------|
| Soft suction catheter with "Y" adaptor | Yankeur sucker |

Soft suction catheters are less traumatic and often preferred, but are less capable of removing voluminous or particulate vomitus, in which case a Yankeur sucker is acceptable

Oxygen Delivery

1. Discuss the role of nasal cannula, Hudson mask, and Hudson mask with reservoir
2. Note that a well applied Hudson mask with reservoir can deliver $FiO_2 > 0.90$
3. Note that a self inflating bag with mask should not be used for simple oxygen delivery – as without positive pressure ventilation FiO_2 may be erratic, and it increases the work of breathing – especially in children.

Oropharyngeal airway Insertion

If the gag reflex is present, it is best to avoid the use of an oropharyngeal tube or other artificial airway, since they may cause choking, laryngospasm or vomiting

Centre of the mouth to the angle of the jaw

1. Select an appropriate size of oropharyngeal airway.
2. Open the mouth using the chin lift taking care not to move the neck if trauma has occurred.
3. Use a laryngoscope blade or a tongue depressor to aid insertion of the airway under direct vision in anatomical alignment - 'the right way up'. This also provides the opportunity to examine the oropharynx for foreign material.

4. Re-check airway patency and look for improvement.
5. If necessary, consider a different size from the original estimate.
6. Provide oxygen with a face mask and reservoir,
7. If assisted ventilation is required – use a self-inflating bag and mask

Nasopharyngeal airway insertion

Discuss benefits (e.g. trismus during a seizure, or obtunded with gag), risks (e.g. haemorrhage/ coagulopathy / sinus infection), and contraindications such as a base of skull fracture.

Lateral edge of the nostrils to the tragus of the ear

1. Select an appropriate size (length and diameter).
2. Lubricate the airway with a water-soluble lubricant.
3. Insert the tip into the nostril and direct it posteriorly along the floor of the nose (rather than upwards).
4. Gently pass the airway past the turbinates with a slight rotating motion. As the tip advances into the pharynx, there should be a palpable 'give'.
5. Continue until the flange rests on the nostril.
6. If there is difficulty inserting the airway, consider using the other nostril or a smaller size from the original estimate.
7. Re-check airway patency.
8. Provide oxygen, consider ventilation by BVM.

Bag – mask ventilation (ensure HME/viral filter between BVM and face mask)

Face mask selection & application

1. Select the correct size face mask
 - a. the correct size mask extends from the furrow of the chin, to cover the bridge of the nose
 - b. It should not apply pressure to the eyes
 - c. The smallest size which achieves this will have the least dead space, and often the best seal



Image from:
http://www.neoresus.org.au/pages/LM1-7-Breathing.php#B_Positive

Face mask with chin lift manoeuvre

1. Place the thumb over upper margin of the mask (over the bridge of the nose), and the index finger around the lower margin of the mask, in a "C" grip.
2. The middle, ring and little fingers are then applied to the bony prominences of the mandible, and then **lift the chin up into the mask**.
3. In this position the thumb and index finger oppose the other fingers and maintain a mask seal, simultaneous with chin lift to maintain the airway
4. Note common errors
 - a. avoid compressing the airway due to pressure on the soft tissues under the oral floor, from fingers creeping medially off the mandible
 - b. avoid excessive pressure of the mask down on the chin, which will move the jaw posteriorly, flex the neck and obstruct the airway.
5. The position of the thumb and index fingers may need to be adjusted to achieve an adequate seal on all sides



"C" Grip on face mask

Image from: F.E. Wood, *et al* Improved techniques reduce face mask leak during simulated neonatal resuscitation: study 2; Arch Dis Child Fetal Neonatal Ed, 93 (2008), pp. F230–F234



OR



6. Squeeze the bag observing the resulting chest movement. "EASY SQUEEZE".
7. Avoid excessive volumes or very rapid inflations as these will tend to inflate the stomach and increase the risk of regurgitation
8. Ventilate at 12-20 breaths/minute depending on the age of the child.
- 9. It should be emphasised that bag and mask ventilation is the foundation skill for the goal of oxygenation and ventilation**
- 10. If oxygenation / ventilation is difficult – bag ventilation techniques should be combined with an oro-pharyngeal +/- naso-pharyngeal airway**
11. If adequate oxygenation still cannot be achieved – progress to two-person technique

Two person bag mask ventilation with jaw thrust

1. Insert an oro-pharyngeal +/- naso-pharyngeal airway if indicated
2. Place the appropriately sized mask gently in its correct position. Use the fingers to apply jaw thrust and the thumbs and thenar eminences to ensure a seal (vice grip).
3. With optimal jaw thrust the lower incisors will move anteriorly relative to the upper incisors.
4. Ventilate at 12-20 breaths/minute depending on the age of the child.



Note:

Bag mask ventilation in 100% O₂ is the technique for pre-oxygenation that we will use in the next two teaching stations. This is based upon the patient having normal anatomy and being unconscious with absent airway reflexes.

Teaching station 2:

Technique for LMA insertion

We are describing LMA insertion in a non-anaesthetised patient, so we need to ensure that our candidates understand that this is an explicitly rescue situation in a patient with absent airway reflexes.

Let the candidates know that there are a variety of effective ways used by experienced airway managers. We are teaching only one technique which is slightly different to that described in the 6th Ed APLS manual.

1. **Only demonstrated on the baby manikin,** firstly with the size 1 LMA which works well with our infant manikins. The size 1.5 LMA can subsequently be used successfully but with difficulty to demonstrate problems to troubleshoot. (Guideline weights and cuff volumes are printed on the LMAs)
2. Preoxygenate the patient with 100% oxygen using a bag-valve-mask device before inserting the LMA
3. Select a size 1 LMA. Half inflate the cuff, about 2 mls.
4. Lubricate both sides of LMA cuff with lubricant spray
5. Extend the head, open the mouth fully, and insert the tip of the mask along the hard palate with the open side facing, but not touching the tongue - **Fig 21.8 a in the 6th edition APLS manual** (jaw thrust by an assistant can move the tongue forward to prevent it obstructing the passage of the LMA or alternatively a laryngoscope or spatula can be used to control the tongue while passing the LMA. **With the hypermobile tongue of the manikins we are using, the laryngoscope, spatula technique works best**)
6. Insert the mask further along the posterior pharyngeal wall by pushing on the tube. Sometimes some twisting manipulation is required to pass the mask around the base of the tongue. Eventually resistance is felt as the tip of the LMA lies at the upper end of the oesophagus – **Fig 21.8 c**
7. Inflate cuff. Attach BVM/filter. Test ventilate checking for chest expansion and that the abdomen is not distending. (If minimal or no chest expansion with adequate pressure, attempt repositioning by gradual partial LMA withdrawal and retesting. If still unsatisfactory, remove and reinsert. If leak is too great, adjust cuff pressure and retest. If still too great remove and insert next size up)
8. Check the solid black line on the LMA tube is aligned midline towards the nose.
9. Secure the LMA with adhesive tape.
10. If LMA insertion is not achieved in 30 seconds, discontinue the attempt, ventilate and oxygenate by mask and try again. If LMA insertion is not successful after two attempts, seek help, if available.

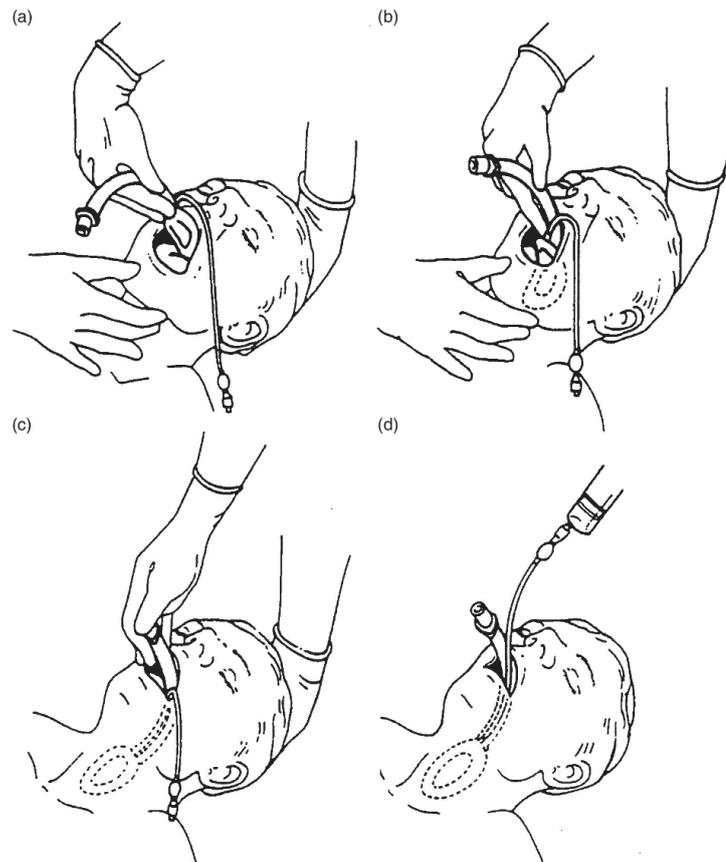


Figure 21.8 (a–d) Insertion of a laryngeal mask airway

It is sometimes easier to insert an LMA rotated 90° or 180° from its final position. The mask is then quickly rotated into its natural position as it passes into position.

Teaching station 3:

Technique of orotracheal intubation

This is about the technical skill of planned intubation in the apnoeic child (or following RSI) but pre-oxygenation and the prime goal of oxygenation of the tissues, are emphasised.

Infant or small child using a straight-blade or curved laryngoscope

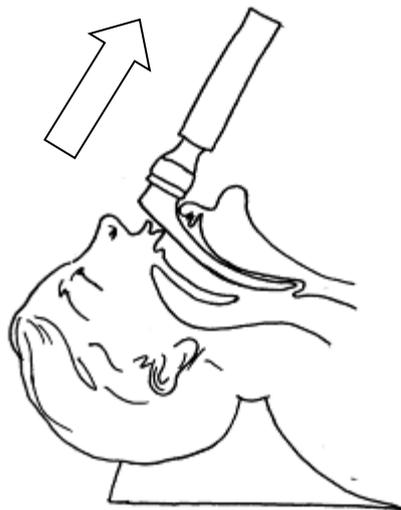
1. Ensure that adequate ventilation and oxygenation by face mask are in progress. The patient should be monitored by ECG, pulse oximetry and capnography. Adequate pre-oxygenation should always be carried out if possible. However, it should be realised that as one of the indications for intubation is failure to ensure adequate patency by any other means, this may not always be possible.
2. Prepare and check equipment. (before inducing RSI if used under these circumstances), including selection of an appropriately sized tube, but prepare a range of sizes, including the size above and below the best estimate (see chapter 5).
3. Ensure manual immobilisation of the neck by an assistant if cervical spine injury is possible. Because of the relatively large occiput, it may be helpful to place a folded sheet or towel under the baby's back and neck to allow extension of the head.

4. Hold the laryngoscope in the left hand and insert it into the mouth along the right side, displacing the tongue to the left. The blade is brought into the midline and either rests in the vallecula or picks up the epiglottis. The handle is then pulled forward to reveal the glottis. It is easy to obscure the view by either looking too far to the left or too far to the right into either piriform fossa or by inserting the blade too far past the larynx and down into the oesophagus. In the circumstance where the laryngoscope blade has been inserted too far into the oesophagus, if the blade is cautiously and slowly withdrawn the vocal cords often pop into view.
5. In the unconscious baby being intubated by the relatively inexperienced doctor, it is often easiest to place the laryngoscope blade well beyond the epiglottis. The laryngoscope blade is placed down the right side of the tongue into the proximal oesophagus. With a careful lifting movement, the tissues are gently tented up to “seek the midline”. The blade is then slowly withdrawn until the vocal cords come into view.
6. Insert the endotracheal tube into the trachea, concentrating on how far the tip is being placed below the vocal cords. The tip should lie at least 2 cm below the vocal cords, depending on age. If the tube has a “vocal cord level” marker, place this at the vocal cords. Be aware that flexion or extension of the neck may cause migration downwards or upwards, respectively.
7. Following intubation, placement of the tube should be confirmed by:
 - a. observing bilateral and symmetrical movement of the chest,
 - b. auscultation of the chest and abdomen,
 - c. monitoring carbon dioxide by either colour-change capnometry or end-tidal capnography. This is the definitive test for tracheal tube placement. [Note that exhaled CO₂ may be low or absent in cardiac arrest.]
8. If endotracheal intubation is not achieved in 30 seconds, discontinue the attempt, ventilate and oxygenate by mask and try again. If intubation is not successful after two attempts, seek help, if available.
9. Once the tube is inserted and fixed firmly into place arrangements should be made to obtain a chest x-ray to confirm correct tube length. The end of the tube on x-ray should be below the level of the vocal cords, but above the carina.

Older child using a curved-blade laryngoscope

1. Ensure that adequate ventilation and oxygenation by face mask are in progress and patient monitoring established.
2. Prepare and check equipment. (before inducing RSI if used under these circumstances), including selection of an appropriately sized tube, but prepare a range of sizes, including the size above and below the best estimate (see chapter 5).
3. Ensure manual immobilisation of the neck by an assistant if cervical spine injury is possible.

4. Hold the laryngoscope in the left hand and insert it into the mouth along the right side, displacing the tongue to the left. The blade is brought into the midline to visualize the tip of the epiglottis
5. Place the tip of the laryngoscope anterior to the epiglottis in the vallecula. The handle and blade isare then pulled forward to visualize the vocal chords as demonstrated in the illustration.
6. Gently but firmly lift the handle towards the ceiling on the far side of the room being careful not to lever on the teeth.
7. Insert the endotracheal tube into the trachea, concentrating on how far the tip is being placed below the vocal cords. The tip should lie at least 2 cm below the vocal cords, depending on age. If the tube has a "vocal cord level" marker, place this at the vocal cords. Be aware that flexion or extension of the neck may cause migration downwards or upwards, respectively.
8. Inflate the cuff if present, to provide an adequate seal.
Following intubation, placement of the tube should be confirmed by:
 - a. observing bilateral and symmetrical movement of the chest,
 - b. auscultation of the chest and abdomen,
 - c. monitoring carbon dioxide by either colour-change capnometry or end-tidal capnography. This is the definitive test for tracheal tube placement. [Note that exhaled CO₂ may be low or absent in cardiac arrest.]



9. If endotracheal intubation is not achieved in 30 seconds, discontinue the attempt, ventilate and oxygenate by mask and try again. If intubation is not successful after two attempts, seek help, if available.
10. Fix tube firmly in place. Once the tube is in place obtain a chest x-ray to confirm correct placement.

Closure

It is vital to allow time for questions. Important concerns may be addressed at this time. There may be issues raised regarding the implications of Covid 19. Laminated guidelines will be available. There will not be time for an extensive discussion. The session can be closed by emphasising the techniques and importance of the basic airway manoeuvres and BVM ventilation in managing the critically ill child.

Challenges

Because there is a great deal to cover on this station, it is very easy to run out of time. Time management is essential to ensure all candidates practice the skills

Candidates with significant paediatric airway experience can enhance the learning experience for all candidates, however it cannot be assumed that they have nothing to learn from the station. To support the diversity of learners it is important to emphasise APLS safe airway management principles and that each candidate receives the opportunity for hands-on practice.

Assessment Techniques

The candidate's performance is assessed informally during the session. This is recorded on a mark sheet and reported back to the faculty meeting. Candidates will be formally assessed during the testing station later in the course