The Difficult Paediatric Airway

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Acute Care Education - Sydney – November 2015

davesainsbury.com/ace

Introductions

No conflict of interest

Wrong room

Assuming none of you are here by mistake…

This is Acute Care Education meeting.

What brings you here today, what do we hope to achieve?

Are you here as a hostage?
Your line manager decided that you had to attend to meet accreditation standards.

Maybe you are a shopper looking for something that might be of interest or of help.

Or perhaps you are an enthusiast.

Working in theatres all week is just not enough, so you have to give up a beautiful Saturday morning to gaze at power point slides of operating theatres.

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For Adult & Paediatric Operating Room & PACU Nurses

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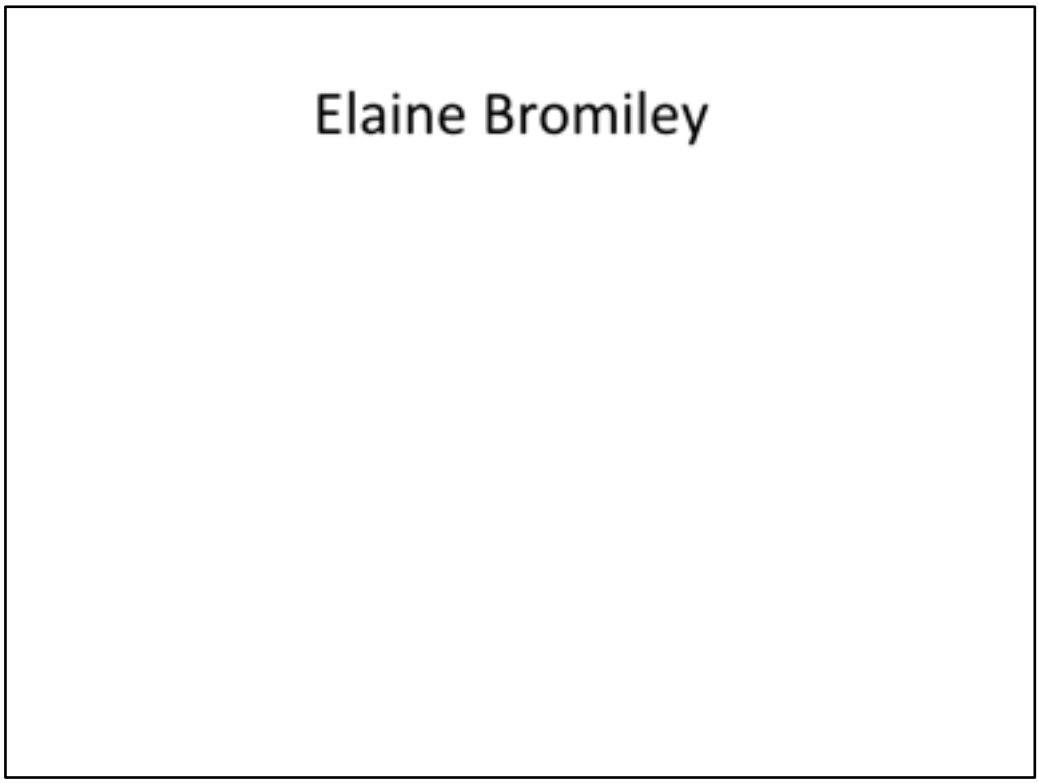


This video about a failed intubation highlights the importance of speaking up on behalf of patients.

The nurses tried to to get the doctors to realise the patient needed a tracheostomy and a bed in intensive care.

They used the principle of “hint and hope” but they were ignored.

This video also shows that you can have all the experts and fancy equipment for difficult intubations,
But,
It can be the non technical aspects that determine the outcome.

The video can be found online, just search Elaine Bromiley.

http://www.dailymail.co.uk/health/article-421989/Blunder-killed-wife.html


RECONSTRUCTION

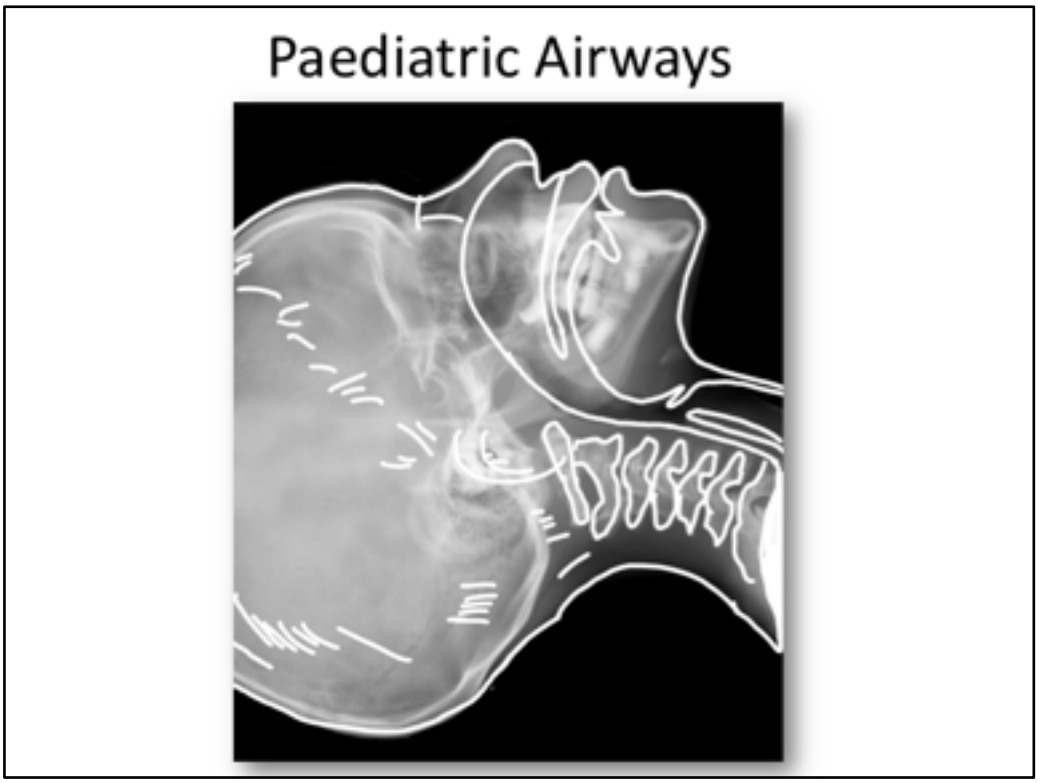
Most cardiac arrests
Secondary to hypoxia
(Excluding CHD)

By the time the heart stops
the brain is damaged

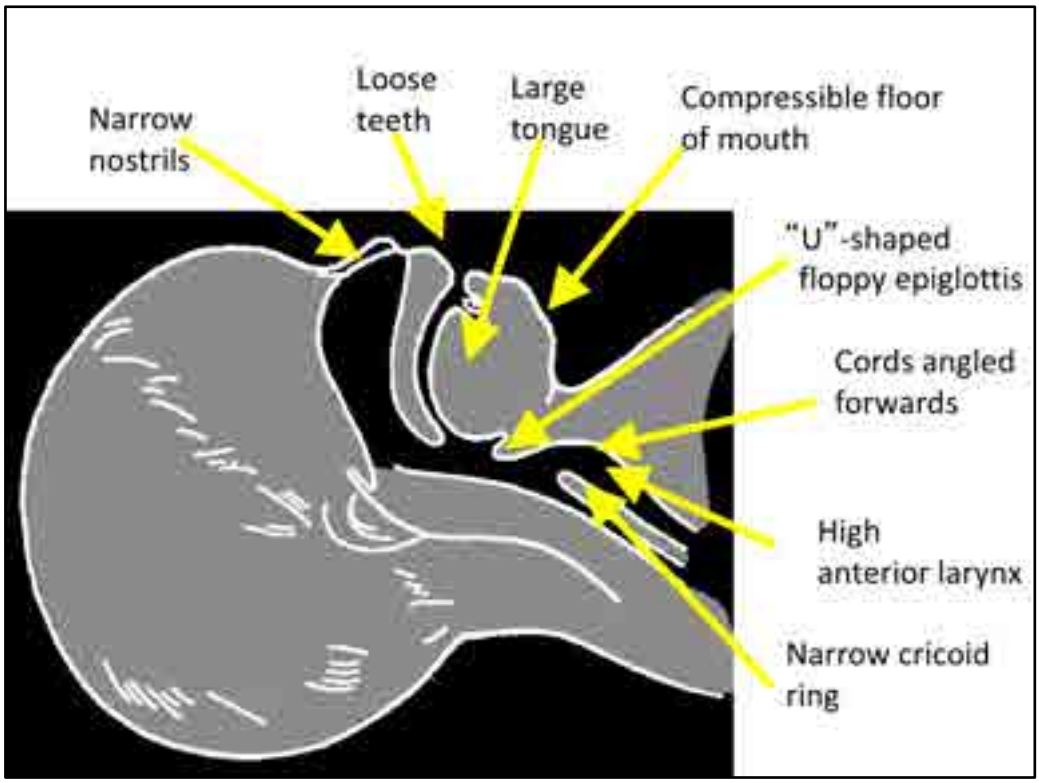
Skills

- assess ventilation
- bag and mask
- advanced techniques
- toys

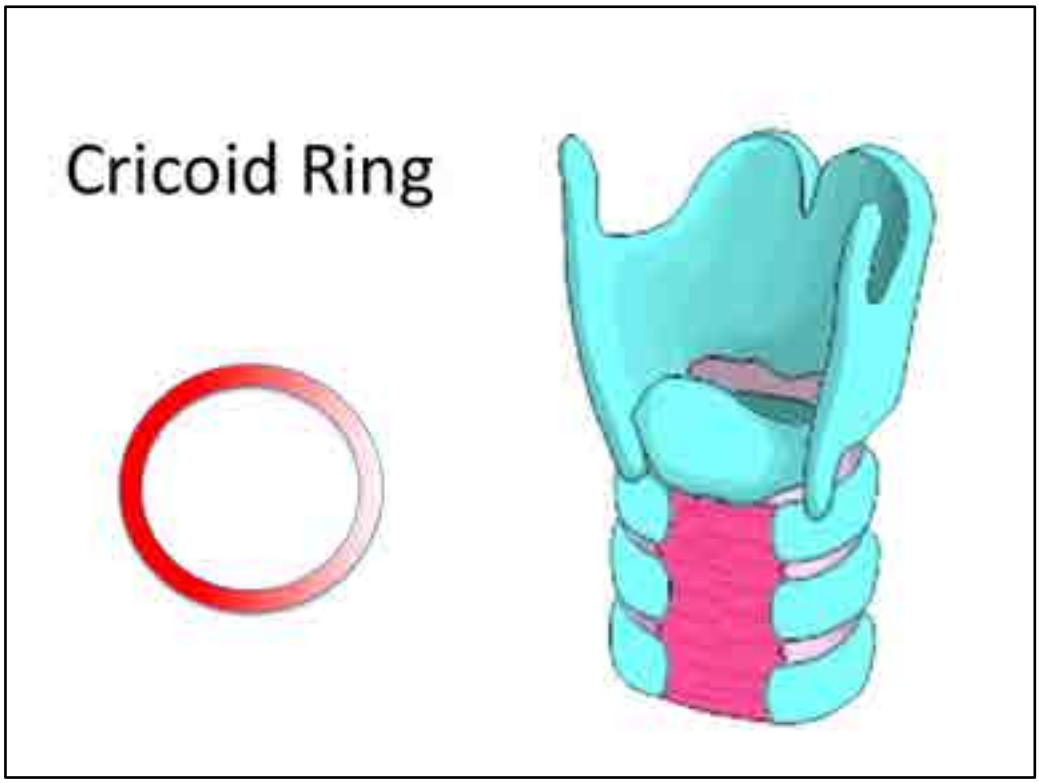
It is important to review basic airway skills before progressing to advanced techniques.
First we will review paediatric airway anatomy.



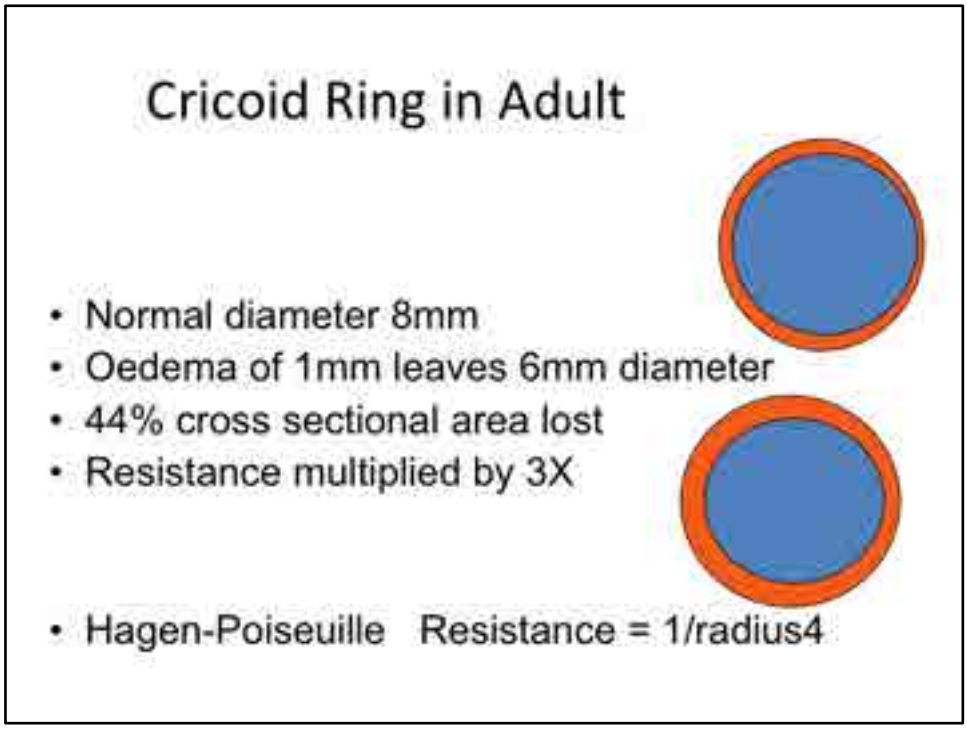
Lateral X-ray of head and neck with major structures highlighted



These are the major differences of the paediatric anatomy



These are the laryngeal & tracheal cartilages, seen from behind
Note that the cricoid ring is the narrowest part and it forms a complete ring.
The tracheal rings are not rings at all!



Now a little bit of swelling within the cricoid ring does not have that much impact in a in an adult.

And some mathematics suggests that 1 mm of oedema in an adult multiples airway resistance by 3

Cricoid Ring in Infant

- Normal diameter 4mm
- Oedema of 1mm leaves 2mm diameter
- 75% cross sectional area lost
- Resistance increases by 16X !!!

Compare this to a neonate where 1 mm of swelling multiplies airways resistance by 16

Message

- Always have a leak around an un-cuffed tube
- Monitor the pressure in cuff of cuffed tubes

The take home message is to always have a leak around an un-cuffed tube so we are not causing reactive oedema afterwards.
Always monitor the pressure in cuffed tubes in babies and infants.

Yes, there are cuffed tubes for neonates, and they are most useful in laparoscopic surgery when the abdominal pressure is increased.
In the past it was too difficult to get the walls of these small tubes thin enough with the addition of a cuff.
It was also difficult to get the cuff far enough to the end of the tube without risking it blocking the tip.

These problems have been largely solved.

Compliant airways: Dynamic airway closure

- Inspiratory stridor
  extrathoracic obstruction
  eg. Epiglottis, croup,
  laryngo-, tracheo-, malacea
- Expiratory stridor
  intrathoracic obstruction
  eg Asthma
- During severe or combined obstruction,
  stridor may be present through out the respiratory cycle.
  eg severe croup

Another difference in paediatric airways is that the paediatric airway is much more compliant (soft) than an adult
The cartilage is softer and often under-developed
The extreme of this is seen in laryngo tracheo broncho malacia where all the cartilage is late developing.

<u>Dynamic airway collapse</u>
If there is airway obstruction outside the thoracic cavity there will be inspiratory stridor.
If the obstruction is inside the the thoracic cavity the stridor will be on expiration.
During severe or combined obstruction, stridor may be present through out the respiratory cycle. eg severe croup

Croup

Inspiratory

Extrathoracic obstruction

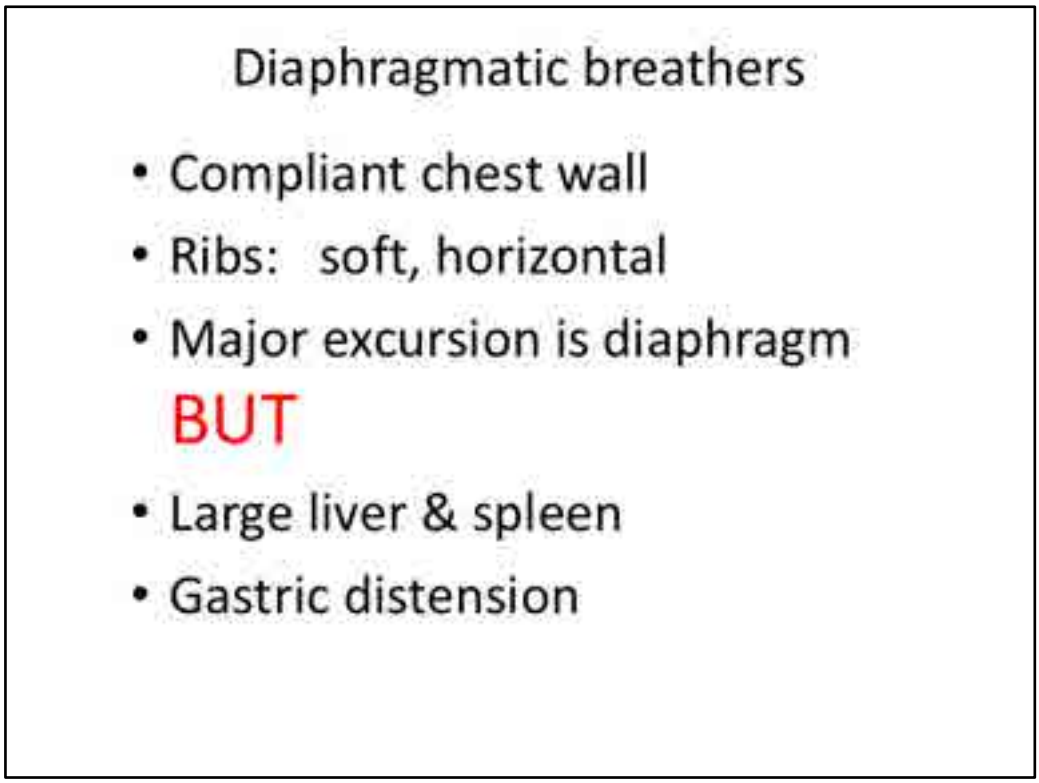
https://www.youtube.com/watch?v=1Enq2BvX9aw

Wheeze

Expiratory stridor

Intrathoracic obstruction

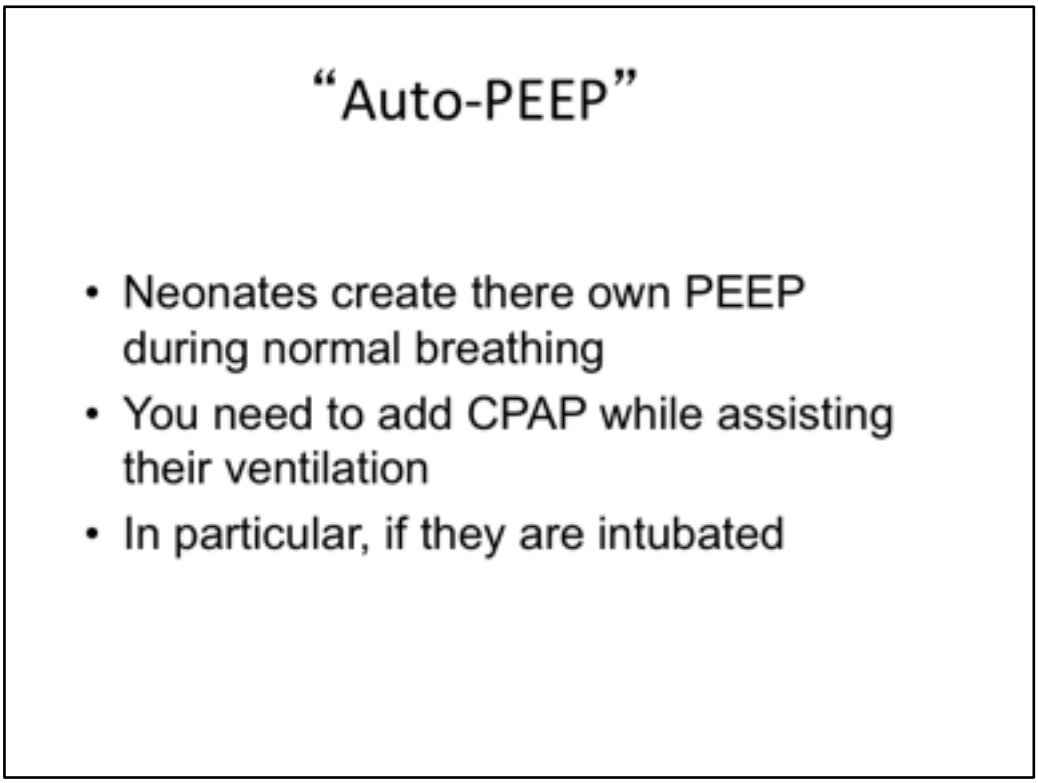
https://www.youtube.com/watch?v=ZS-PJ9jlpFw



The next point is that children in general and neonates in a particular are diaphragmatic breathers.

They do not expand their rib cage like adults because they have soft, horizontal ribs

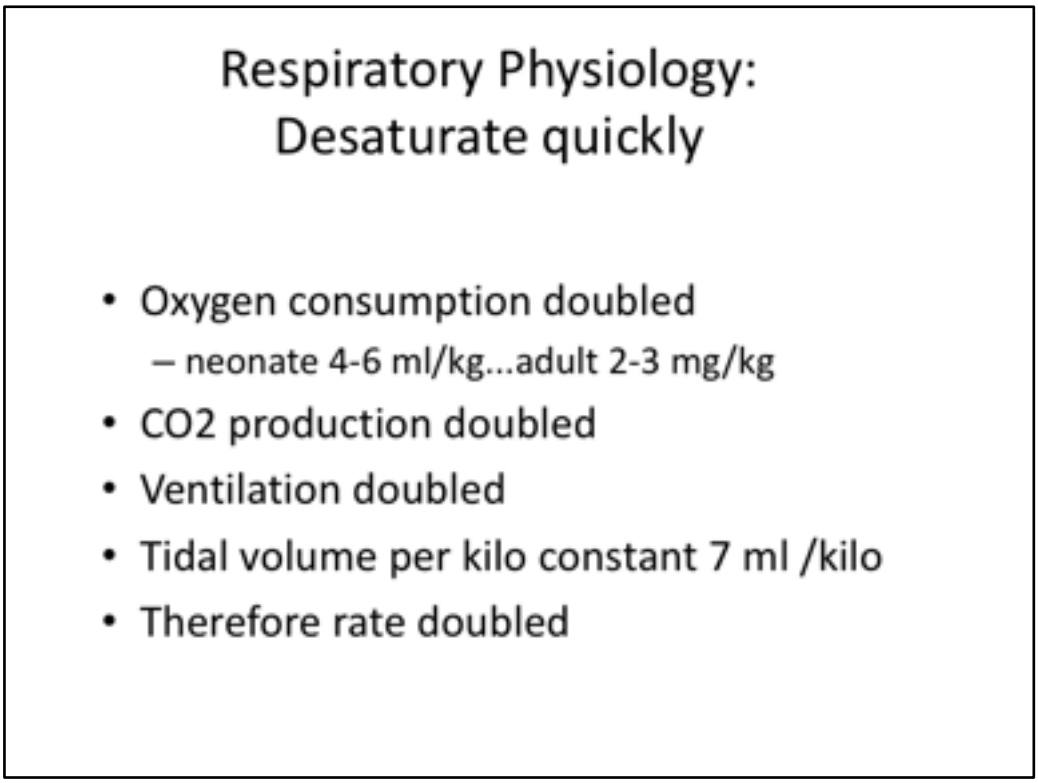
So, to inflate their lungs, they have to pull their diaphragm down.
But this is problematic because they have relatively large abdominal organs, particularly liver and spleen.
Over enthusiastic bagging can inflate the stomach.



In neonates that the pressure from their abdomen can squeeze parts of the lung shut during normal breathing.

To stop this happening their upper airways naturally provide a degree of expiratory resistance.
This produces a form of PEEP to keep the airways open.

This means that when neonates are intubated they will need some CPAP to prevent atelectasis, shunt and desaturation



The next important physiological fact is that neonates have twice the oxygen consumption of adults.

neonate 4-6 ml/kg...adult 2-3 mg/kg

If they burn twice as much oxygen, they produce twice as much carbon dioxide

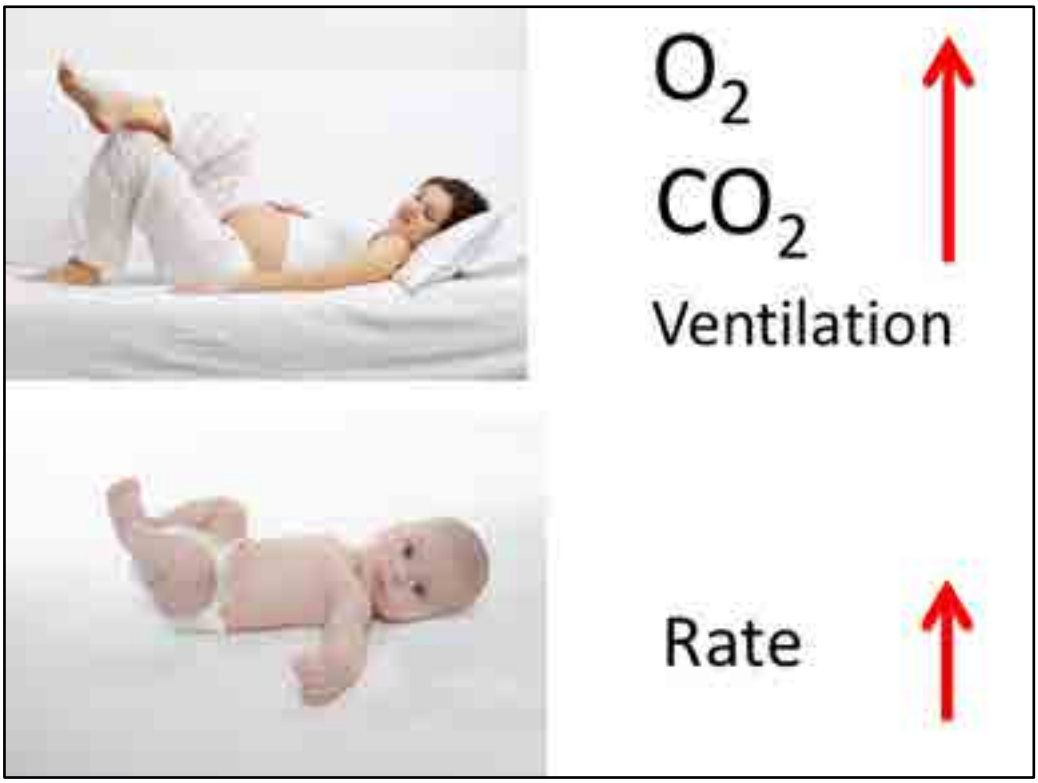
To get rid of this carbon dioxide their minute ventilation must be doubled

Tidal volume per kilo constant 7 ml /kilo
And for the reasons explained they cannot increase their tidal volume.
(Soft horizontal ribs, limited diaphragmatic movement)

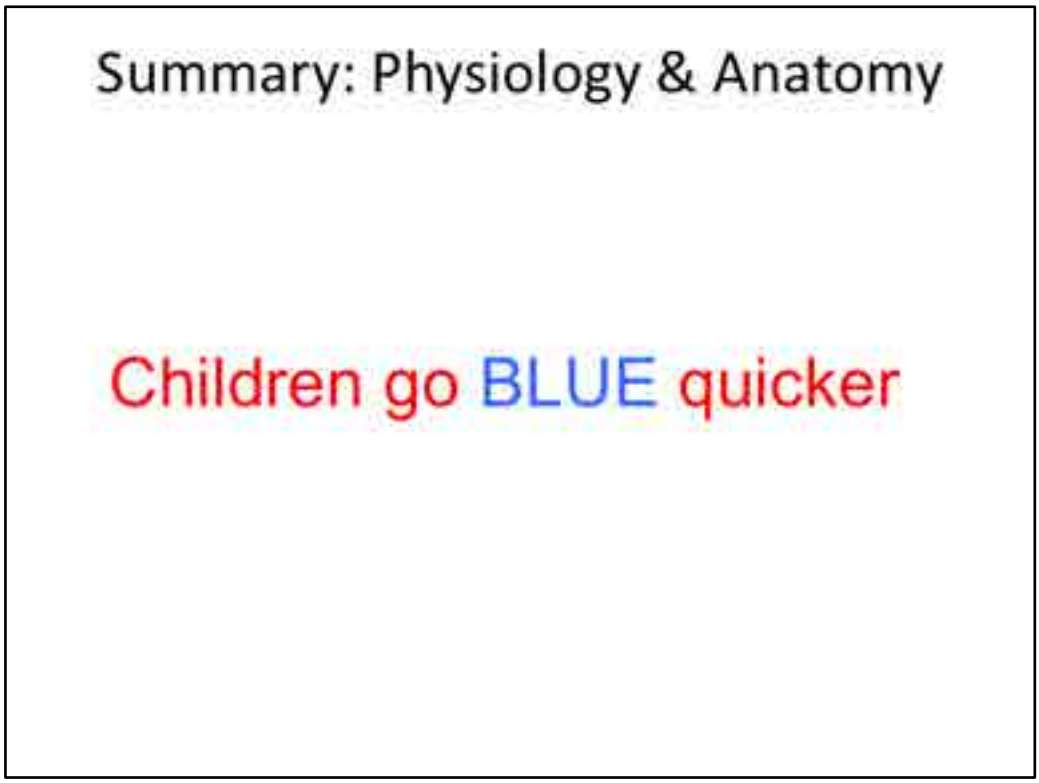
As a result the neonate's respiratory rate is doubled

But there is a problem here too.
They have a lower proportion of type I muscle fibres fibres so they fatigue easier

The bottom line is that they do not have much reserve and go blue quickly.



In this respect they are like a pregnant woman.
While the pregnant woman is able to increase her tidal volume this is not available to the neonate, who is forced to increase rate



Little reserve; Children go BLUE quicker
So it is important to recognise airway obstruction early.

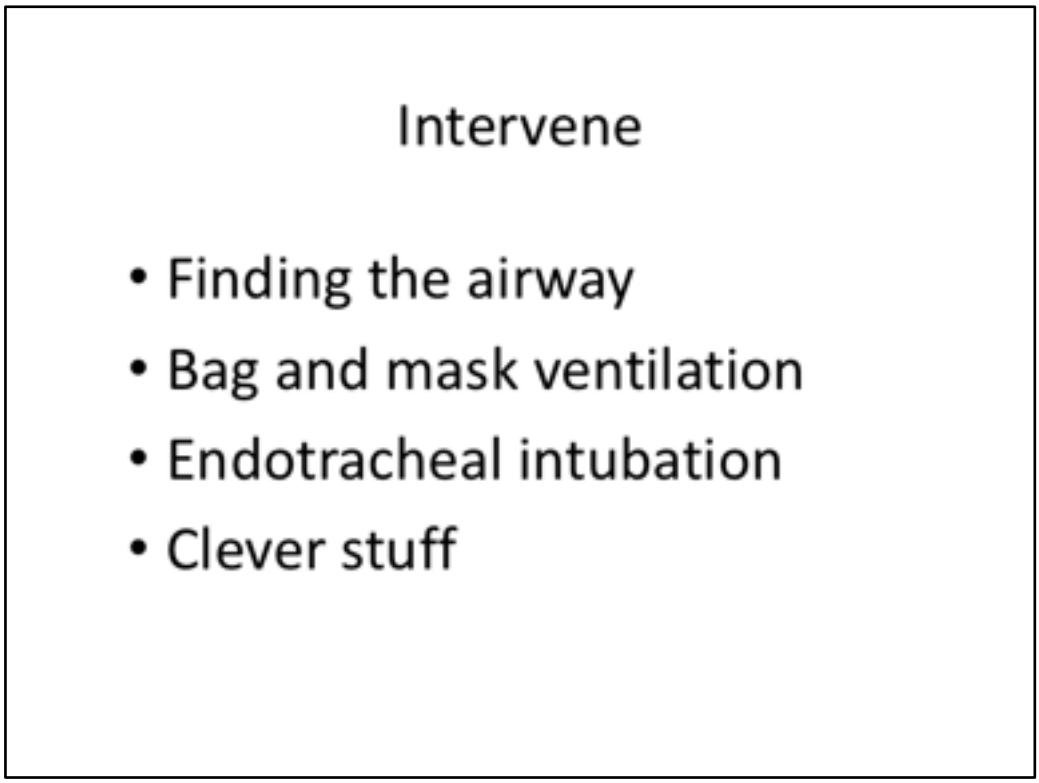
The recognition of airway obstruction is one of the most important skills of paediatric recovery nurses.

In an extreme case like this it is easy to see the chest sucked in as the diaphragm pulls down.

There is a rocking, see-saw, movement of chest and abdomen but no air is moving.

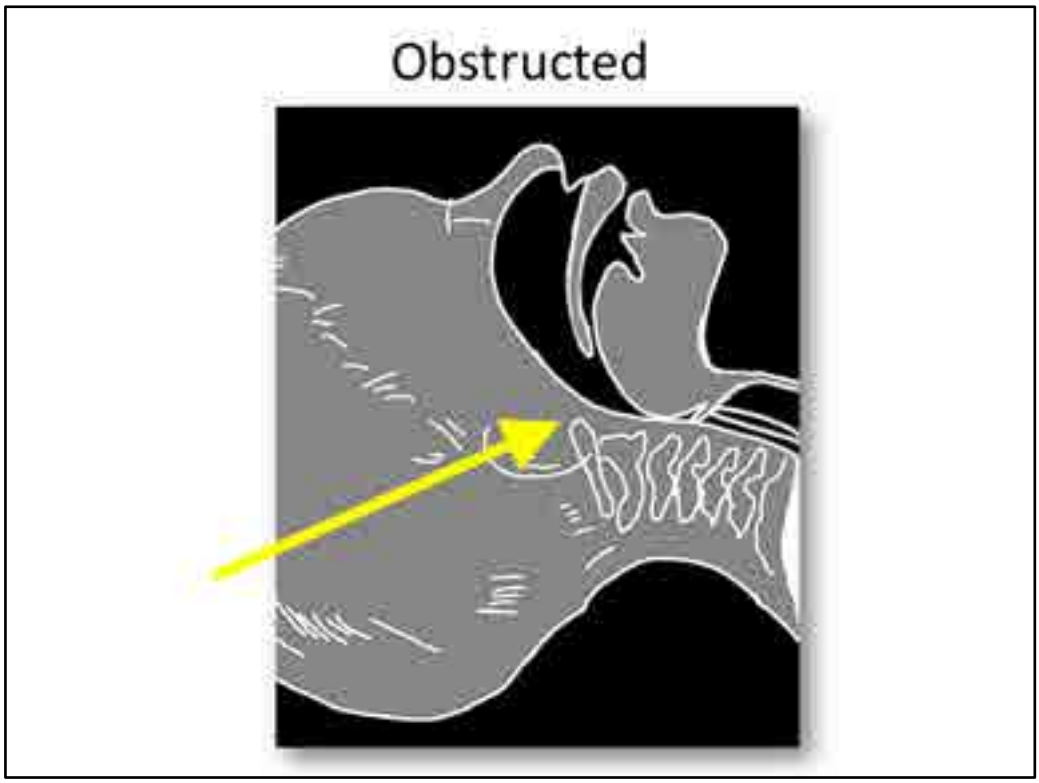
It can be a lot more subtle.
In a child with an oxygen mask, significant obstruction may go unnoticed with desaturation being a late sign.
This is similar to the adult Chronic Obstructive Airways Disease patient staying pink on oxygen but retaining CO_2 until they fall asleep.

It is always necessary to see the chest and abdomen, but this can cause problems if we want to keep our patients warm.



There are 3 levels of intervention.

First helping the child to find their own airway.
Second assisting ventilation with a bag and mask.
Finally endotracheal intubation.



Here the jaw has slipped back
It carries the tongue back as well.
This blocks the airway at the back of the throat

Position the head

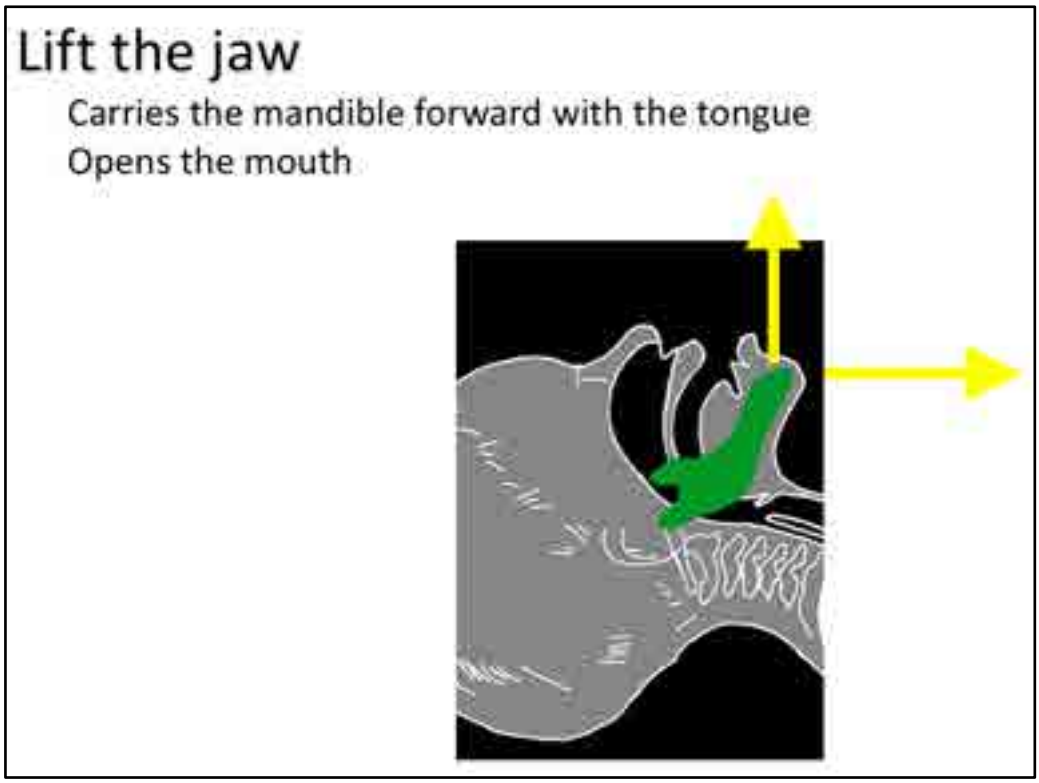
- Straight up or slight extension

Large occiput

- Extends head on neck
- Flexes neck on chest

The first job is to position the head so the child is looking straight up.
Maybe slight extension in the older child.
They do not need a pillow under their head because the back of a child's head is relatively large.
This may be enough to open the airway.

Over extending the neck can bring the cervical spine forward and occlude the airway from behind.



The next step is to lift the jaw upwards and forwards.
This is done by placing a finger behind the back of the jaw and lifting forward.
You may feel the joint “slip” under your fingers.
This is called “subluxation” which is like a gentle dislocation.

This lifts the jaw and also opens the mouth.

1. Airway 1st
2. Then O2 Mask
3. Then CPAP

Finally you can add a mask under your free fingers.
Note that your fingers should not touch the soft tissue under the jaw.

Then you can get someone else to provide CPAP by partially occluding the tail of the ventilating bag.

Here is an example where I am lifting the jaw forward with by third fingers and using my index fingers to help open the mouth.

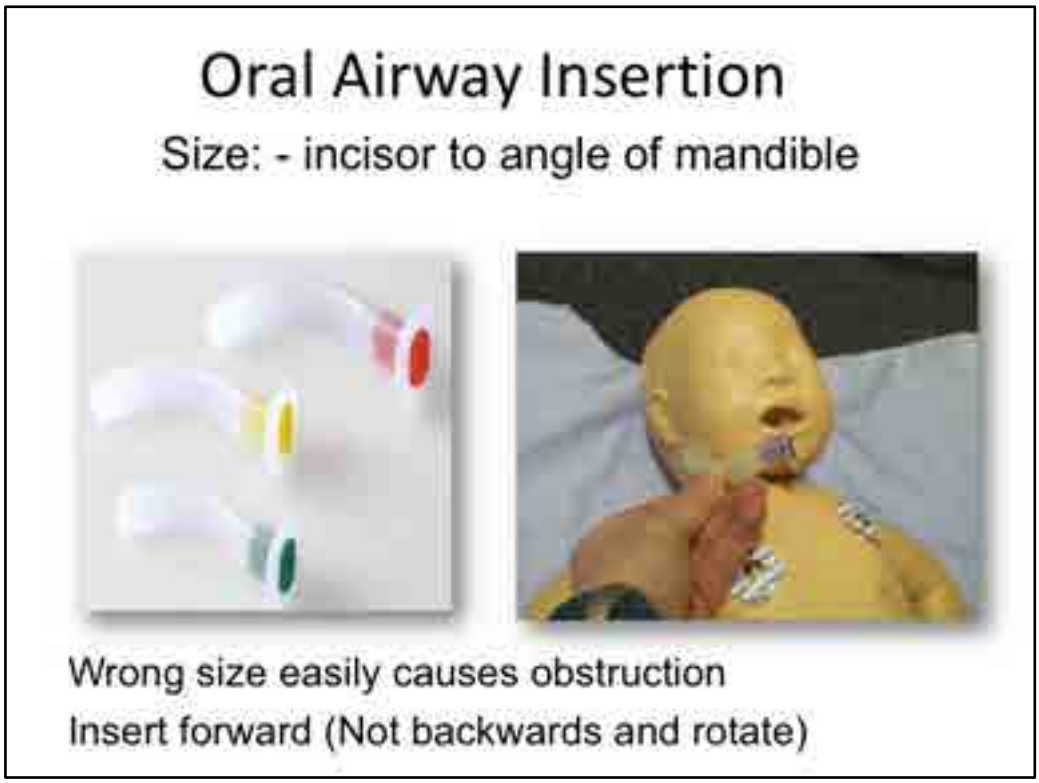
This picture gives you a better idea of where to lift from.

Finally, when you are sure the airway is open, you can add the mask.

Bag & Mask

- Good seal with mask
- Insert Guedel airway if obstructed
- Be gentle - being heavy handed will squash nose and push tongue back
- Don’t press on soft tissues of neck
- NG tube if stomach distended
- Squeeze bag sufficiently to inflate chest

Here are a few other notes on the mask airway.

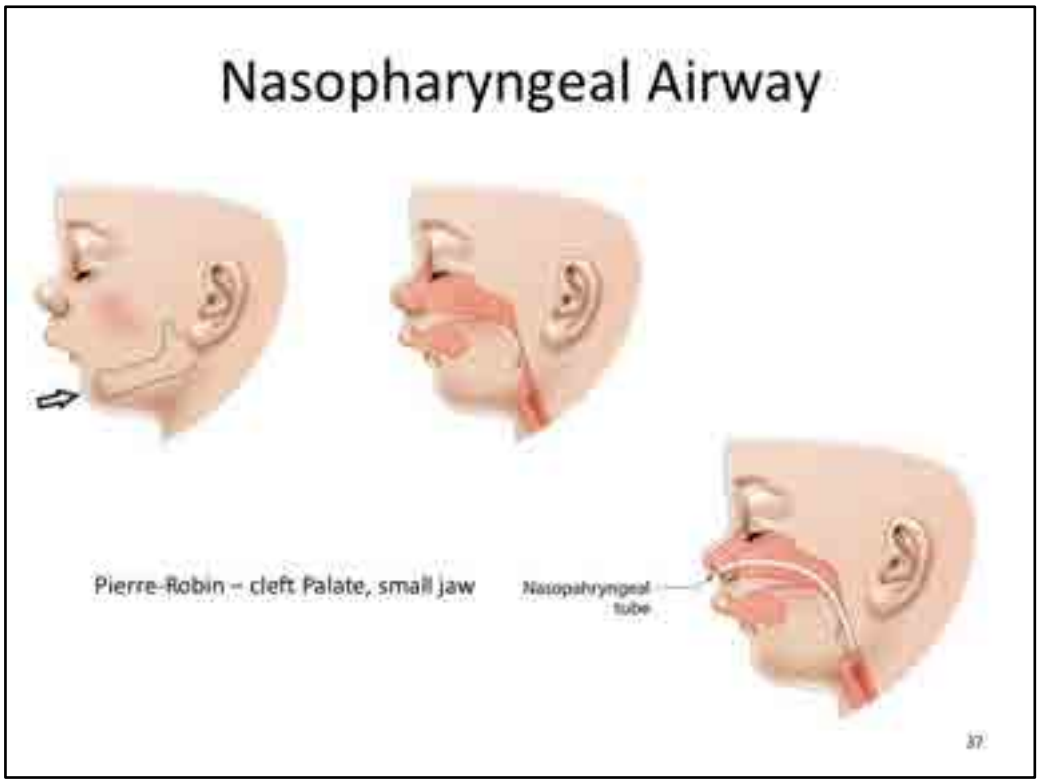


Guedel airways usually come in 2 sizes.
The one that is too big and the one that is too small.

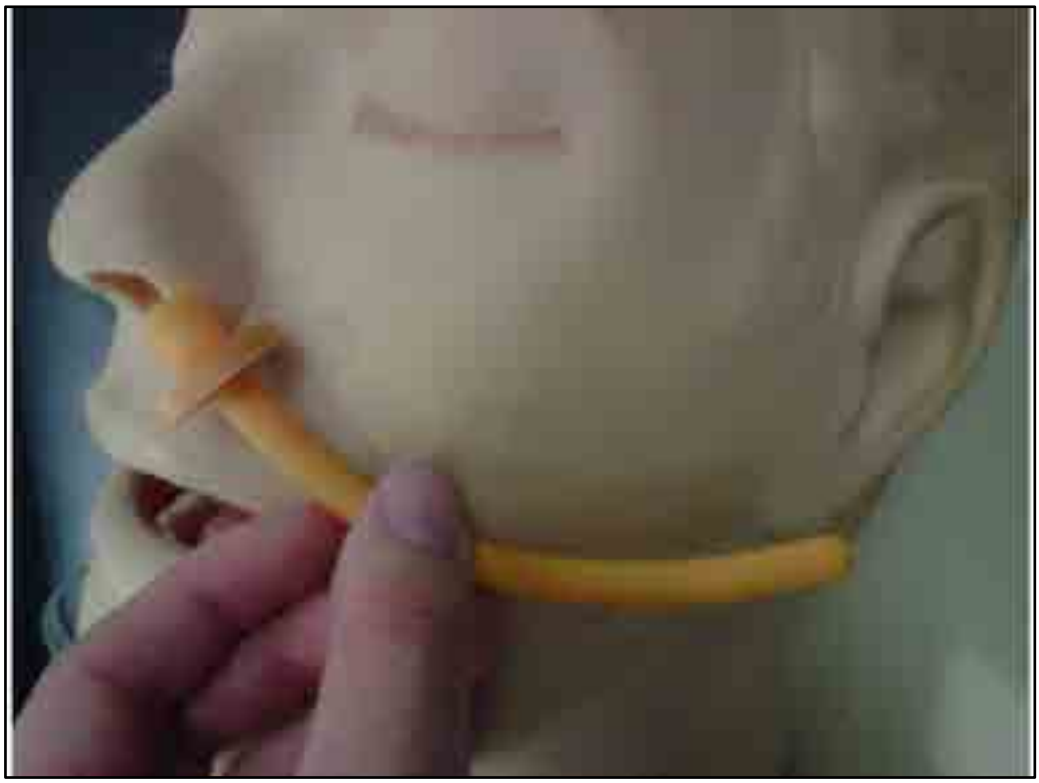
The one that is too big will hit the larynx and may cause laryngospasm
The one that is too small will push the tongue back and make the obstruction worse.

We usually make the mistake of getting one that is too small, so check the size against the side of the child's head.
It should reach from the middle incisors to the angle of the jaw.

There is no right or wrong way to insert the airway as long as you watch what you are doing.
It is preferable just to curve it back over the tongue the right way up from the beginning.



This is an example of the use of a nasopharyngeal airway in a child with Pierre Robin syndrome.



Sizing a nasophryngeal airway is similar to oropharyngeal.

Here is a baby with multiple congenital abnormalities including a small lower jaw.
As part of the sequence of intubation we used a nasopharyngeal tube.
You can find a connector from a normal endotracheal tube and push it into the end.

The next most invasive airway device is the Laryngeal Mask Airway,
This has revolutionised our approach to the difficult airway.

This is a patient we cared for in Timor.

She had this enormous tumour growing from her upper jaw.
Present for 5 years.
As a result she was kept out of site, and always had a scarf around her face.

After spraying her nose with vasoconstrictor I gave a small dose of propofol. As she drifted off to sleep I put in a nasopharyngeal tube

Then we could keep her asleep with gas and take her deep enough to tolerate a flexible LMA

When she woke she was elated crying out and thanking her god.
Most of the theatre team was also in tears.

Of interest, the following days she fell into a profound depression because she had to come to terms with an entirely new way of life.

Intubation

- BAG WITH OXYGEN FIRST
- Neonate
  - Head in neutral position
  - Straight blade down centre of tongue
  - Lift the epiglottis

- Child
  - May need folded towel under head
  - Curved blade down right side of tongue
  - Lift the base of tongue
    (Blade in vallecula fossa)

This brings us to intubation.

There is a slightly different approach to neonates, as documented on this slide.

The most important part is to oxygenate the child first because they go blue so quickly.

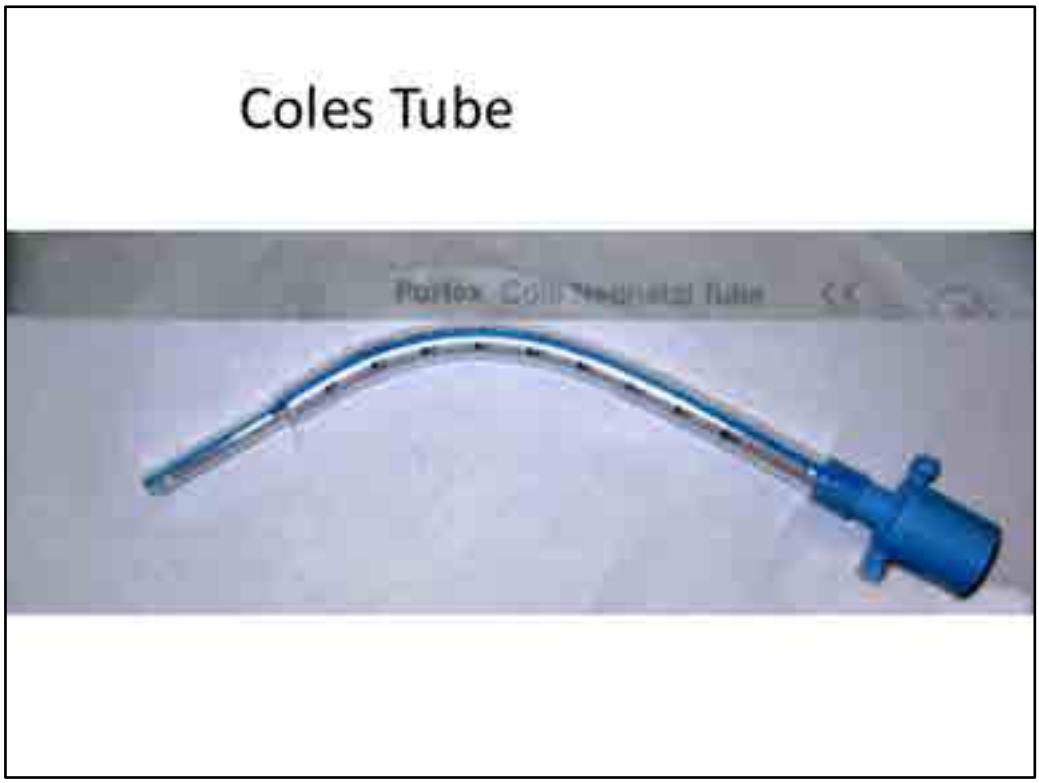
Paediatric Endotracheal Tubes

- Do not usually have cuffs
- Always have a leak
- If it won't go, don't force it
- Lubrication not required (unless cuffed)

- Size = 4 + age/4 (Internal Diameter)
- Length = Age/2 + 12 cm

These are some characteristics of paediatric tubes

Here is an assortment of endotracheal tubes.
Including an old red rubber tube from my history



The Cole's tube should also be a part of history.

It was originally designed to minimise the resistance of the tube by making its upper part wider.
The problem came when it was pushed in too far causing laryngeal damage.

They were popular for a while with neonatologists.

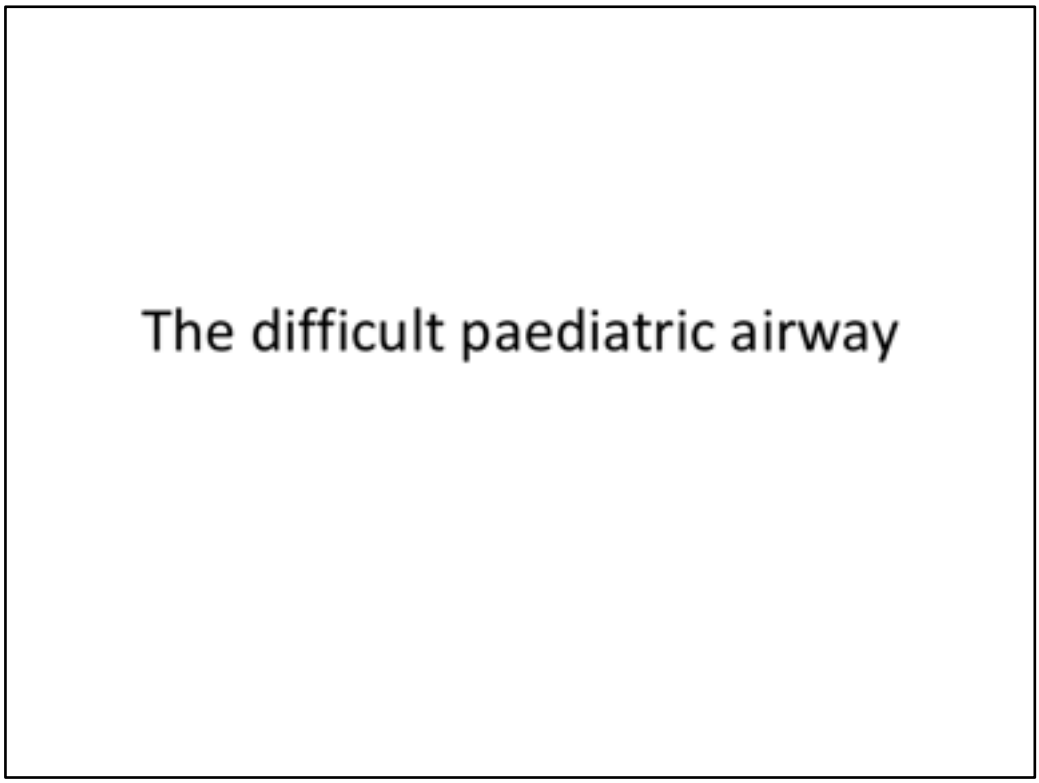
Confirming ET intubation

1. See it go through the cords
2. Chest movement – clavicals
3. Listen, armpits and stomach
4. Fogging – unfogging
5. Oximetry
6. End tidal CO2

It is very easy to intubate the oesophagus of a small child or baby

The first 5 of these methods of confirming tube placement have all been described in the coroners court.
They can all be positive in the case of oesophageal intubation.

But only one is certain method of confirming tube placement is Carbon dioxide monitoring



Next we will talk about the difficult airways in children.

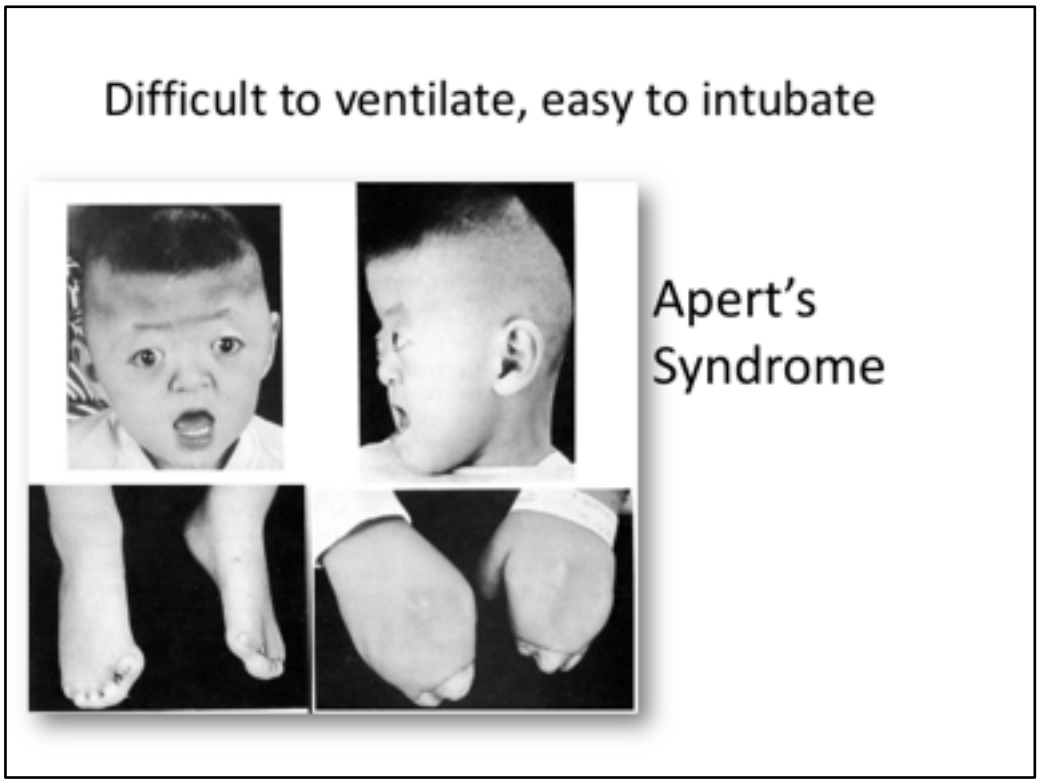
Congenital
- Laryngomalacia
- Tracheo-oesophageal Fistula
- Hypoplastic mandible

Acquired
- Infection
- Burns
- Blunt Trauma

Why do we need a different approach to the airway and intubation in children?

- Not cooperative & frighten easily
- NEED TO BE ASLEEP before we intubate then

  - Difficult to ventilate, easy to intubate
  - Easy to ventilate, difficult to intubate
  - Difficult to ventilate, difficult to intubate



Starting with patients who are difficult to ventilate but relatively easy to intubate

A typical example is Apert's Syndrome.
The middle third of their face does not grow normally so they develop a 'dished' in face.

They commonly have airway obstruction because they cannot breath through their nose.
They can be difficult with an inhalational induction and may need a Guedel airway as soon as they can tolerate it.
A nasopharyngeal airway is difficult to pass through their small nasal cavity.

The good news is that they are relatively easy to intubate.
The middle of the face and maxilla are back out of the way.
Even though the mandible may be a little smaller than usual, one can usually get a good view of the vocal cords.

Easy to ventilate, difficult to intubate

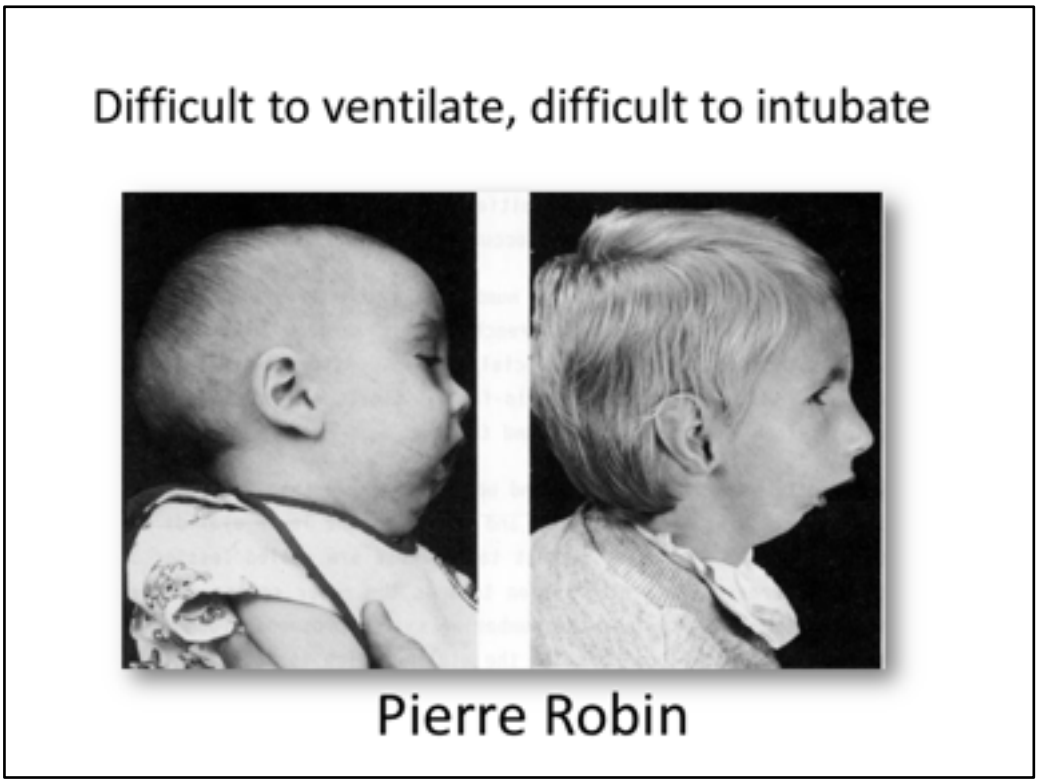
- Hemifacial Microsomia
- Goldenhar syndrome

The next group of patients are those that have a good airway but are very difficult to intubate

Typical of this group are patients with significant facial asymmetry such a hemifacial microsomia, atrophy, or hypertrophy

They do well with an inhalational induction and maintain a clear airway.
The problem comes when you try to intubate these patients.
They are a difficult intubation because of limited mouth opening and midline shift.

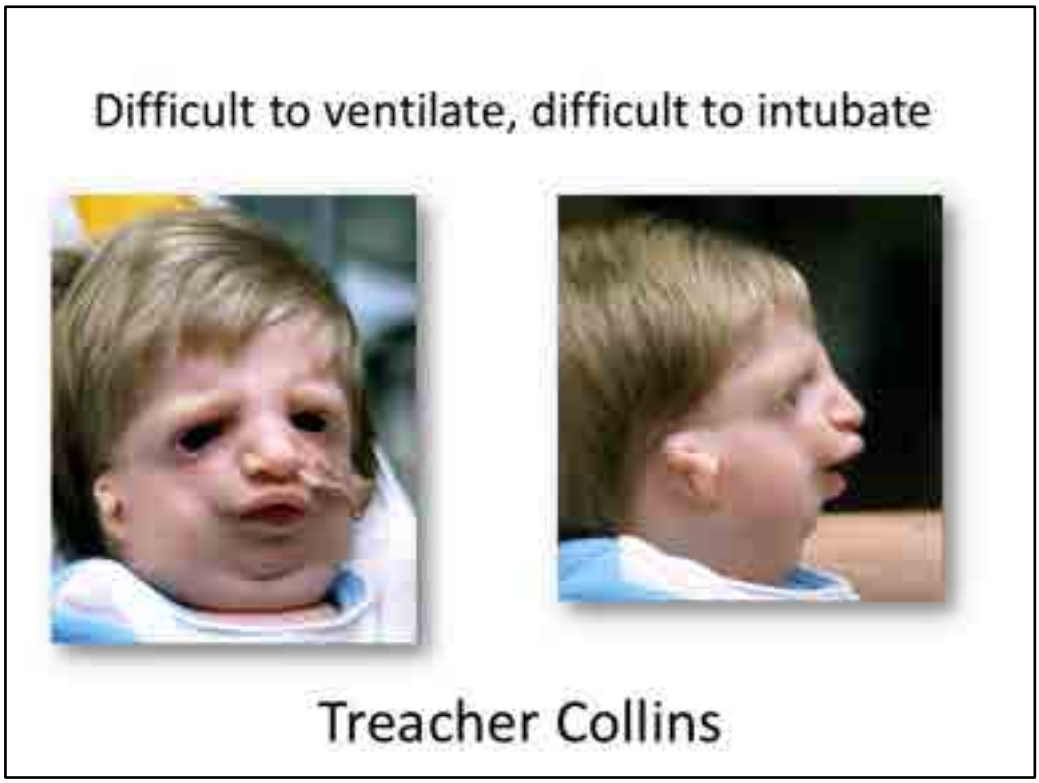
It is also important to note that these children become more difficult to intubate as they get older.
So a previous easy intubation is no guarantee.



Finally the most difficult of all, those who are difficult to ventilate when they go off to sleep AND are difficult to intubate.

Severe Pierre Robin syndrome is an example
Pierre Robin is a combination of cleft palate and small lower jaw.

Traditionally these children are said to become easier to intubate as they grow older. Men with the disorder tend to grow a beard to mask their small lower jaw and they can present as an unanticipated intubation problem



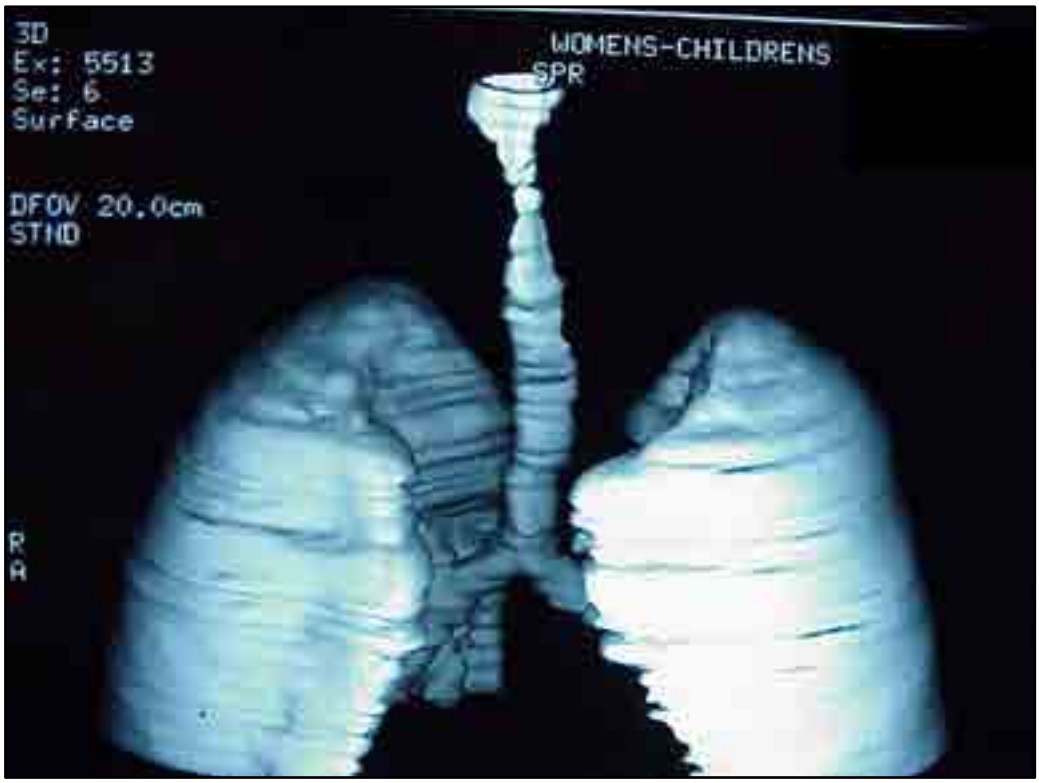
The next group are children who are both difficult to intubate and ventilate have Treacher Collins syndrome
They are characterised by serious ear abnormalities and a small lower jaw

Amongst the acquired causes of airway difficulties, burns are common in third world countries such as East Timor.
As the scar tissue contracts the lower jaw is pulled backwards.
This pushes the tongue against the back of the throat, causing obstruction

In this boy we secured intravenous access
Sprayed his throat with local anaesthetic,
Gave him an inhalational induction.
Slipped in a flexible LMA as soon as he was asleep.
We had a surgeon scrubbed and ready to cut through the scar tissue if we could not get the LMA in.
The lower right picture shows how the jaw came forward with the burn release.

Mucopolysaccharidosis

There is occasion when the lower airway is obstructed by congenital diseases such as mucopolysaccharidosis.

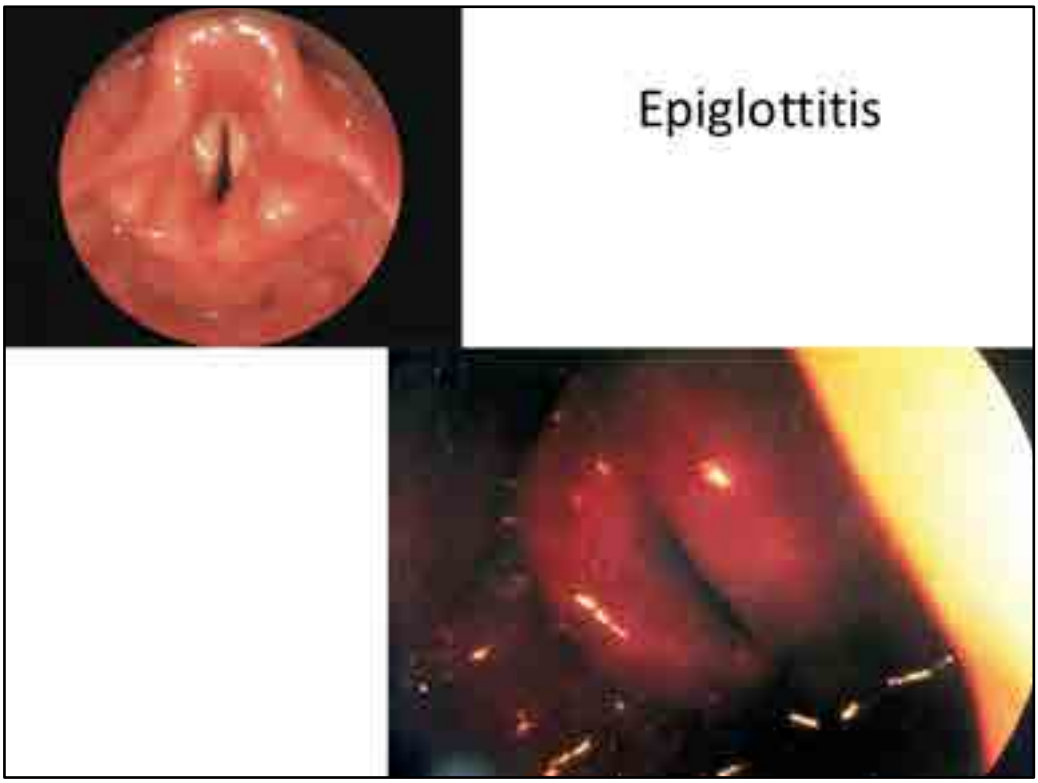


Here is a CT scan of this child's chest

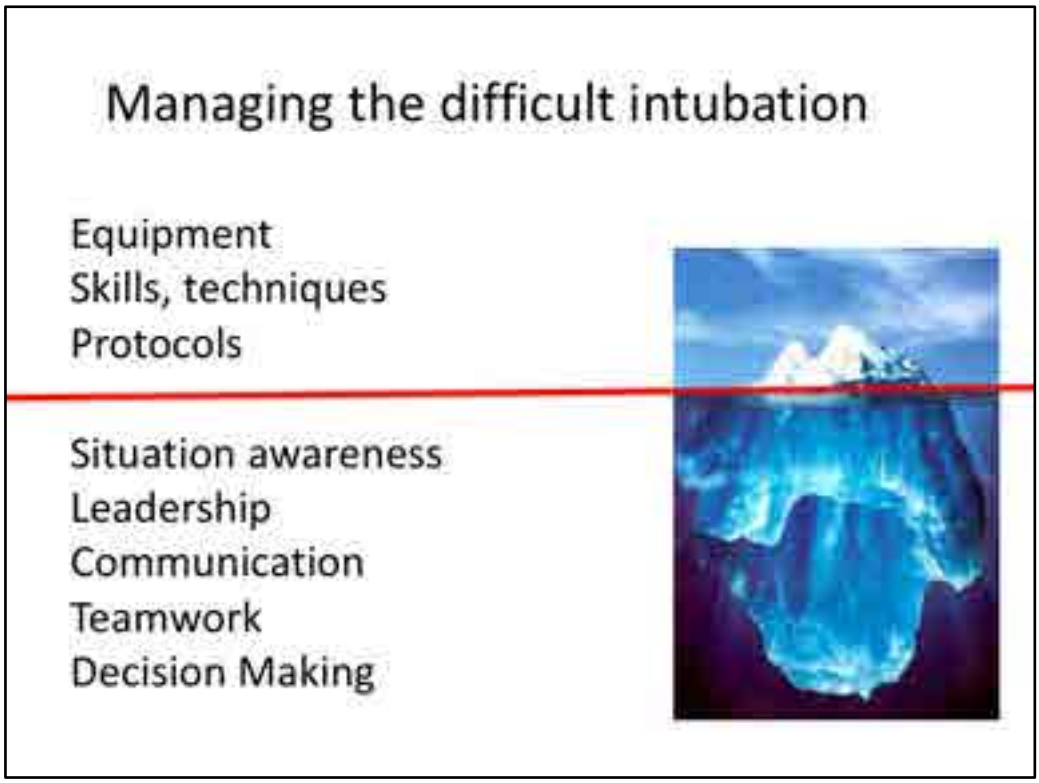
Here is a magnified view showing the compression of the upper airway

The mucopolysaccahride get deposited around the airway causing severe narrowing. An endotracheal tube may not fit.
Or it may cause post operative swelling with the need for long term post-operative intubation.

In this case he was managed with a ketamine infusion and kept is nasal CPAP mask on.



This disease has almost disappeared with routine immunisation against *Haemophilus influenzae* type b (Hib) vaccination
The immunisation was brought in mainly to combat Hib meningitis.

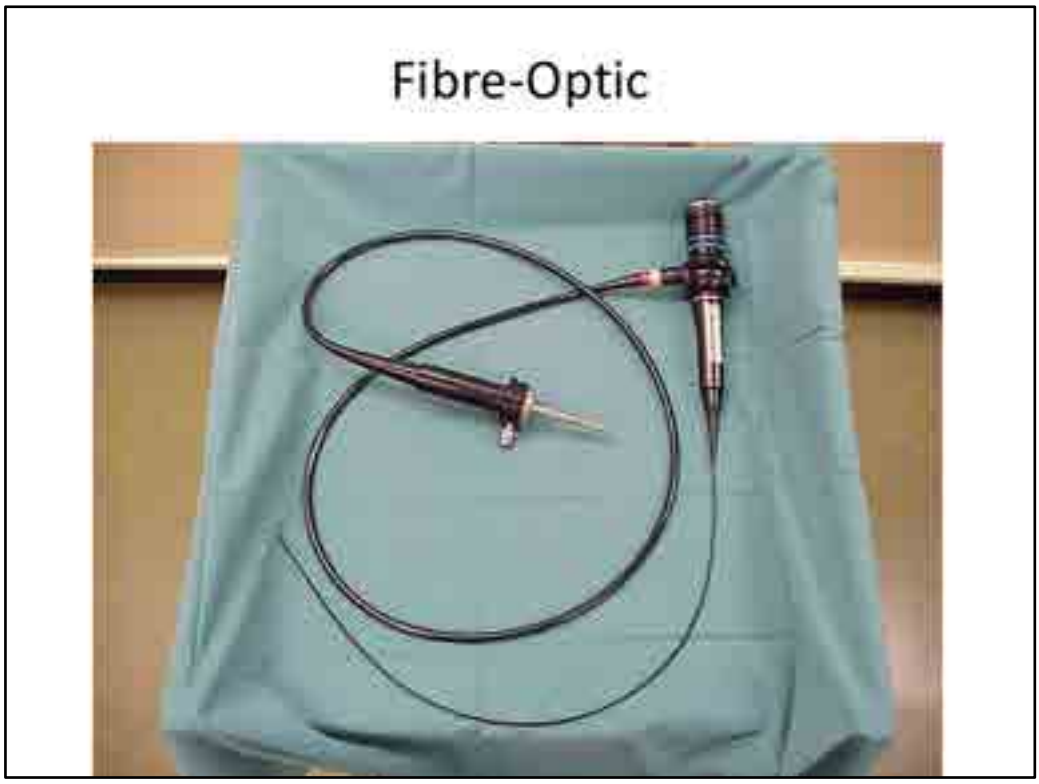


When discussing difficult intubation, the focus is often on the 'above the line' conscious, scientific aspects of equipment, protocols, techniques etcetera.

There is growing interest in the less conscious "human factors"
Problems in this area led to the death of Elaine Bromiley.

Blunder that killed my wife | Mail Online - Daily Mail
http://www.dailymail.co.uk/health/article-421989/Blunder-killed-wife.html

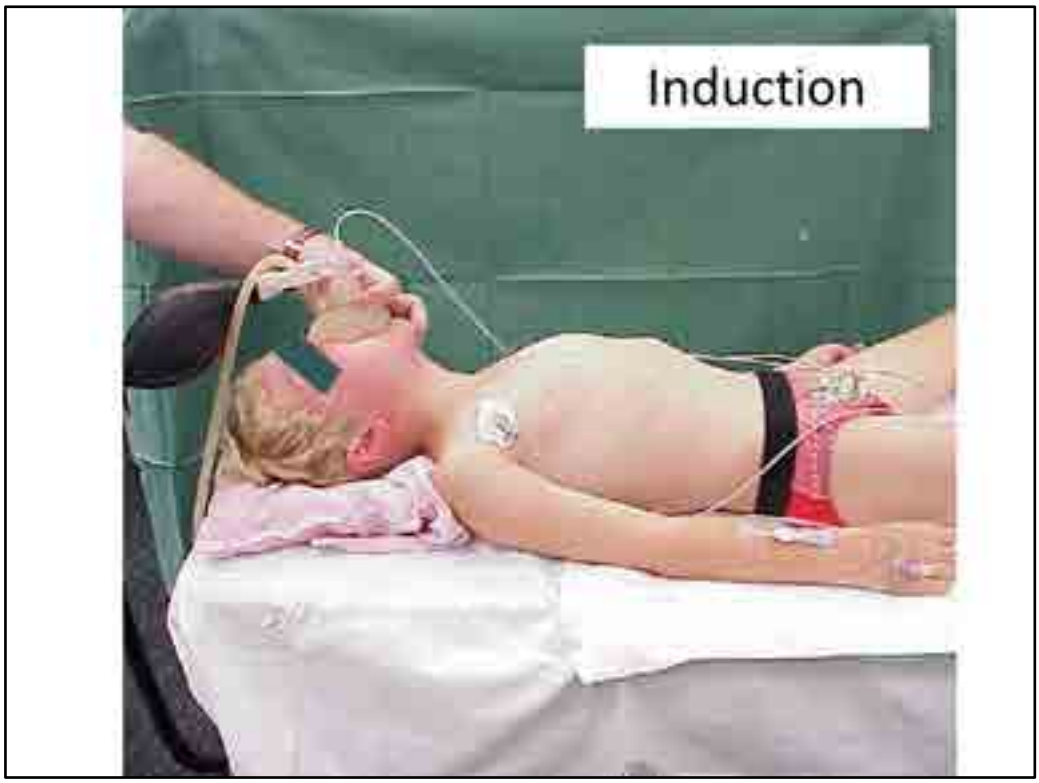
Here is a mnemonic for checking all of the background factors that will make or break a difficult intubation.



The fibre optic scope is a common piece of equipment.

Fibre-optic intubation through LMA

This is the intubation challenge.
Mandibular hypoplasia as a part of Pierre Robin.
The surgeons would like an oral RAE tube while they repair the cleft palate.



This boy has had an inhalational induction with his parents present.
No pharmacological premedication.
Some people give atropine to decrease airway secretions.
I think that this just makes the child uncomfortable and the mouth sticky.

An IV was placed before induction (EMLA was placed on both hands 1 hour before)
Basic monitoring; NIBP, pulse oximetry, ECG, O2, CO2 & anesthesia gases via a sampling line coming off the mask elbow.
A difficult intubation is not necessarily a difficult airway.
This boy's airway was relatively easy to maintain even at deeper planes of anaesthesia.

When anaesthesia was deep enough an LMA was easily inserted.
Insertion is assisted by jaw lift (if possible).
Sometimes it is easier to insert if a laryngoscope is used.
With the airway secured both patient and anaesthetist can breath easily!

Local anaesthesia to the airway decreases the likelihood of coughing during the procedure.
This can be given via a nebuliser or injected trough the suction channel of the scope.
Some anaesthetists tip a few cc's of local anaesthetic into the oro-pharynx and push the larynx back, "dipping" the cord in the pool of local anaesthetic.

In this case it is given via cricoid puncture.
The bubbles in the syringe demonstrate correct placement.

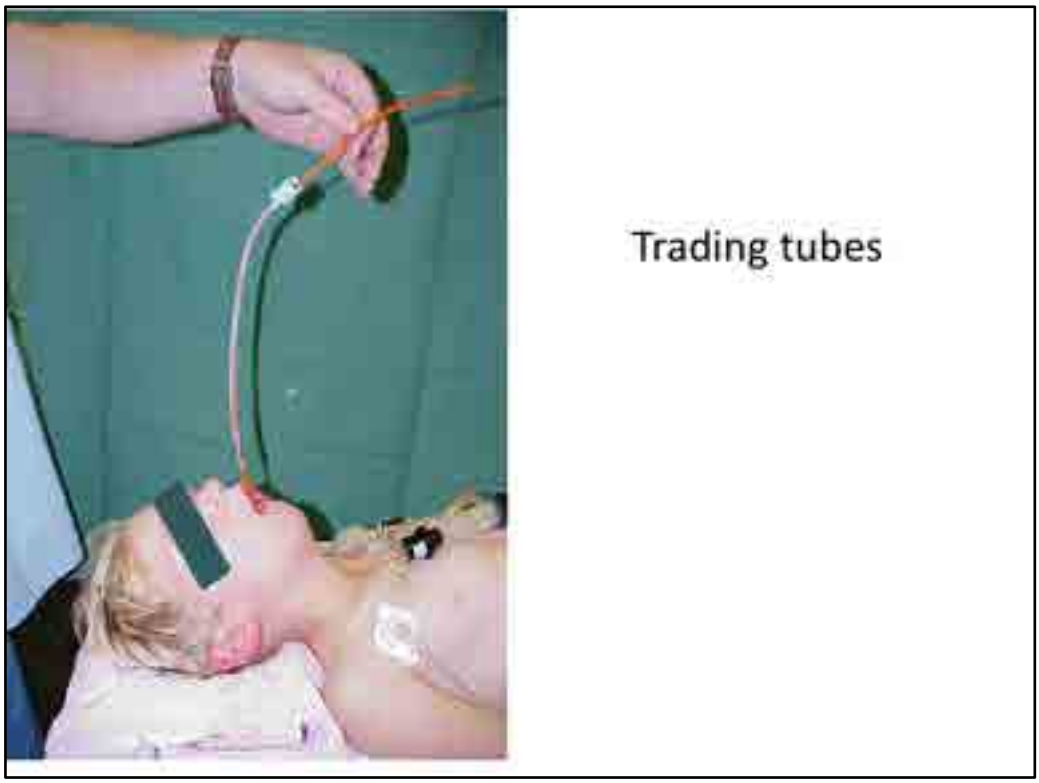
Local can also be injected trough the suction channel of the scope.

And now for the scope.
2 tubes are placed on the scope.
The proximal tube is reversed and used for pushing the distal tube off the scope.
Sometimes the tube seems to "catch" on the cords.
A gentle twisting motion sometimes helps it pass through
The elbow on the circuit has been changed for a suctioning elbow so the scope can be passed through it.
The Gas sampling port is on the black connector by the T-piece.

Are the tubes in place.
The upper tube is held in place while the LMA is removed.
This stops the lower tube from coming out with the LMA.

Some anaesthetists wedge a smaller tube into the top end of the lower tube to hold it in place while the LMA is removed. (Thanks for the tip Jerry)

Now the tube is in place.
We used a smaller straight ET tube that would fit easily through the LMA.
Now it is time to trade up to a larger RAE tube.



This is easily accomplished over a plastic guide.


Securing the airway: 3

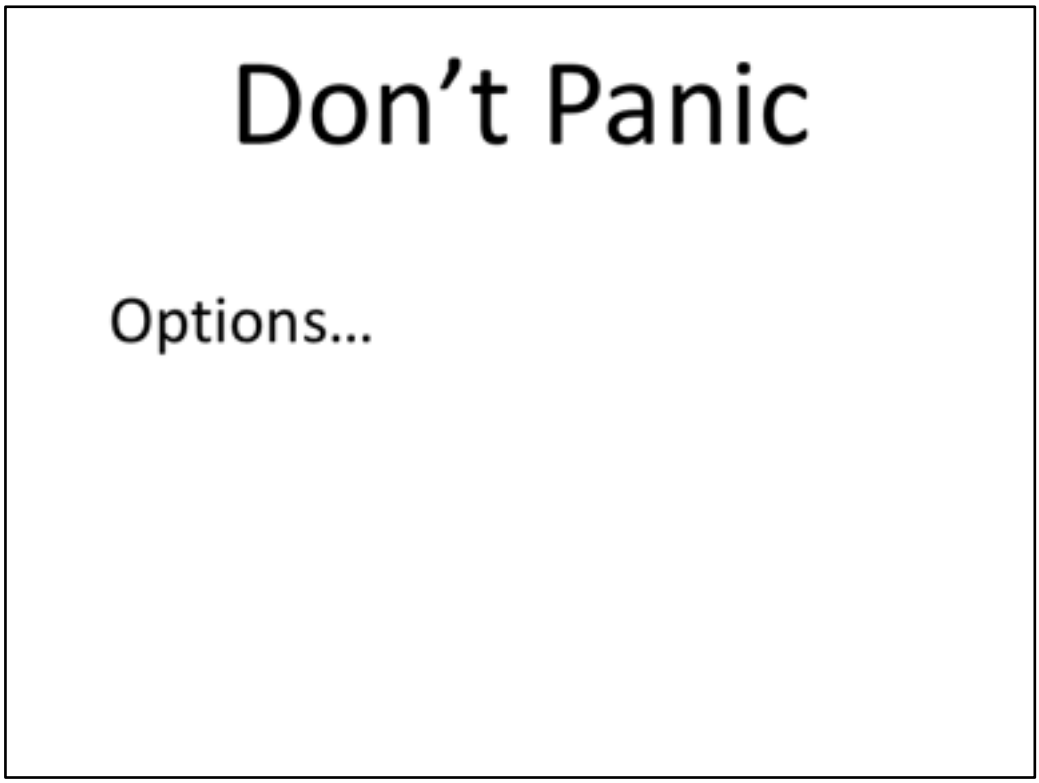
Success!
Please email you comments, additions, criticisms on this technique.
david.sainsbury@adelaide.edu.au

Here is another child that presents with intubation problems, for dental surgery.

Sitting in dad’s lap she chooses a flavour for her mask.

Giving her back some control, she flavours the inside of her mask.

Now she blows up the balloon.
And drifts off to sleep.

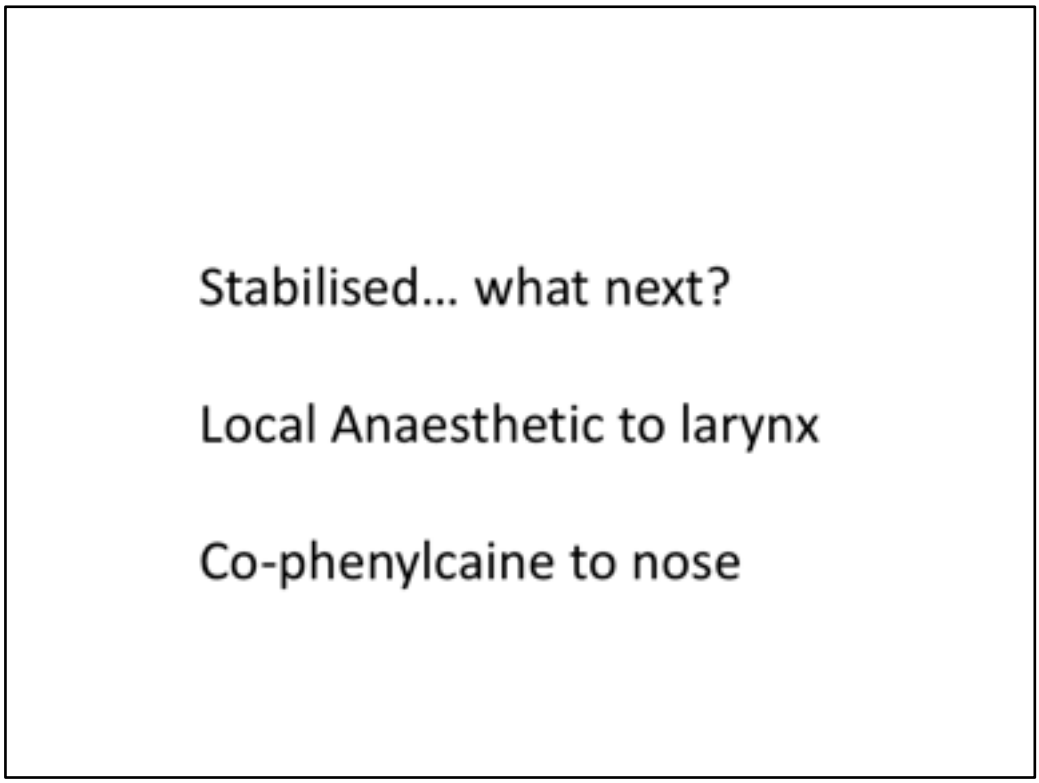


Once asleep she promptly obstructed as her small lower jaw pushed her tongue against the back of her throat.

What are the options here?
Let her wake up and regain her airway.
Nasopharyngeal airway to lift her tongue forward.
Oropharyngeal airway (Guedel)
Laryngeal mask airway. May be difficult to get fit in her small mouth
Grab her tongue with Magill forceps and lift it forward, out of her mouth, and off the posterior pharyngeal wall

This worked well except we could not get the fresh gas hose off the T-piece.
It was welded on!
So we had to smash the T-piece to get the hose free.
You can see the plastic tip still in the end of the hose.

The tube is just pointed down the back of her throat, insufflating anaesthetic agent to keep her asleep



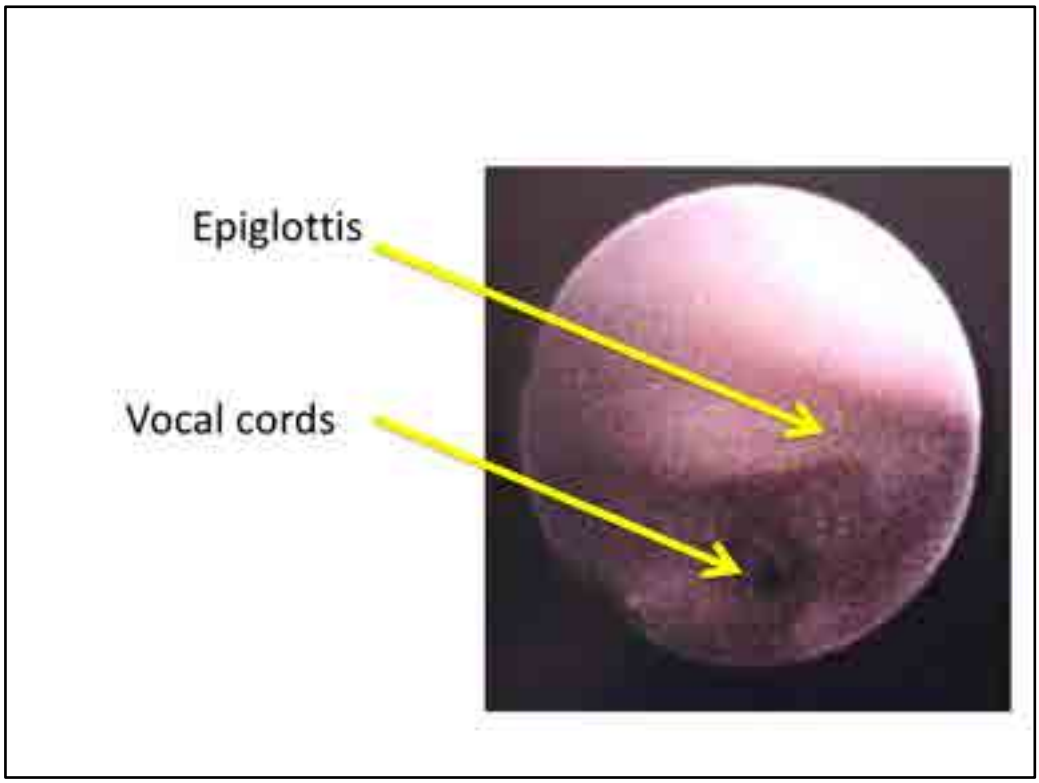
Now she had a stable airway and was asleep.
We could put co-phenylcaine in her nose to shrink the nasal mucosa and decrease the likelihood of bleeding.
And spray local anaesthetic into her oropharynx to anaesthetise her cords and decrease the likelihood of laryngospasm.

Her vocal cords could not be seen with a standard laryngoscope blade

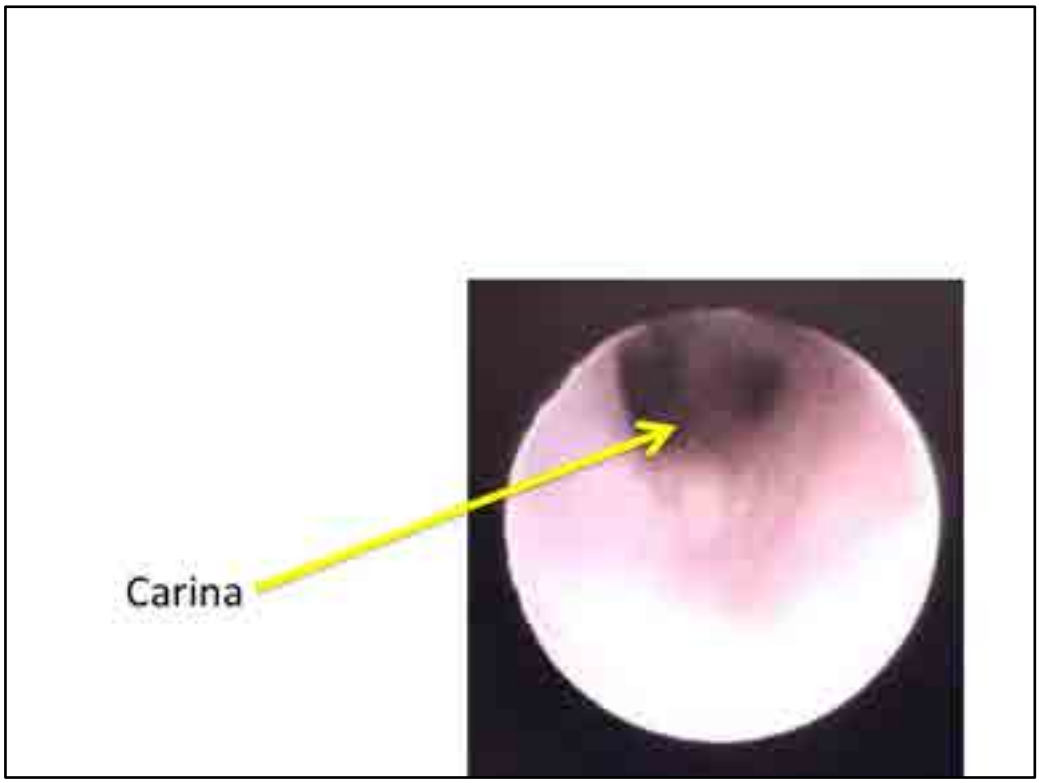
Next, a nasopharyngeal tube was inserted to continue insufflating anaesthetic agent and oxygen.
It still helped to hold her tongue out of the way

An endotracheal tube was mounted on the bronchoscope

The bronchoscope was introduced down the other nostril



Here is the epiglottis and cords in the distance



Now the scope is through the cords and down the trachea.

When you can see the Carina with left and right main bronchi you know you are in position.

Tube in place

Taped in position

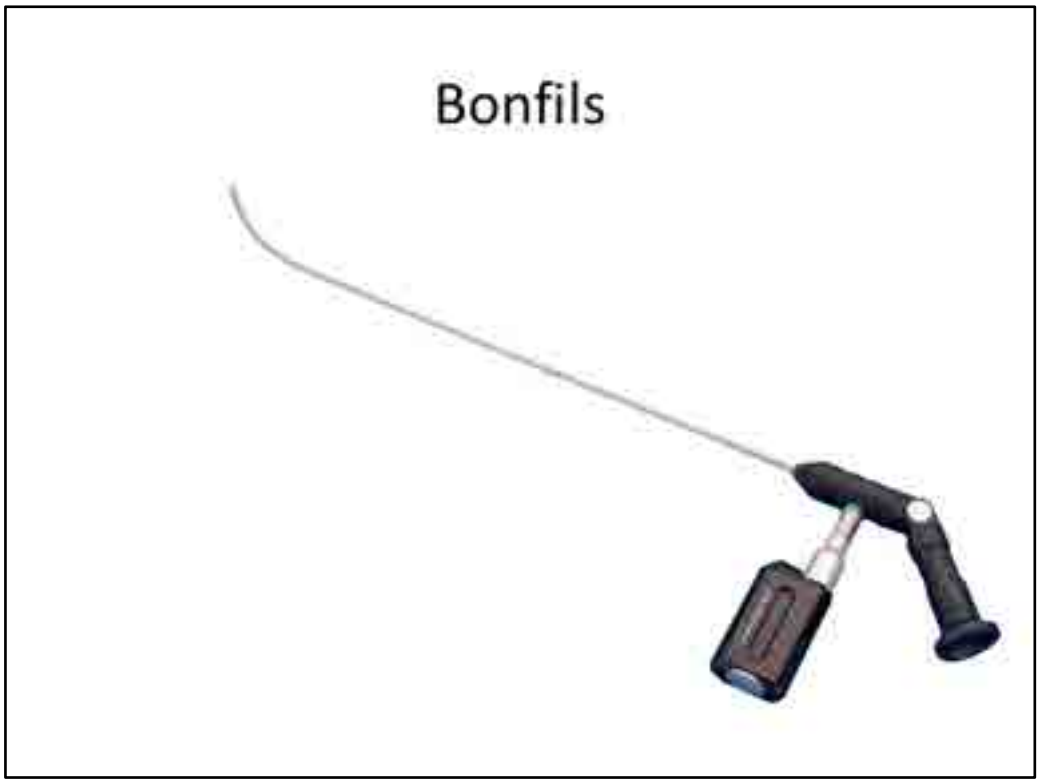
The dentist put in a tongue stitch to keep holding the tongue forward so he had a good view of the upper teeth

This is our bronchoscope trolley

This is the Storz C Mac system.
A camera is mounted in the laryngoscope and shows an image on a dedicated screen.
It is easy to set up and one can usually get a reasonable view of the vocal cords.

Unfortunately everyone in theatre can see the vocal cords and provide advice on how to pass the tube.

The electronics are in the black block that fits into the handle.
The handles and blades are fixed together and have a camera inside.
They are relatively easily sterilised.



Storz also make the Bofils fibreoptic introducer.
A tube is mounted over the introducer.
You can look into the eye piece or use an adaptor made for the C-Mac video system

You can also use a straight bronchoscope with this adaptor.

This is our difficult intubation trolley.
The further down the drawers you go, the deeper you are in….

Green, top drawer laryngoscopes, handles and blades

Orange, 2nd and 3rd drawers dedicated to laryngeal mask airways of all sorts.

By the time we get to the 4th drawer we are in to cricothyroidotomies and jet ventilation.

This is the Manujet for jet ventilation

And the ENK for oxygenation via a cricothyrotomy.


Emk Oxygen Flow Modulator Set
REF C-EFMS-100
REF G12399
6.0Fr / 7.5cm
COOK

The last drawers contain rarely used gadgets and a spare flexible bronchoscope