EdWISE

Basic and Advanced Airway Management

For on site tutorials as part of the remote simulation program

Paediatrics: 5

This project was possible due to funding made available by Health Workforce Australia

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Introductions

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Very quick round the room to assess stage of professional development for each participant.

General Aims

- Learn in a team setting
- Blend clinical skills with team skills
- Reflect critically on practice

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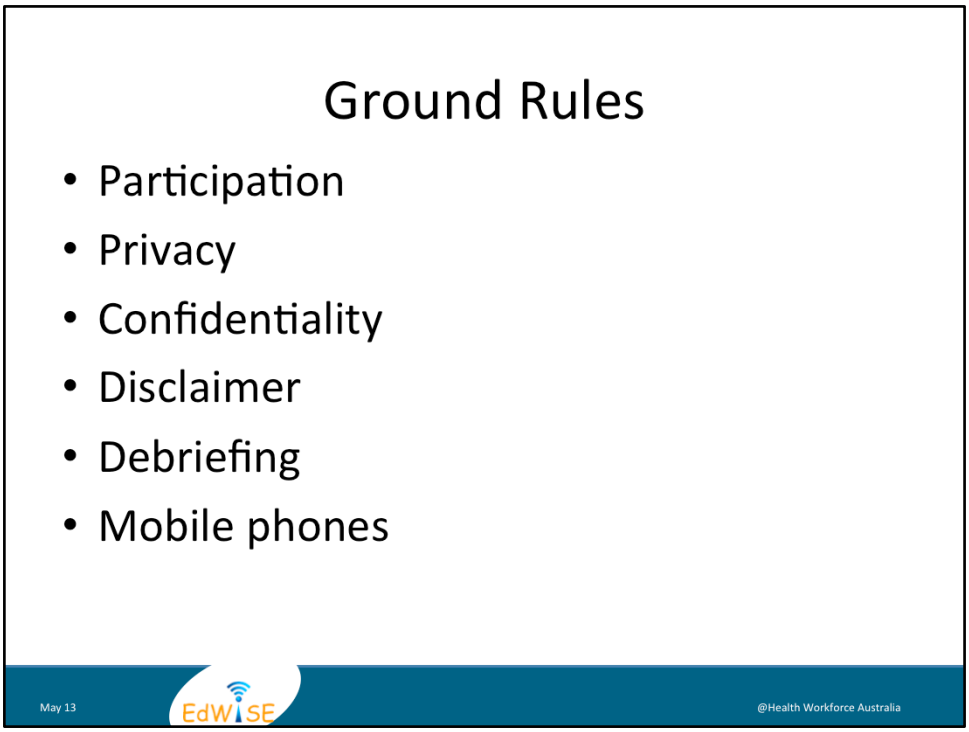
These aims are the same for all sessions – please do not modify

Speakers' notes

- This session, and package as a whole, involves learning together. Learning with the teams that you work with helps that team to function more efficiently and effectively. It allows you to learn from each other, explore different perspectives and to understand the importance of all members of the team.
- We are targeting higher level learning – applied skills and performance in contextualised events. This is through team discussion and also through working through simulated scenarios as a team. It also allows you to put into practice knowledge attained from the eLearning and other solo learning environments.
- To review and reflect upon our own practice and current best practice standards. During our feedback sessions we will facilitate this but we would also encourage you to reflect on your practice and experience after these sessions.



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Speakers notes

- Challenge of video conferencing tips: don't change your seat, speak up nice & clearly
- Details collected and de-identified for reporting purposes
- Signed form, don't speak outside about how people performed as not necessarily indicative of real life. This is a chance to try new things, don't tell anyone about the scenarios as they are used again on subsequent courses.
- We try to use best evidence practice and strive to include as up-to-date material as possible. Please do refer to your local policies, guidelines and protocols.
- Debriefing is a chance to reflect upon what we did and how that translates to the workplace. Please use this time to explore the complexities of performance and decision making. Please contribute, we will all learn from each other's experiences.
- Like most things in life, the more that you put in the more you will take away with you.
- It is an open forum where everyone's ideas and thoughts are to be valued.
- If you could please switch your phones off or to silent or vibrate for the duration of the course.

Session Objectives

- Review an approach to the paediatric airway
- Rehearse basic and advanced airway management
- Demonstrate communication and teamwork skills

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This module of the paediatric EdWISE program is related to basic and advanced airway management.

The A4.1 module of the airway EdWISE module is also basic and advanced paediatrics, thus these two programs can be used to supplement each other.

Scenario

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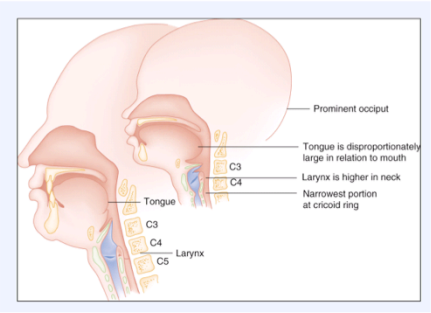
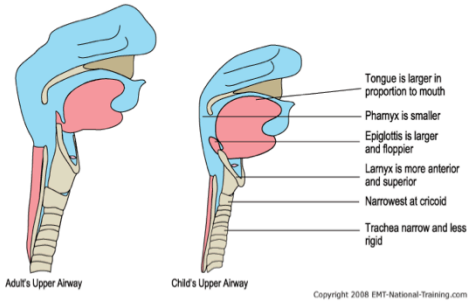
The EdWISE P5 session is a PBL style scenario. The participants should be made aware that the scenario will be paused and that this has been planned.
The scenario is designed to run until the team is preparing for intubation. At this point the scenario should be paused for a brief 5 minute debrief of the events and communication. Following the debrief the Powerpoint presentation that follows this slide is to be given, being mindful of the learning needs of the group based on the skills demonstrated during the scenario.

This is a reminder to the facilitator that the scenario is designed to run until the decision has been made to intubate the child and preparations are beginning.

Anatomical & Physiological differences





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Here is the time to point out how the anatomical and physiological differences between the infant and adult impact on the airway management.

Large head to body ratio- rolls around during airway manipulation- can stabilise with shoulder roll or rolls either side of head.
Large occiput, large tongue, increased soft tissue and flexible trachea - means that obstruction due to tongue falling back or causing neck flexion and tracheal obstruction occurs more readily and is remedied by Oro-pharyngeal (which should be put in with a tongue depressor the correct way and NOT turned on the soft palate) or Naso-pharyngeal airway.
The large tongue makes intubation more tricky, moving tongue out of way when placing scope on right hand side of mouth will improve the view.
Floppy U shaped epiglottis and anterior larynx means a straight blade over epiglottis is technique of choice when intubating babies.
Cricoid narrowest at C3-4 means to use uncuffed or cuffed ET with leak around this area is best. The conical shape of the larynx affects the airway based on the Hagen-Poiseuille law of flow proportional to the fourth power of the radius – such that any swelling in a small cylinder has major implications for flow. (Hagen-Poiseuille law states that Flow=Pxr4xpi/8x viscosity x length of tube.) Therefore airway odema in a small tube has much more significant implications than in a larger tube. Consider the effect of the virus causing croup on the paediatric airway and cough vs that of the adult with the same virus.
If cuffed endotracheal tube used, it is half a size smaller than the uncuffed, the cuff should not be inflated past 20cm H20 and should be checked regularly.
A higher carina and shorter trachea means length at which ETT sits is important, endobronchial intubation is more common and dislodgement easily occurs during transfers and with head movement.
The lower FRC means less 02 store and higher V02 (6ml/min/kg vs 3 in adults) and increased ventilation/ perfusion (V/Q) mismatch means there is less time for intubation with more rapid desaturation. This is exacerbated by FRC being 10% of adult when sedated due to loss of muscle tone compared with FRC 40% of adults when awake.
Infants have straighter ribs so increased WOB, immature muscle fibres and less glycogen and fat stores so easily fatigued if prolonged respiratory distress.
Babies have high vagal tone so may become bradycardic on laryngoscopy, hypoxia and second dose of suxamethonium. Treatment is remove stimuli and treat with atropine 20mcg/kg. Atropine should be available at the bedside for all intubations in the paediatric population.
There is an increased tendency to laryngospasm, if too light, painful stimuli, oral secretions on the cords, or recent urti. Treat any laryngospasm with PEEP (BVM with PEEP valve), remove stimulus, deepen anaesthesia with propofol or suxamethonium (0.5-2 mg/kg) and ensure intubation.

The LEMON assessment can be applied in assessment for airway difficulty. With looking for dysmorphic features and anatomical variations the most important step in the assessment process.

Airway Management

- Position the head/body
- Jaw thrust, chin lift, head tilt
- Apply Oxygen
- Consider foreign bodies and removal steps
- Suction
- Airway adjuncts
- Intubation
- Difficult Airway Plan

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The airway algorithm in children is essentially the same as the algorithm as that applied to the adult population. The major difference is the cause of obstruction and the perceived stress level of the emergency physician. Often simple maneuvers and application of oxygen are the most helpful steps in paediatric airway management.

Simple maneuvers should be initially performed and the airway cleared of foreign bodies, oxygen applied and the use of adjuncts early. If intubation is considered then the 7 Ps of intubation apply in this population also.

Any anticipated airway management in children should prompt an early request for expert assistance.

Position the Head

- Place a towel under the shoulders will place the airway in a better alignment

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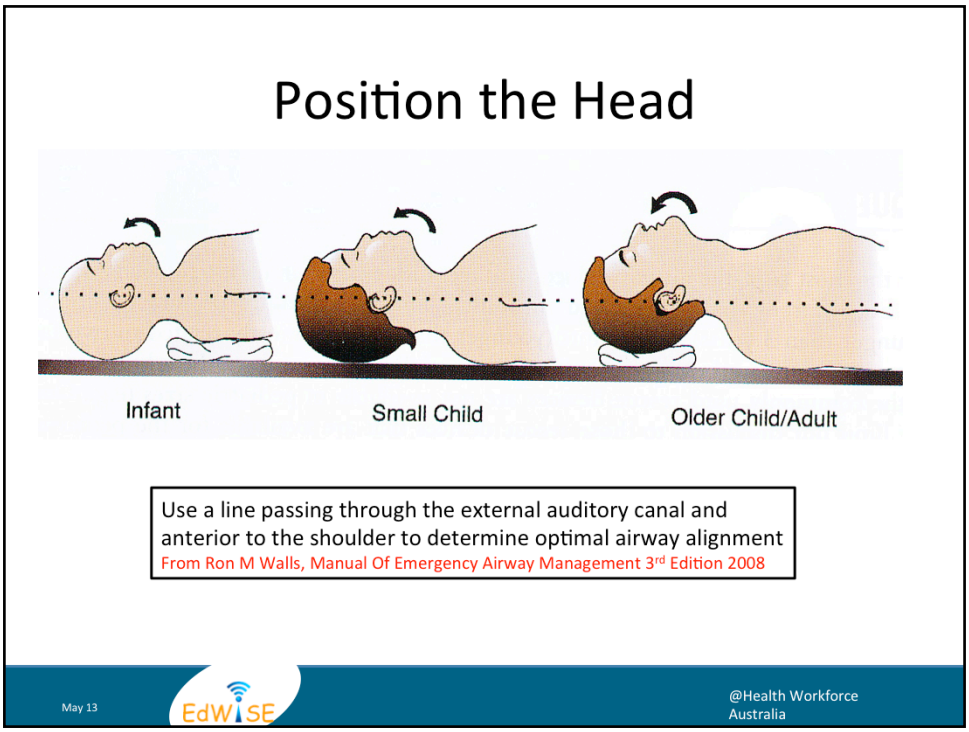
Infants have a large occiput, this contributes to flexion of the head and obstruction of the airway. A towel placed under the body, rather than the head in other populations, compensates for this flexion and produces a better alignment.

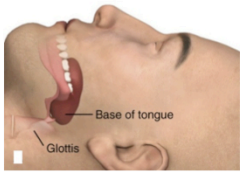


As the child grows the relationship of the occiput changes the influence on the airway. With appropriate positioning for the anatomy of the child obstruction of the airway may be improved to allow for adequate oxygenation and ventilation.
The evidence suggests that aligning the external auditory canal and the anterior shoulder will provide optimal airway positioning.

Open The Airway

- Tongue is the aetiology of the top 5 causes of upper airway obstruction!!!

Chin Lift



Jaw Thrust

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The tongue is relatively larger in the infant compared to adult anatomy. The tongue falls back into the oropharynx and contributes significantly to airway obstruction. The base of the tongue is attached in such a way that simple manipulation of the jaw will move the tongue within the oral cavity and reduce the obstruction.
Lifting the chin brings the tongue anteriorly and can be easily performed with one hand and is the first choice in patient's with potential cervical spine injury.
Jaw thrust can be performed, again bringing the tongue forward, although care must be taken to ensure the fingers are on the boney prominences and not the soft tissue where major vessels flow.
Head tilt is the third basic airway maneuver, this is contraindicated in patients with cervical spine injury and in very young children a head tilt may cause further occlusion as the airways are smaller and more compressible.

Airway Adjuncts

- Oropharyngeal airway (OPA)
  - Use in unconscious child to keep the tongue from occluding the posterior pharynx
  - Can not use it in patients with an intact gag reflex
  - Insert concave down using a tongue depressor to assist

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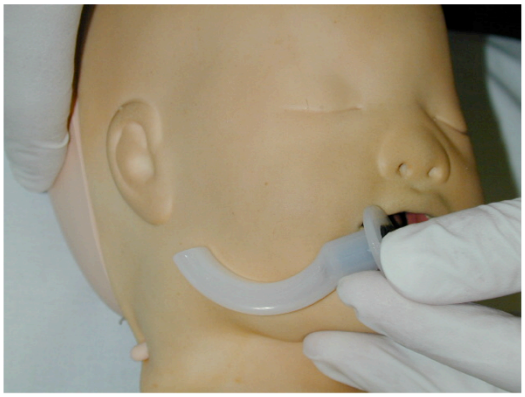
The oropharyngeal airway (OPA or Guedel) is a devise which allows the tongue to be displaced anteriorly, opening the obstructed airway in the unconscious patient. It cannot be used in a patient with an intact gag reflex as it will induce a gag and subsequent vomit and aspiration.
In the paediatric population the soft palate is friable and at increased risk of trauma, therefore the OPA should be inserted concave down, with the use of a tongue depressor to assist in its insertion.
The OPA is sized from the centre of the incisors to the angle of the jaw, or the corner of the mouth to the tragus of the ear.

The following slides demonstrate the insertion of an OPA.

Centre of the incisors to the angle of the Jaw



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Tongue Depressor

Insert concave down

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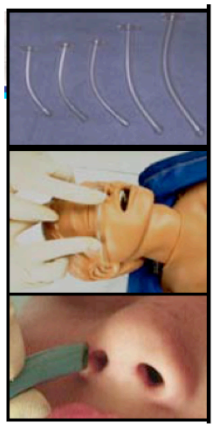
Nasopharyngeal Airways

- Length: tip of the nares to the tragus
- Width: < size of nostril
- Contraindication : Base of skull fracture
- Very well tolerated, use lots of lubricant and do not force in



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The nasopharygneal airway (NPA) is another airway adjunct which can be used in the paediatric population. It is often better tolerated than the OPA as it does not illicit a gag reflex.

The chosen size should be less than the width of the nostril and well lubricated. The NPA is inserted, once well lubricated, with the flat surface initially along the septum wall and the NPA will follow the nostril cavity curvature straight backwards.

Bag and Mask Ventilation

- Measure from the bridge of the nose to the cleft of the chin
- Ensure good seal
- Avoid direct compression of the eyes (vagal)

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Bag and Mask ventilation is a life saving skill in the patient with the threatened airway. It should be the first step in airway management.
To perform BMV the patient requires a patent airway and a good seal. Airway adjuncts should be considered when performing BMV.

An appropriate sized face mask should be chosen from the circular or anatomical selection available. The size chosen should cover the mouth and nose completely and provide a tight seal of the face. An anatomical shaped mask can be used upside down to provide this in cases of emergency airway being required without a selection of masks.

The mask in this image is too big for the child as compression of the eyes is likely to occur, this may cause vagal stimulation.

Bag and Mask Ventilation

- Bag size
  - Adult 800-1200ml
  - Paediatric 750ml
  - Infant 290-500ml
  - Neonatal 80-120ml

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Bags are available in weight appropriate sizes, in both re-useable or disposable varieties. Choose the appropriate bag for each patient to avoid barotrauma, this can be estimated by the weight of the child, using 6-10ml/kg as a guide.

As with all equipment the bag should be checked prior to use for ability to ventilate and that the reservoir bag inflates, this is to provide the highest level of oxygen. Most paediatric bags have a pressure valve set to 45mmHg, this means that a significant effort or external support is needed to provided the higher FiO2 desired with the use of a BVM. Physiological tidal volume is 6-8ml/kg, you can estimate 10ml/kg to achieve chest rise, and this should be carefully monitored for.

A quantitative ETCO2 monitor can be attached to the BVM for assessment of ventilation and oxygen saturations should be observed continuously during BVM ventilation.

EC Clamp hand technique

- C holds mask to the face
- E pulls chin into the mask (makes a clamp)
- Beware of too much pressure on the submental area
- Do not be afraid to use 2 hands to hold mask

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The EC clamp hand technique is one method for holding the face of the patient into the mask.
The C holds the mask on the face and the E pulls the face up into the mask, which is preferred over holding the mask down onto the face.
Especially in the paediatric population it is essential to consider the position of the fingers under the jaw, which should be on the mandibular bone, rather than the submental soft tissues.

A two handed mask technique, with a second person to hold the bag, is often required to achieve an adequate seal to provide the highest percentage of oxygen. Junior staff should be actively encouraged to use this technique in emergency situations.

Bag Mask Ventilation

- Control rate and volume
- Give only amount of air needed to get the chest to rise
- Say Squeeze (just until chest rise is initiated) and then say release, release

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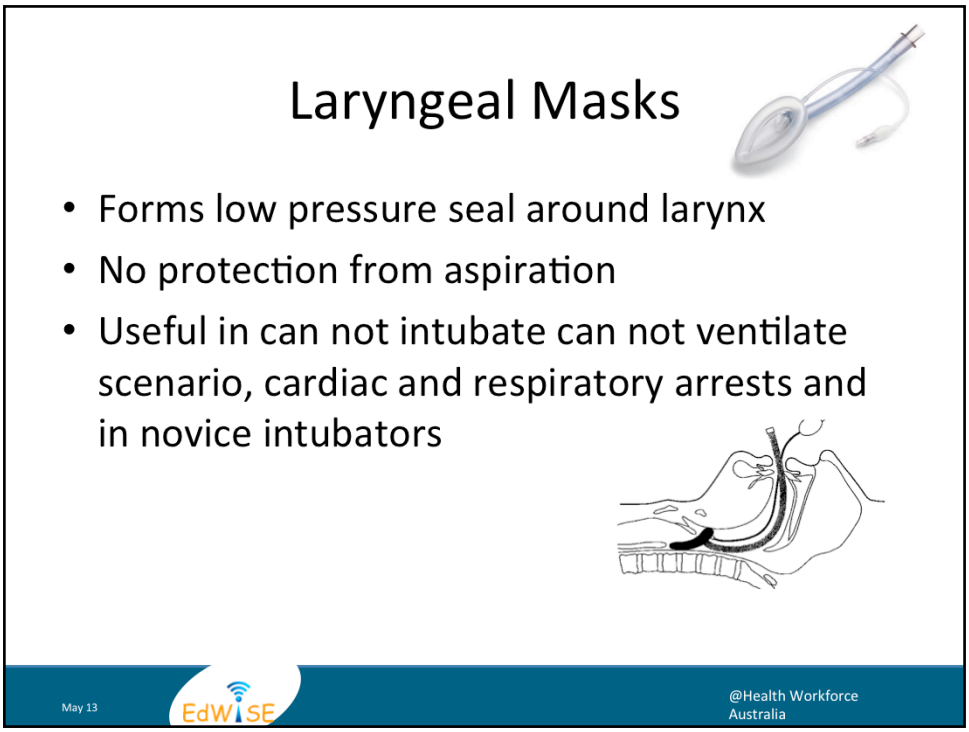
Maximum ventilation rates:

Neonates – 40/min (squeeze, release)
Infants – 30/min (squeeze, release, release)
Children – 20/min (squeeze, release, release)

Slower rates are best, too hard and too fast will lead to gastric distension, which can cause vomiting, impaired ventilation and decreased cardiac output.

Ongoing assessment for adequacy involve vigilant observation of the chest rising and falling, misting of the mask, colour of the child and monitoring of saturations and end tidal CO2.

Trouble shooting difficulty begins with an assessment of airway patency and patient positioning. After optimising the patient position, inserting airway adjuncts should be attempted to improve patency and a two-person two handed technique of BVM should be trialed. Requesting an assistant call for urgent help in anticipation of ongoing difficulty is essential, although In most instances these simple techniques will allow adequate ventilation.



The laryngeal mask (LMA) is a tool in the airway algorithm which can be used as either the primary device or as a rescue device.
It is simple and rapid to insert and does not require paralysis. These advantages make it a device which is ideal for use in the cardiac arrest situation or for the novice.
There are many different brands and styles of LMA, including those with gastric ports and intubating LMAs, which accept an ETT. Staff should be familiar with the devices available in individual departments, including location and best method of use.

LMA sizing

Size	Patient Age/Weight	Max Cuff Inflation
1	Neonates/Infants (<5 kg)	4 mL
1.5	Infants (5-10 kg)	7
2	Infants/Children (10-20 kg)	10
2.5	Children (20-30 kg)	14
3	Children (30-50 kg)	20

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LMA sizes are weight based, as with most paediatric equipment. This table is a guide for use and sizes above and below may be required if the LMA does not give a good fit for the child being ventilated.

When should I intubate?

- Inadequate airway protection
- Inability to ventilate and/or oxygenate
  - Shock
  - Respiratory failure
- To keep small children still
  - Transfer to another facility or for investigation
- Allow safe and adequate analgesia and sedation for procedures
- Predicted deterioration of the child

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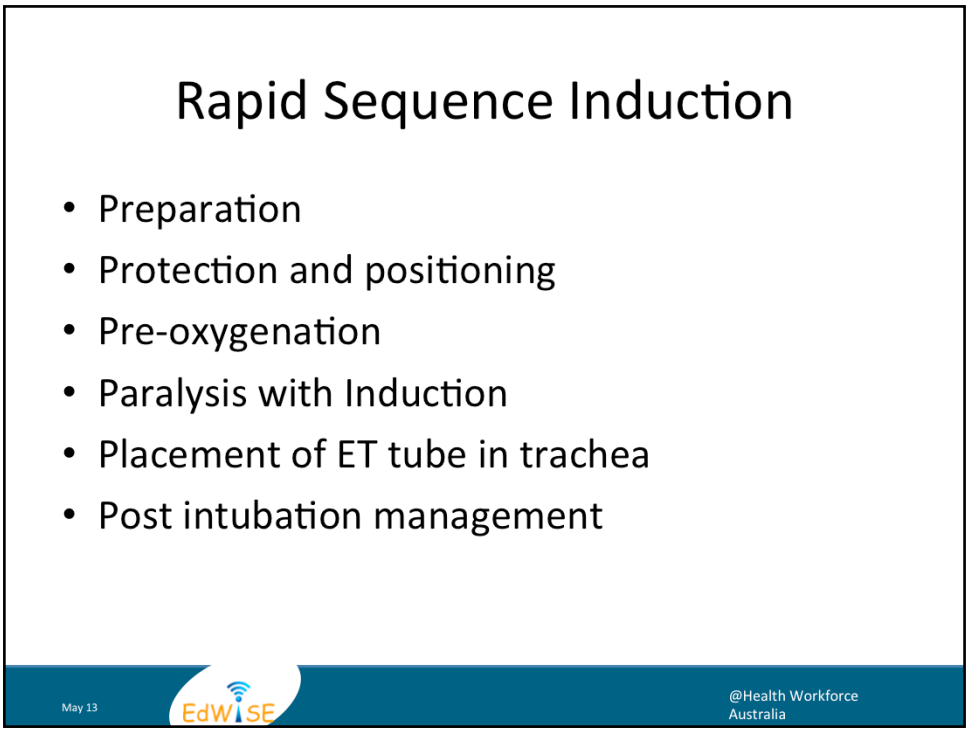
The indications for intubation and ventilation of a child are essentially the same as that of an adult, although some aspects may have different emphasis.
The airway needs to be kept patent and protected, with adequate ventilation and oxygenation.
In the critically unwell child, or a child who is expected to deteriorate the safest method of maintaining adequate physiological parameters is with airway control.

Children who need investigation which requires them to remain still such as a CT scan or MRI may need sedation +/- intubation to facilitate this procedure, this should be discussed with the referring team and based on the behaviour of the child at the time of the procedure.



The 7 P's of intubation apply in the paediatric population, with the addition of the parents who should be considered in the context of any paediatric case management.

It remains important to articulate the failed intubation drill and prepare the equipment for any failure of this procedure.
In the event of failed intubation, Plan B is commonly to attempt insertion of a laryngeal mask (LMA) if this fails then jet insufflation may be performed in children over 8 years of age, a surgical cricothyrodotomy is preferred in all ages but in neonates and small children a surgical incision of neck followed by a cannula cric may be the least damaging.. (note the reference which is different from the APLS guidelines)

Pre-oxygenation should be performed again for nitrogen wash out, being aware that these children can wriggle and be distressed with this and may require a small dose of sedation to perform this in the emergency department. If adequately breathing then can also use 15l/min via NRB.

The drug doses which are required in children should be calculated on a weight based formulae. Suxamethonium is the paralytic of choice in the emergency department and a higher dose of 2mg/kg is required.If needed a repeat dose can be used but often itself causes bradycardia and atropine administered preemptively. Other medications including atropine and normal saline boluses should be available in case of bradycardia or hypotension during the procedure. Sedatives are given based on local practice and familiarity often fentanyl, midazolam, thiopentone, ketamine or propofol will be considered by the team, the dose will depend again on the child's weight and clinical condition.

Post intubation care involves securing the tube (and the head as movement can dislodge), ongoing sedation and analgesia, as well as insertion of indwelling catheters and nasogastric tubes.(or orogastric if trauma has occurred) The disposition of the intubated child is a significant consideration in non-tertiary paediatric centres with early consultation with the Newborn and Paediatric Emergency Transport Services (NETS), strongly advised before, during and following any paediatric intubation in the emergency department.

The role of the parents is important in any paediatric resuscitation. They should be kept informed as to the management of their child and have a staff member assigned to them during this process.

Blade size

- Miller 0 – premature infant or small newborn
- Miller 1 – normal newborn to 12 kg (2 years)
- Miller 2 – 13-24 kg (7 years)
- Macintosh blade may be used after 2 years of age
- Too small a blade can get you into trouble (Miller 2 after 2 (years))

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This is a guide to the weight based selection of equipment for intubation.

A Miller blade is a straight blade, this is designed to lift the epiglottis, which is commonly large and floppy in younger children, out of the way.
The MacIntosh blade is the curved blade, commonly used for adults. The MacIntosh blade is designed to sit in the valeculla and lift the epiglottis from it's base out of the way of the view of the vocal cords.

ED Intubation Checklist

Team

- ☐ ED Consultant aware of RSI?
- ☐ Out-of-hours, if difficulty anticipated, anaesthetics contacted?
- ☐ All members introduced by name & role and each briefed in turn by TL
- ☐ Difficult intubation plan briefed?
- ☐ Difficult airway trolley at hand?
- ☐ Anticipated problems – does anyone have questions or concerns?

Patient

- ☐ Pre-oxygenation optimal?
  - Add nasal prongs or NIV
- ☐ Patient position optimal?
- ☐ Patient haemodynamics optimal?
  - Fluid bolus?
  - Pressor?
- ☐ Does it look like it might be difficult:
  - Difficult BVM?
  - Difficult laryngoscopy?
  - Difficult cricothyroidotomy?

IVI/Drugs

- ☐ Fluids connected, runs easily?
- ☐ Spare IVC?
- ☐ Monitor: ECG, BP, SaO2.
- ☐ RSI drugs drawn up, doses chosen?
- ☐ Post-intubation anaesthesia plan - drugs drawn up?

Equipment

- ☐ Suction working?
- ☐ BVM with ETCO2 connected
- ☐ OPA and NPA available?
- ☐ 2 x laryngoscopes working? Correct blade size?
- ☐ Tubes chosen, cuff tested
- ☐ Bougie or stylet in tube?
- ☐ Tube tie or tapes ready?
- ☐ Ventilator circuit available?
- ☐ LMA sized & available?

Version 1.2
Developed by T Fogg, J Kennedy and J Vassiliadis, RNSH ED 20/04/2012

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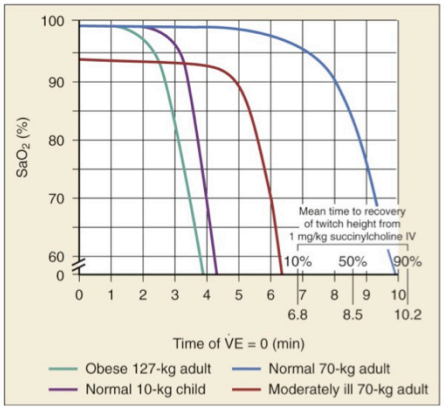
It is vital that during your preparation and planning phase, the whole team is aware of what will happen during the intubation attempt and what the back up plans are if there are any problems.
A good way to do this, is to have a team member go through a checklist prior to intubation.
The one illustrated here has been developed and used at RNSH. The nurse scribe reads out the above list and the medical and nursing members of the team confirm aloud to all the team members the answer to each of the above questions.

We would recommend that ED resuscitation room doctors use a checklist like the above one prior to each intubation.

Preoxygenate

- De-nitrogenation
  - Use 100% oxygen
  - Infants become hypoxic quickly
  - This is not the time to practice intubation
  - Avoid positive pressure ventilation



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Pre-oxygenation is essential to improve the functional residual capacity and prolong time to desaturation with any intubation.
A minimum of 3 minutes of oxygen through a bag valve mask with a tight seal is ideal, this will give close to 100% oxygen. In the upset child crying may contribute to gastric insufflation and the operator should be aware of the effect this may have on the ventilation ability.

The graph on this slide demonstrates desaturation times, most importantly it should be noted that in the 10kg normal child (the purple line) the curve begins to fall rapidly from 2 minutes and is comparable to the obese adult. It would be expected that an unwell child would be significantly faster than this. The unwell child will desaturate rapidly, as they have a high metabolic rate and a poor FRC. Therefore this is not the time to practice intubation, but when the most experienced operator should place the ETT.

Sedation, Paralysis and Placement of the endotracheal tube are the procedural steps of the rapid sequence induction.
The choice of medications will depend on the clinical context and clinician preference and familiarity. Sedation and paralysis should only be given by experienced clinicians, with preparation and planning as discussed during this talk. Medication choices may include midazolam, fentanyl, thiopentone, ketamine or propofol, for paralysis suxamethonium or rocuronium would be the most commonly chosen. The nuances of these drugs for induction and paralysis are beyond the scope of this talk.

Placement of the ETT is a technical skill which is best taught during skills stations, in the simulated environment and a controlled theatre environment. The Larygnoscope is taken in the left hand, inserted in the right of the mouth, sweeping the tongue to the left and aiming the tip of the blade into the valeculla (for a MacIntosh blade) to allow visualisation of the vocal cords. Once the cords are visualised the ETT is inserted between the cords to an acceptable depth (age/2 +12 or 3xETT size or the black line at the cords).

Once in place the ETT should be held at all times until the position is confirmed and the tube is securely tied.

Post Intubation Management

- Confirm position of tube
- Tape tube
- CXR
- Sedatives
- Ventilation strategies
- Ongoing Management

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Once the ETT has been placed it it essential to confirm the position of the tube. The gold standard of confirmation is visualising the passing of the tube between the cords with subsequent quantitative end tidal CO2 capnography demonstrating a sustained expiration of carbon dioxide. Five points of auscultation (bilateral anterior chest and axilla for breath sounds, and over the stomach for an absence of bubbles), misting of the ETT and maintenance of oxygen saturations will contribute to the clinical picture of correct tube placement.
A gastric tube should be inserted in all paediatric patients to decompress the stomach, either oral or naso route is acceptable.
The tube should be secured with tape to maintain position, and the head position maintained as any movement may dislodge the ETT tip.
Once stablised a chest X-ray is advised to confirm the depth of the tip of the tube above the level of the carina, and the position of the gastric tube.

Ongoing sedation +/- paralysis will be required for maintenance of anaesthesia.

Ventilation strategies are beyond the scope of this talk, but should be discussed with the accepting ICU team or anaethesitics should asssistance be required as children are susceptible to barotrauma.

In any instance of intubation and ventilation ongoing management of the patient should be a priority in regard to the underlying condition, cause, complications and co-morbidities. The disposition and long term management will be dependent on the management of the factors.

The scenario should be recommenced from the point it was paused for debriefing and the powerpoint presentation. Following the scenario a further debrief will occur and then the module is completed with a summary slide.

Summary

- A calm approach provides structure to airway management.
- Simple maneuvers and positioning should be carefully optimised in children.
- Equipment choices are sized based and can be assisted with charts.
- An early request for experienced assistance is best practice for intubation.

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References

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- Weiss and Engelhardt Proposal for the management of unexpected difficult pediatric airway, Paediatric Anaesthesia 2010, 20:454-464
- Advanced Paediatric Life Support Manual, 5th Edition

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