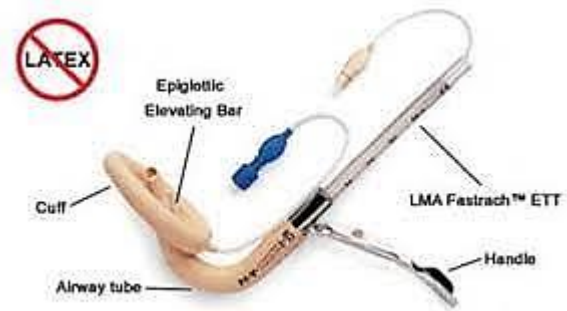
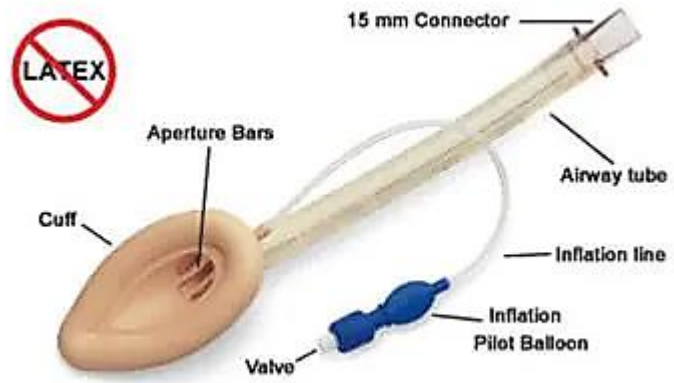
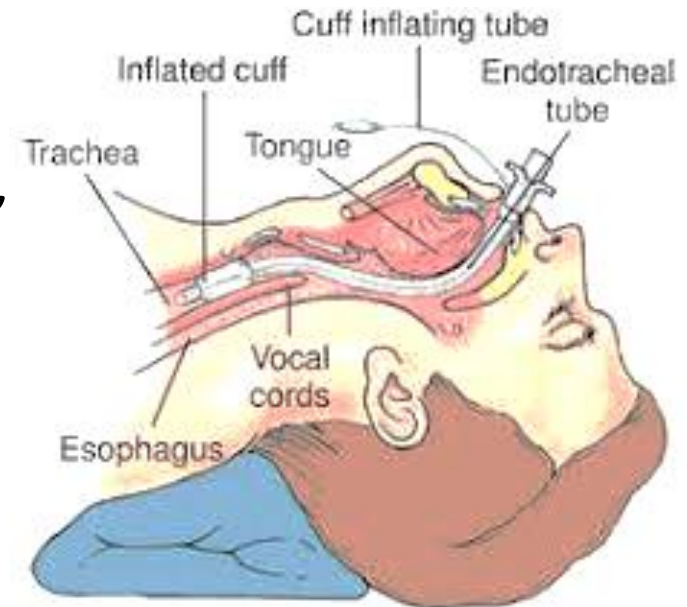


# Tracheal and tracheostomy tubes and airways



# ***Tracheal tubes (Endo-tracheal tubes)=ETT***

- ***Provide a mean of securing the patient's airways i.e.***
  - 1) Guarantees ventilation of the lungs.***
  - 2) Protects them from being contaminated by secretions, vomitus, blood or pus).***



# ***Tracheal tubes*** ***(Endo-tracheal tubes)=ETT***

## ***Characteristics:***

- 1. Disposable.***
- 2. Plastic made of PVC (polyvinyl chloride).***
- 3. Could be clear, ivory or siliconized.***
- 4. Have a radio-opaque line along their lengths.***
- 5. In the past they were made of red rubber which is reusable after cleaning and autoclaving.***

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# ***Tracheal tubes (Endo-tracheal tubes)=ETT***



***Clear***



***Ivory***



***Red rubber***

# *Features of Tracheal tubes*

- 1) The “size” refers to the internal diameter(ID) in mm, narrower tubes increase resistance to gas flow specially in spontaneous ventilation e.g. reducing the size by 4mm increases resistance by 16 times. The usual male size is 8.5-9.0 mm ID while the usual female size is 7.5-8.0 mm ID. There are various formulae to detect size in pediatric tracheal tubes, the commonly used is  $(Age/4+4)$ .**



# *Features of Tracheal tubes*

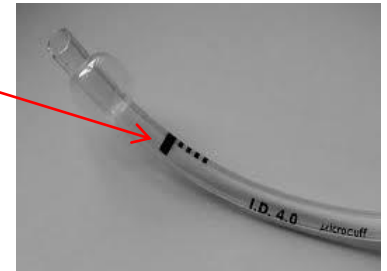
*2) The “Length” (taken from the tip of the tube) is measured in cm. The tube can be cut at suitable length as too long tubes:*

*a) increase dead space.*

*b) Increase the risk of advancement into a main bronchus (usually the right side), therefore a **black intubation depth marker** is located at 3 cm proximal to the cuff, if its single it should be at the level of the vocal cords .*

*while if there are two markers the vocal cord should be in between.*

*However correct position should be confirmed by auscultation.*



# *The bevel*

- 1. Its left-facing  
(improve view of the vocal cords)  
and is oval in most designs.*
- 2. Some designs have a side hole  
(Murphy eye) which enables  
ventilation when the bevel is  
occluded by secretions, blood  
or the wall of the trachea.*

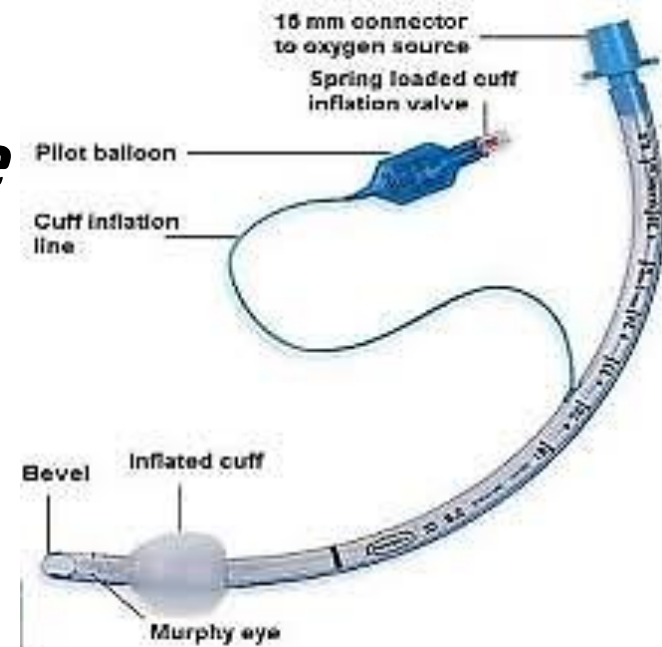


Figure 1- Endotracheal Tube Cuff System



# *The cuff*

- 1. Tracheal (oral or nasal) tubes can be either cuffed or uncuffed.*
- 2. When inflated provide an air tight seal between the cuff and the tracheal wall. it protects the lungs from aspiration and allows efficient ventilation.*
- 3. Two main types are available:*
  - a) The high pressure **low volume**.*
  - b) The low pressure **high volume**.*



# *The cuff*

a) *The high pressure **low volume**: they exert high pressure on the tracheal wall .If left for long periods they may cause necrosis of the mucosa.*



a) *The low pressure **high volume**. They exert low pressure on the tracheal wall as the pressure equilibrates over a wider area . This allows the cuff to remain inflated for longer periods.*

# *The cuff*

*Therefore regular checking of the cuff pressure by **cuff pressure gauge** is mandatory to avoid:*

- 1. Cuff expansion specially when **N<sub>2</sub>O** is used as it diffuses into the cuff and the pressure rises by 10-12 mm Hg with 66% N<sub>2</sub>O after 30 min. The cuff may also expand due to **body temperature** and from **O<sub>2</sub> diffusion** .*

*Nowadays cuffs are made of (Soft Seal, Portex ) that allows minimal diffusion.*

- 2. Low pressure cuff because of leak in cuff or pilot balloon's valve.*



# *The pilot balloon*

- 1. The cuff is connected to its pilot balloon which has a valve for injection of air, it indicates if the cuff is inflated or deflated.*
- 2. After intubation the cuff is inflated until no air leak is heard during IPPV.*

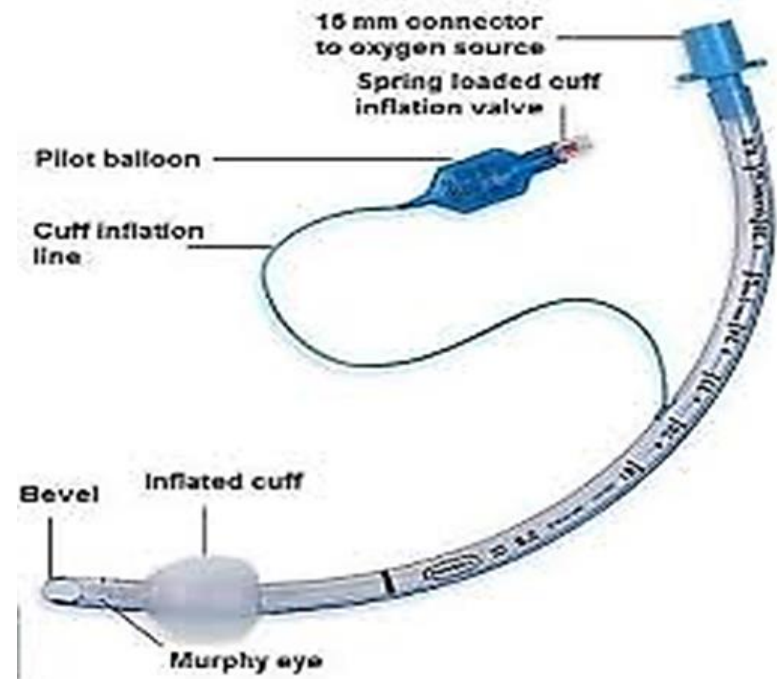


Figure 1: Endotracheal Tube Cuff System

# ***Route of insertion***

- 1. Tubes can be inserted orally or nasally.***
- 2. Indications for nasal intubation:***
  - a) intra oral surgery like ENT or Dental surgery.***
  - b) Long term intubation as in ICU, patients can tolerate nasal intubation better and can not bite the tube. However it may cause sinus infection.***
- 3. Nasal intubation is avoided in children below the age of 8-11 years as it may cause profuse bleeding if the adenoids may be hypertrophied.***
- 4. Ivory PVC nasotracheal tubes are less traumatic.***

# *Route of insertion*



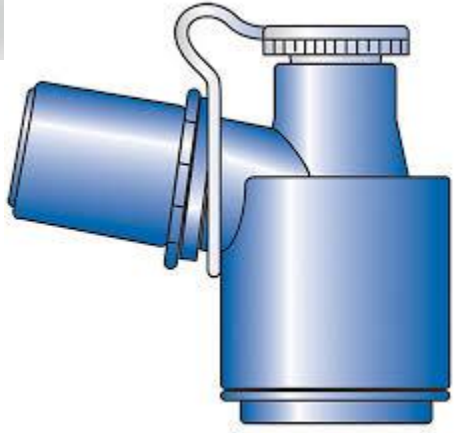
# ***Tube connectors***

- ***They are plastic or metallic parts that connect the tracheal (tube on one hand )to the breathing system (on the other hand).***
- ***The size of the tube side suitable to the tube size, while the size of the breathing system side is 15 mm .***
- ***Their internal diameter should be adequate to prevent resistance to flow.***
- ***Connectors for nasal tubes have a more acute angle, some has extra port for suction ,some are swivel port to avoid tube rotation during movement the tube in some surgeries.***

# *Tube connectors*



Fibreoptic bronchoscope swivel connector 100/257/000





# ***Problems in practice and safety features***

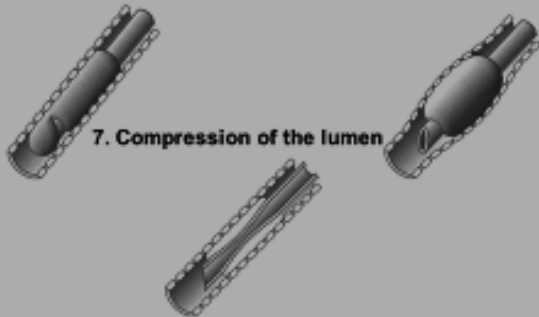
- 1. Obstruction of the tracheal tube by kinking, herniation of the cuff, occlusion by secretions, foreign body or the bevel against the wall of trachea.***
- 2. Esophageal or un-intentional bronchial intubation.***
- 3. Trauma and injury to various structures like lips, teeth, tongue, larynx and trachea during and after intubation. Some of them are disastrous.***

# Problems in practice and safety features

**Complications of endotracheal intubation**

5. Herniation of the cuff    6. Stretching of the tracheal wall

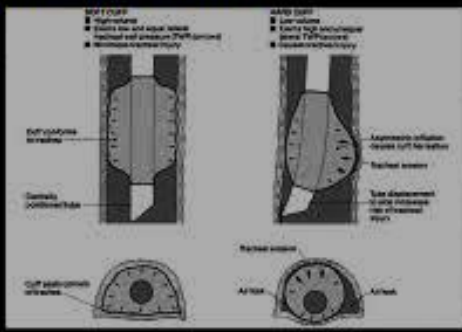
7. Compression of the lumen



The diagrams show cross-sections of an endotracheal tube. The first diagram shows the cuff herniating into the tracheal lumen. The second diagram shows the cuff stretching the tracheal wall. The third diagram shows the cuff compressing the lumen.



**High Volume Low Pressure Tubes**



The diagram compares HVLP and LVHP tubes. HVLP tubes have a high volume, low pressure cuff that conforms to the tracheal wall, reducing the risk of cuff herniation and tracheal injury. LVHP tubes have a low volume, high pressure cuff that does not conform to the tracheal wall, increasing the risk of cuff herniation and tracheal injury.

**HVLP CUFF**

- High volume
- Flattens the air-liquid interface
- Reduces cuff pressure (P<sub>cuff</sub>) around
- Increases compliance

**LVHP CUFF**

- Low volume
- Exerts high intracuff pressure (P<sub>cuff</sub>) around
- Increases compliance

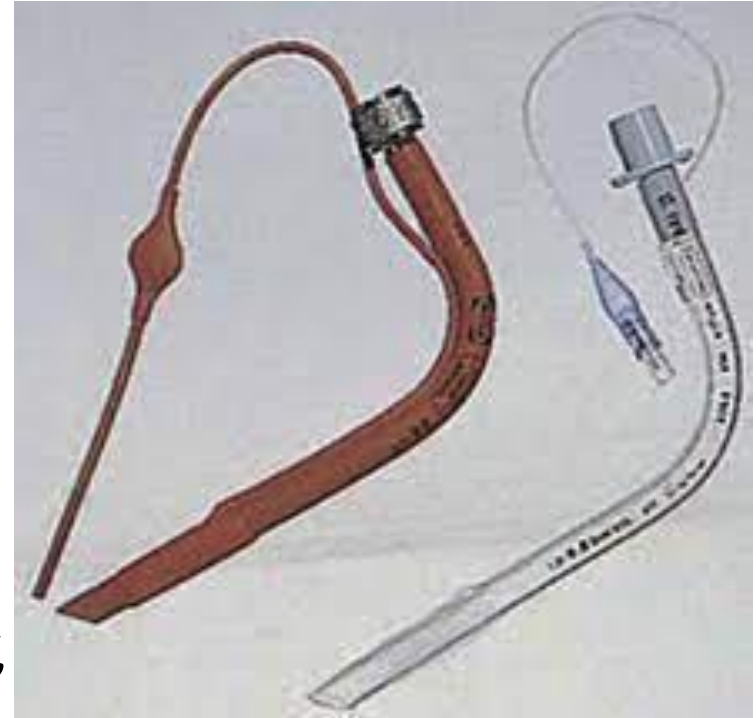
**Labels:** Extracuff air interface, Cuff air-liquid interface, Cuff pressure interface, Radial airway, Airway, Airway.

Figure 2. Removed ETT inflated outside.

# ***Specially designed tracheal tubes***

## ***Oxford tracheal tube:***

- ***L-shaped.***
- ***Used for head and neck surgery.***
- ***Non kinking, thick wall .***
- ***Stylet-guided.***
- ***The bevel faces posteriorly.***
- ***Risk of bronchial intubation because of fixed length of its distal part.***



# ***Specially designed tracheal tubes***

## ***Armoured tracheal tube:***

- ***Made of plastic or rubber silicone.***
- ***The wall is thick because it is armoured with metal or tough wire spiral making it non-kinking and flexible.***
- ***Stylet –guided.***
- ***Can not be cut to the desired length, thus the patient is liable for bronchial intubation.***



# ***Specially designed tracheal tubes***

## ***Polar and RAE tracheal tube:***

- ***Polar tube is north or south facing preformed oral or nasal tracheal tubes.***
- ***Cuffed or uncuffed.***
- ***Mainly used in maxillo-facial surgery.***
- ***Their shapes fit the nose or the mouth and connected to the breathing system over the forehead or chin.***
- ***Liabile for bronchial intubation.***
- ***Can be cut at the suitable length and converted to ordinary tube.***



# ***Specially designed tracheal tubes***

## ***Laser resistant tracheal tubes:***

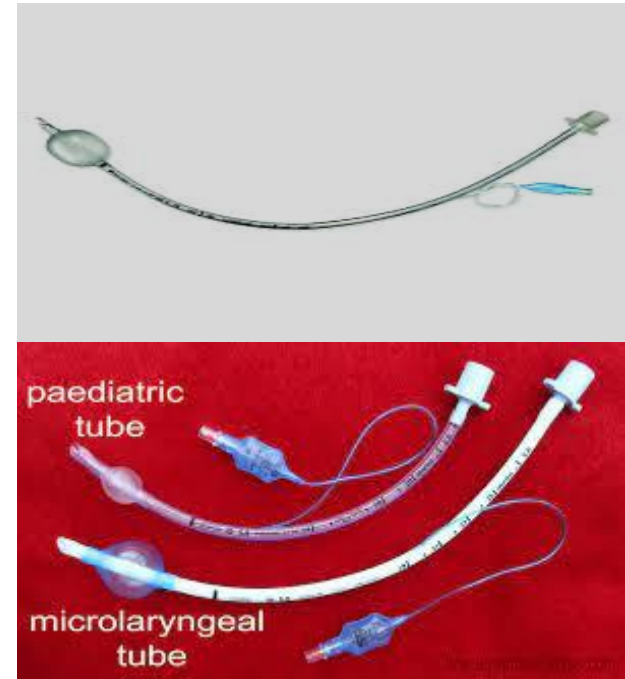
- ***Used in anesthesia for laser surgery on the larynx or trachea.***
- ***Designed to withstand laser beam, avoid fire of the tracheal tube and damage to healthy tissue.***
- ***Some designs are flexo-metallic, others have a laser resistant metal foil wrapped around the tube.***
- ***The cuff is filled with methylene blue colored saline as an indicator for cuff rupture.***
- ***Some designs have saline-filled double cuffs and not air for extra protection.***



# ***Specially designed tracheal tubes***

## ***Microlaryngeal tube (MLT):***

- ***Allows better exposure and surgical access to the larynx.***
- ***Its usual diameter is 5mm.***
- ***Adult size cuff.***
- ***Long enough to allow nasal intubation if required.***
- ***Made of Ivory PVC to reduce trauma to nasal mucosa.***



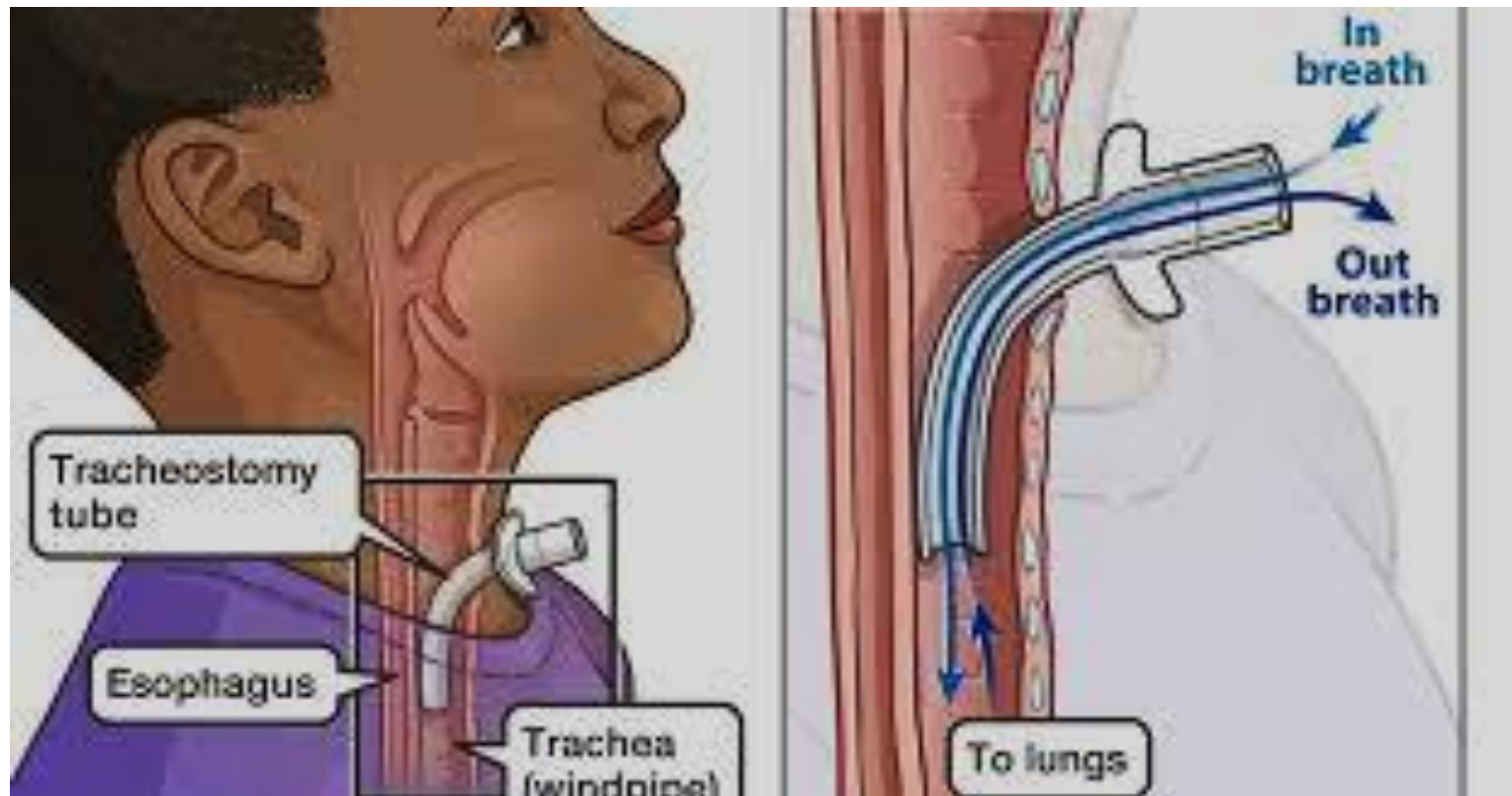
## ***Laryngectomy(Montandon ) tube:***

***facilitates surgical access, usually Replaced with tracheostomy tube at the end of operation.***



# *Tracheostomy tracheal tubes*

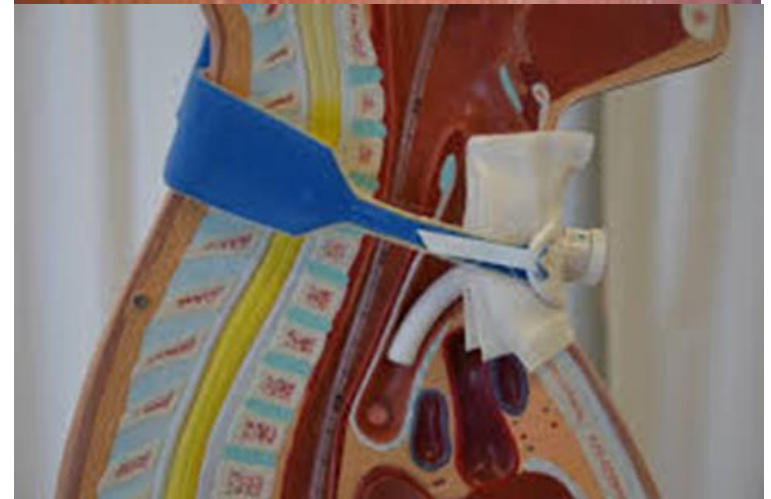
- *These are curved plastic tubes usually inserted through 2<sup>nd</sup>, 3<sup>rd</sup> and 4<sup>th</sup> tracheal cartilage rings.*





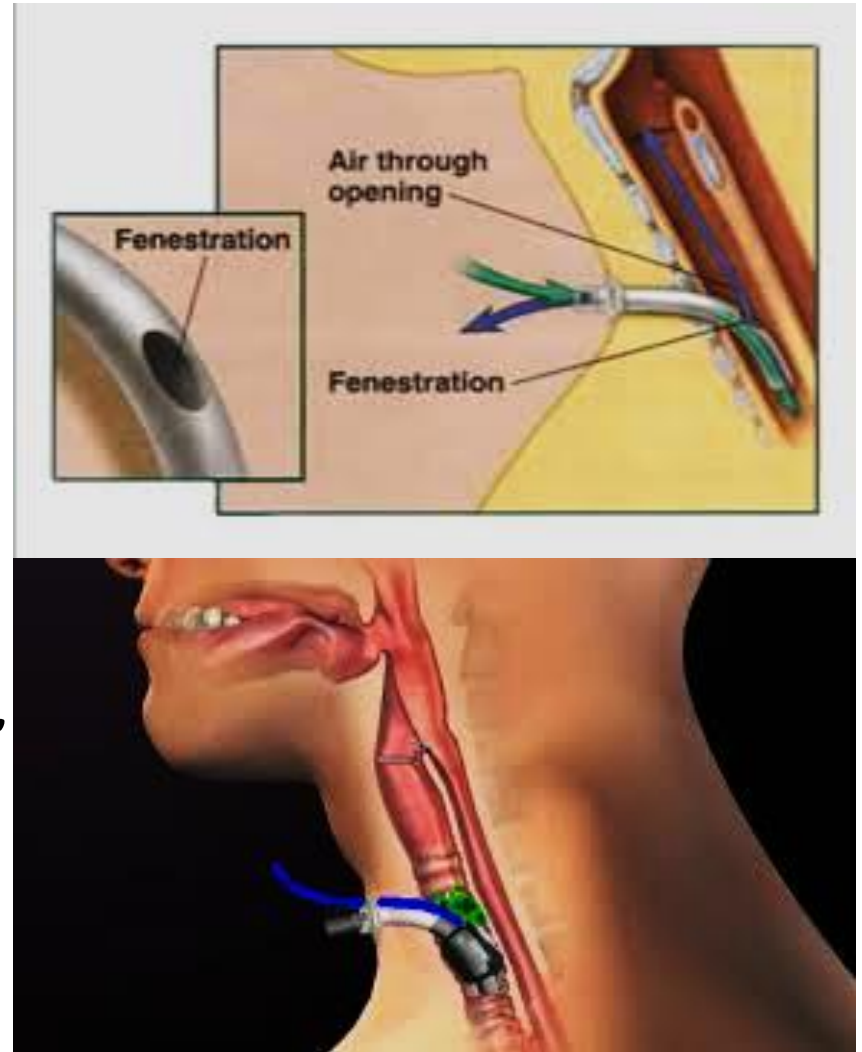
# *Tracheostomy tracheal tubes*

- *Components:*
  1. *An introducer.*
  2. *Wings for fixation or sometimes adjustable flange.*
  3. *Cuff and pilot balloon or without cuff.*
  4. *Proximal standard 15mm connector.*
  5. *Square rather than bevelled tip.*



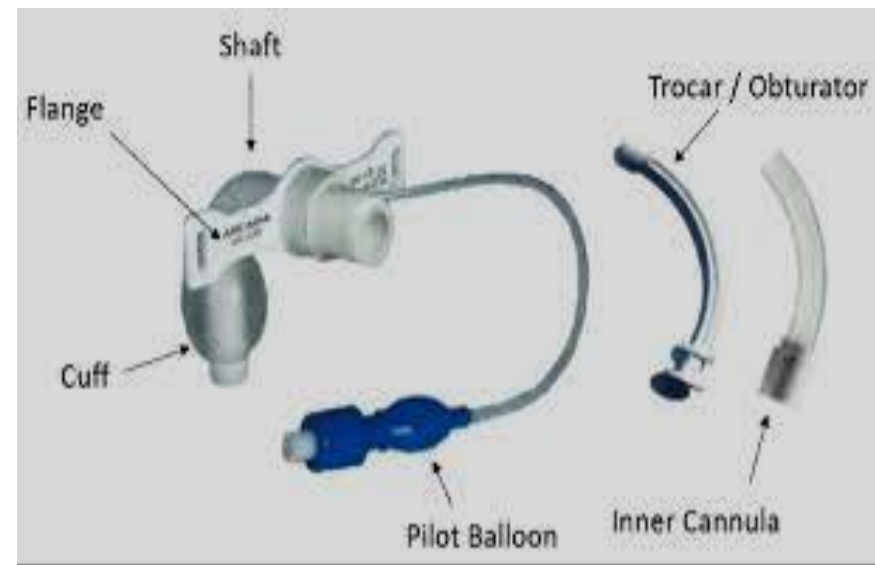
# *Tracheostomy tracheal tubes*

- *Components:*
- 6. *Recent designs have additional lumen for suctioning secretions above the cuff via a fenestration(opening).*



# *Tracheostomy tracheal tubes*

- *Components:*
  7. *Some designs have an inner cannula that can be changed in case of obstruction instead of changing the whole tracheostomy tube.*



# *Tracheostomy tracheal tubes*

- *Components:*
- 8. *Different sizes are available to fit neonates adults .*



# ***Tracheostomy tracheal tubes***

- ***Components:***

***9. Old uncuffed metal tracheostomies made of non-irritant antibacterial silver are rarely used now.***



# ***Minitracheostomy tracheal tubes***

- ***Inserted percutaneous through blood less cricothyroid membrane usually used for emergency life-saving purposes.***



# ***Tracheostomy tracheal tubes***

- ***Uses of tracheostomy tubes:***
  1. ***Long term IPPV.***
  2. ***Upper airway obstruction that can not be managed with oral or nasal tracheal tube.***
  3. ***Protection and maintenance a patent airway when pharyngeal and laryngeal reflexes are impaired or after a major surgery like laryngectomy.***
  4. ***Long term control of excessive secretions in unconscious patient.***
  5. ***To facilitate weaning from a ventilator.***

# ***Problems in practice and safety features***

***Mortality rate is less than 1% but total complications are up to 40% specially in the ICU and emergency patients.***

## ***Complications:***

- ***Immediate:***
  - a) ***Hemorrhage.***
  - b) ***Tube misplacement.***
  - c) ***Obstruction by tracheal wall or carina or by cuff herniation.***
  - d) ***Pneumothorax.***



# ***Problems in practice and safety features***

## ***Complications:***

- ***Delayed:***
  - a) Sudden or gradual Blockade by secretions or blood. This is rare with humidification and suction.***
  - b) Infection (skin or airways)***
  - c) Pressure necrosis by over inflated cuff.***

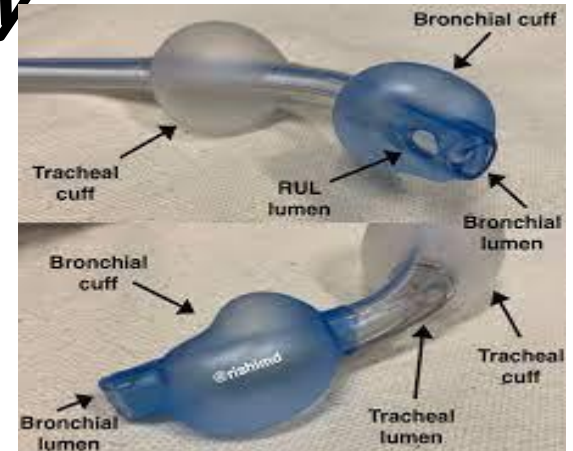
# ***Problems in practice and safety features***

## ***Complications:***

- ***Late:***
  - a) ***Grannuloma may cause difficult respiration after extubation.***
  - b) ***Persistant sinus at the tracheostomy site.***
  - c) ***Tracheal dilatation.***
  - d) ***Tracheal stenosis.***
  - e) ***Scar formation.***

# ***Double lumen endobronchial tubes***

- ***During thoracic surgery there is need for deflation of one lung ,this offers a better and an easier access for the Surgeon.***
- ***Double lumen tube allows the anesthesiologist to selectively deflate one lung and maintain standard ventilation of the other lung.***



# ***Double lumen endobronchial tubes***

- ***Components:***

1. ***Two separate color-coded lumens ,one ends in the trachea and the second ends either in the right or in the left main bronchus.***

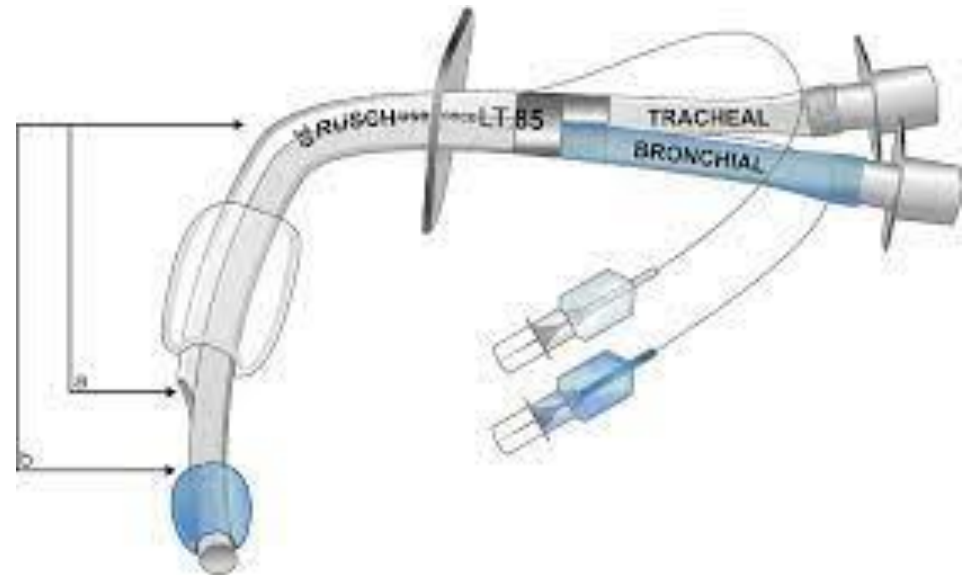


Fig 1 Double lumen tube for tracheobronchial intubation (Büsch, Tracheoset 85)

# ***Double lumen endo-bronchial tubes***

- ***Components:***
  - 2. Each lumen has its own color-coded cuff and pilot balloon.***
  - 3. It has 2 curve ,one is the antero-posterior (oro-pharyngeal) curve and the other is lateral curve to the Rt. Or Lt. main bronchus.***

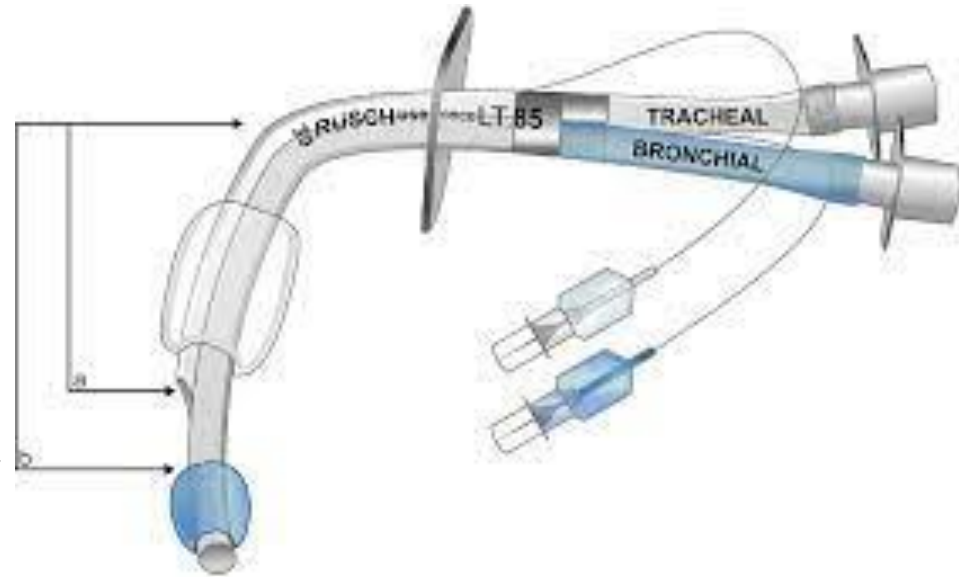


Fig 1 Double-lumen tube for tracheobronchial intubation (Bleich, Tracheostomy)



# ***Double lumen endo-bronchial tubes***

- ***Components:***

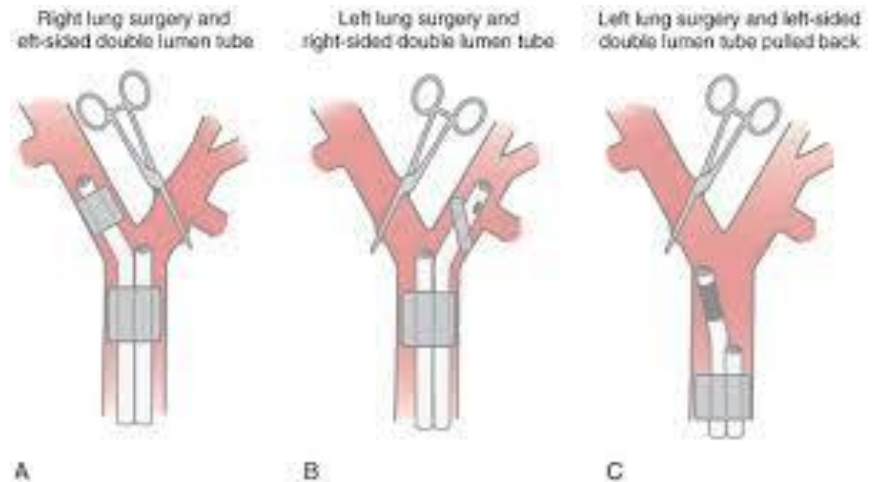
***4. the proximal ends are connected to a Y-shaped catheter mount attached to the breathing system.***



# ***Double lumen endo-bronchial tubes***

## ***Mechanism of action:***

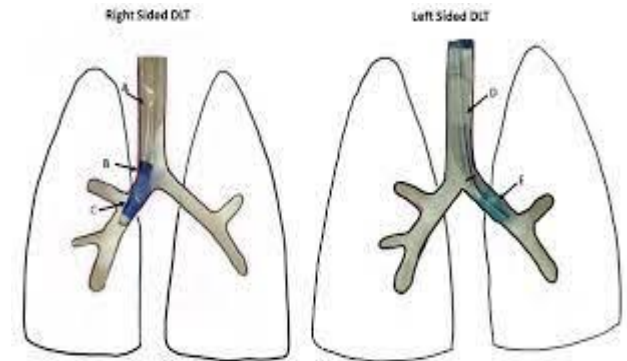
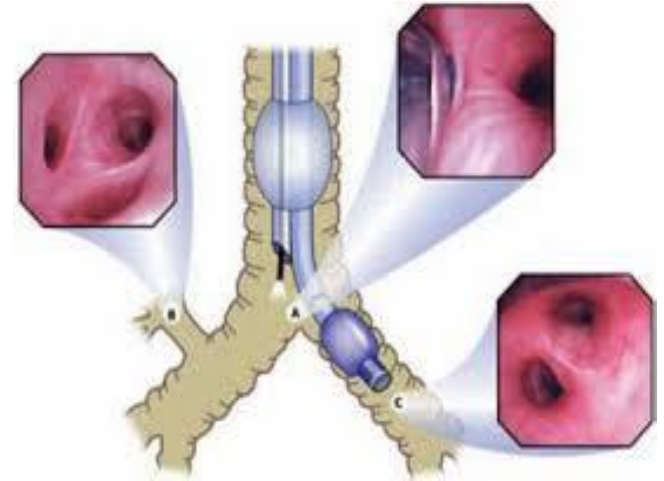
- 1. both Rt.-sided and Lt.-sided double lumen tubes must be available.***
- 2. Once correctly positioned either of Rt. Or Lt. lung can be deflated and the contralateral lung can be ventilated.***



# ***Double lumen endo-bronchial tubes***

## ***Mechanism of action:***

- 3. Lt.-sided tube is safer and can be used in all Rt. Or Lt. lung surgeries except Lt.pneumonectomy since it is cut with the stump.***





# ***Double lumen endobronchial tubes***

## ***Mechanism of action:***

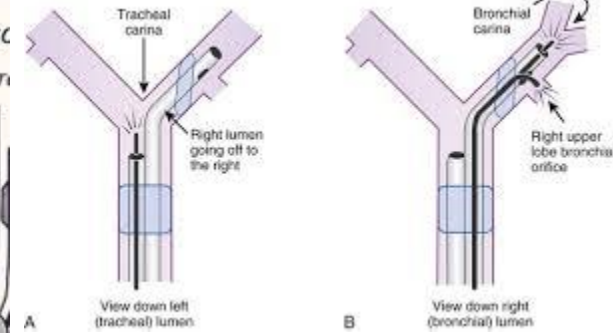
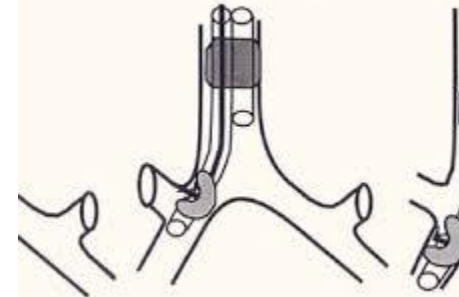
***4. Rt.-sided tube has an eye in the bronchial cuff to facilitate ventilation of the Rt. upper lobe of the lung.***

***5. Different (French) sizes are available for adults but not pediatric patients.***



**GHT SIDED DLT: FIBEROPTIC BROCHOSC**

**TUBE TOO FAR OUT TUBE TI**



# ***Double lumen endo-bronchial tubes***

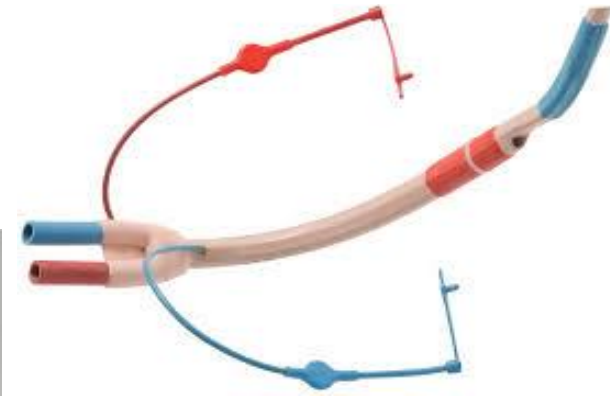
## ***Tube positioning:***

- 1. Check the position by auscultation before and after patient positioning. Use of fiberoptic bronchoscope is also recommended to confirm correct positioning.***
- 2. Inflate the tracheal cuff until no air leak is heard. at this point both lungs can be ventilated.***
- 3. Clamp the tracheal limb of the Y-catheter and disconnect it from the tracheal lumen.***
- 4. Inflate the bronchial cuff gently until no air leak is heard from the tracheal lumen. At this stage only the lung ventilated from the bronchial lumen can be ventilated.***
- 5. Check ventilation of the other lung by clamping the bronchial limb of the Y-catheter, at this stage the other lung is ventilated selectively from the tracheal lumen.***

# Double lumen endo-bronchial tubes

## Commonly used double lumen tubes:

1. *Robertshaw (rubber) tubes.*
2. *Single-use plastic tubes: a more recent version has facility of applying CPAP to the deflated lung to improve arterial oxygenation.*
3. *Carlens (left-sided version) which has high resistance and difficulty in suctioning. White (right-sided version) tubes. both have a carinal hook which may be traumatic.*



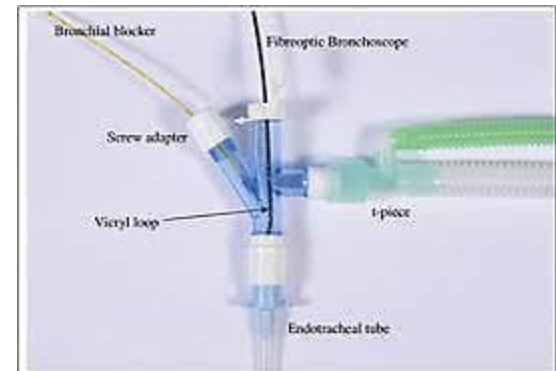
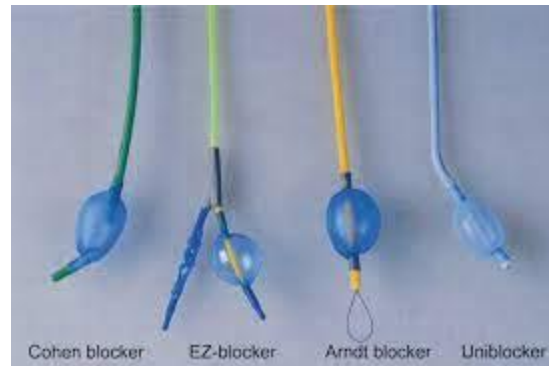
Specific DLT

- CARLENS DOUBLE LUMEN TUBE: 1950  
left sided; with carinal hook; cross sectional shape oval in horizontal plane.



# ***Endo-bronchial blockers***

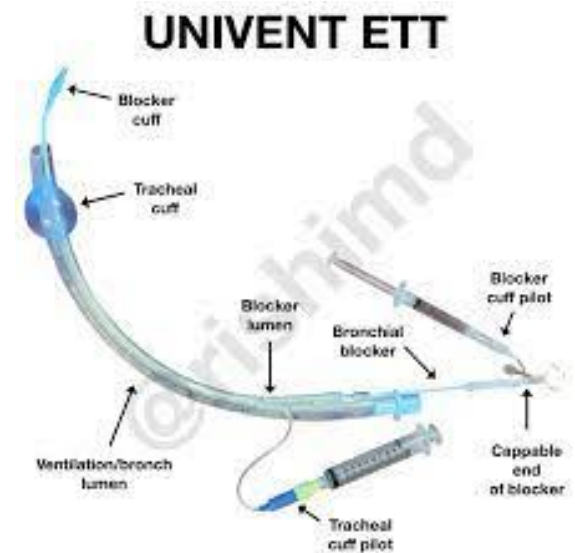
- ***An alternative to double lumen tubes used for one lung ventilation.***
- ***Consist of a 9FG and 78cm length catheter with a distal cuff inflated via a pilot balloon.***
- ***A guide loop at the tip and a multiport adaptor at the proximal end.***



# ***Endo-bronchial blockers***

## ***Univent tracheal tube:***

- ***Special tube with a small anterior lumen housing the bronchial blocker and wider posterior tracheal lumen for ventilation.***
- ***The blocker catheter has a cavity for suctioning and oxygenation of the isolated lung.***
- ***It need fiberoptic bronchoscope for confirmation of placement.***  
***suctioning of through the main lumen is difficult.***



# Oropharyngeal airway

- ***Guedel airway are the most commonly used.***
- ***Available in 9 sizes :***  
***(smallest 000- to largest 6) .***
- ***Made from hard plastic .***
- ***having a flange to prevent posterior displacement, straight. bite block and a curved body.***
- ***The air channel must pass suction catheter.***
- ***In adults it is inserted with the curve towards the chin then rotated 180 degrees, while in children a tongue depressor is used.***
- ***Suitable size is selected according to one of the following distances:***
  - a) Incisor teeth to the angle of the mandible.***
  - b) Mouth angle to the ear tragus.***

## Guedel Airway

Medicine drives through these vents and drains.  
Anatomically correct shape.  
Smooth edges.  
Flexible.  
Through-line and open-mouth.  
The same airway device for every patient.  
Flexible to allow dental procedure.  
Strong and clean pack for packaging.  
COW coded.

Size	Weight	Color	Material
000	0.5g	Red	Plastic
00	1.0g	Red	Plastic
0	1.5g	Red	Plastic
1	2.0g	Red	Plastic
2	2.5g	Red	Plastic
3	3.0g	Red	Plastic
4	3.5g	Red	Plastic
5	4.0g	Red	Plastic
6	4.5g	Red	Plastic



# *Oropharyngeal airways*

*Bermann airway: is another type of oropharyngeal airways. In addition to its functions ,it facilitates fiber optic bronchoscopy .The lateral slit it has facilitates removal of the airway from the bronchoscope.*



# ***Problems in practice and safety features***

- 1. Trauma to different tissues ( lips, tongue ,palate and teeth cups and crowns) during insertion.***
- 2. Vomiting and laryngospasm if inserted while the pharyngeal reflexes are not depressed enough.***
- 3. Confer no protection against aspiration.***
- 4. The degree of airway patency must be assessed not assumed.***
- 5. Badly inserted airways may worsen patency.***



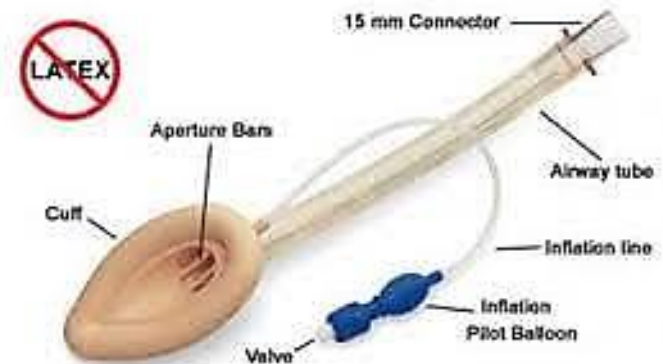


# *Laryngeal Mask Airways( LMA)*

- *Very useful alternative to either the facemask or tracheal tube . Its available as reusable or single use versions and in different sizes (1-5)*

## *Components:*

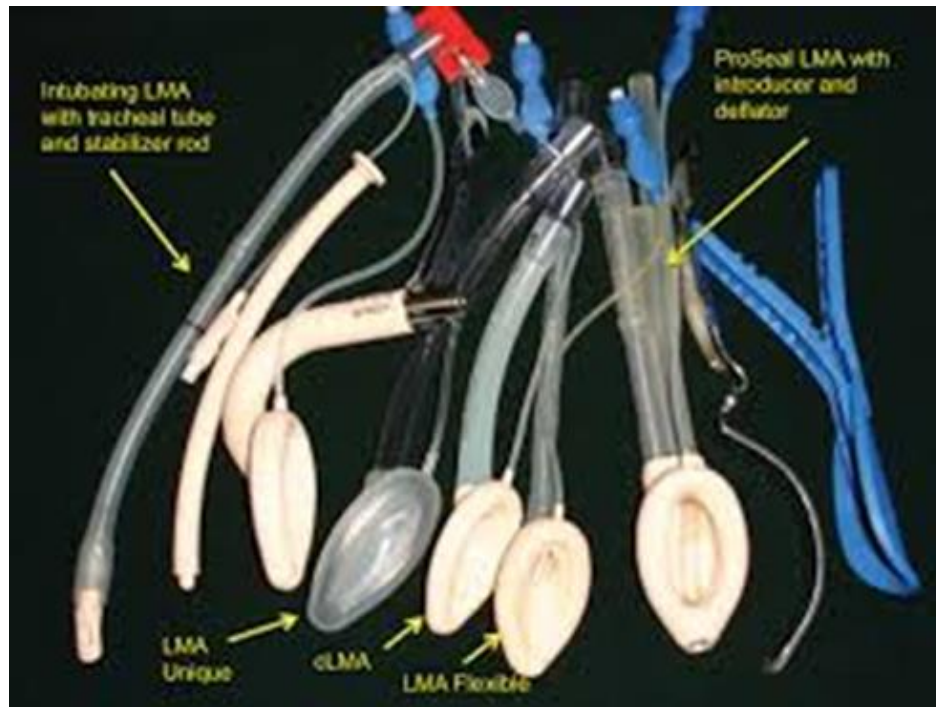
1. *A wide diameter transparent tube (re-inforced in some designs).*
2. *An elliptical cuff to form an air-tight seal around the larynx.*
3. *The classical type has 2 bars to prevent the epiglottis from closing the larynx or the tube lumen.*
4. *A modified LMA design has an additional lumen for drainage of gastric air or secretions. Both tubes are integrated within a bite block.*



# *Laryngeal Mask Airways (LMA)*



# *Intubating Laryngeal Mask Airways (ILMA)*



# ***Intubating Laryngeal Mask Airways ( ILMA)***

- ***It is a specially designed modification of LMA.***
- ***Designed for intubation either blindly or assisted by a fiberscope with minimal head and neck manipulation.***
- ***It is introduced 1<sup>st</sup> ,then a specially designed tracheal tube is passed through it ,then the vocal cords to the trachea.***



# ***Problems in practice and safety features of LMAs***

- 1. Does not protect against aspiration.***
- 2. Still 10% get airway obstruction by down-folding of the epiglottis , some authors report (20-56 )%.***
- 3. Not more than 40 times recommended to be re-used because autoclaving perish the cuff.***
- 4. Rotation of LMA causes complete airway obstruction thus the black line should always face the upper lip and teeth.***
- 5. Cricoid pressure may prevent correct placement.***

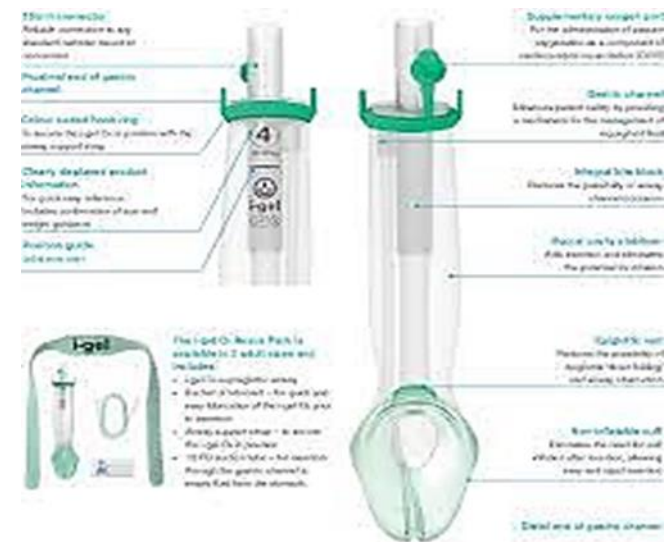


# ***I-gel airways supra-glottic airway***

- Uses an anatomically designed mask that fits the peri-laryngeal and hypopharyngeal structures without an inflatable cuff.***



- It incorporates a 2<sup>nd</sup> drain tube.***





# ***I-gel airways supra-glottic airway***

## ***Components:***

***1. The wide body consists of :***

***a) Large ventilation lumen.***

***with a 15mm connector.***

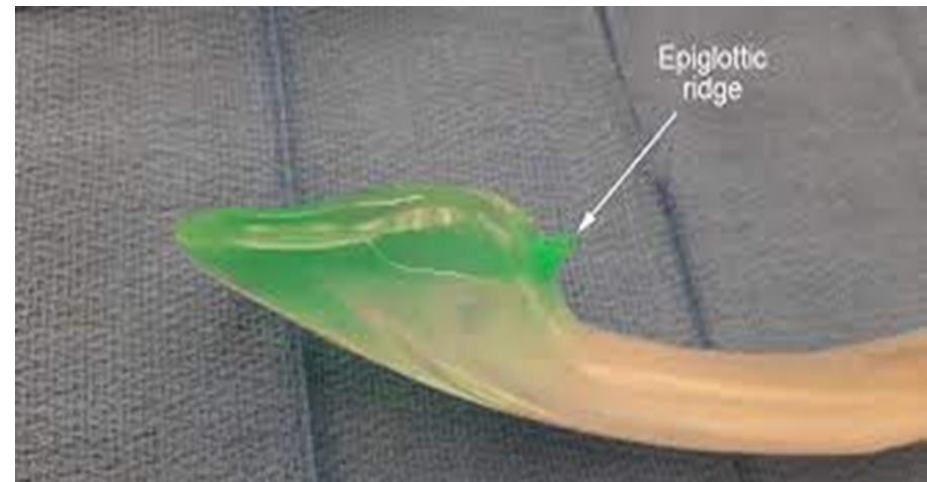
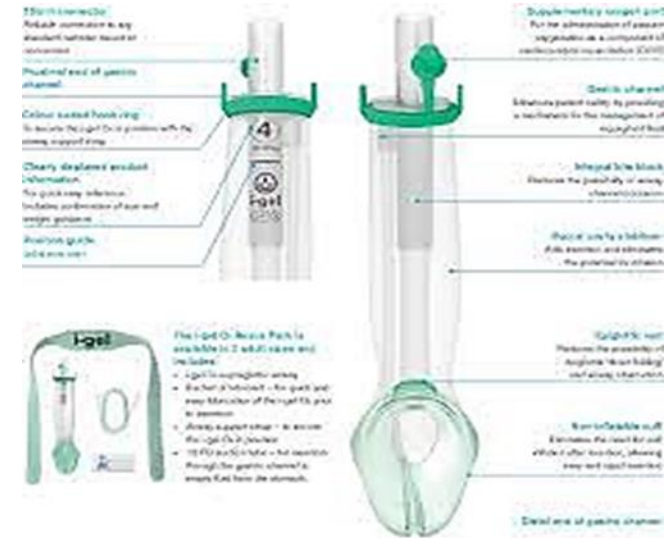
***b) The gastric lumen ends***

***at the upper esophagus.***

***2. Non-inflatable gel mask***

***with an anterior superior***

***ridge.***



# ***I-gel airways supra-glottic airway***

## ***Mechanism of action:***

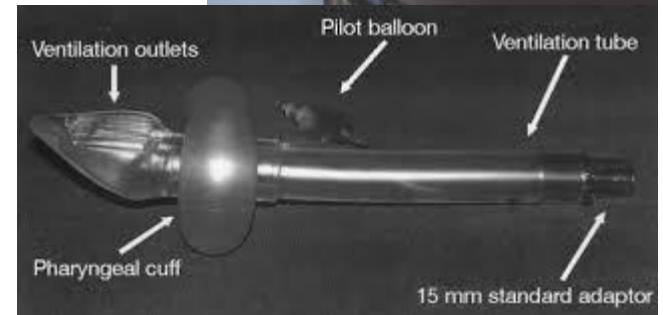
- 1. The soft ,gel-like plastic cuff tend to mold into place.***
- 2. The gastric channel allows direct suctioning and passage of a gastric tube.***
- 3. The wide oval in cross-section body prevent rotation and act as a bite block.***
- 4. The epiglottic blocking ridge prevents down-folding of the epiglottis.***
- 5. Its available in adult and pediatric sizes.***
- 6. Its used for fasted patients both in spontaneous and controlled ventilation or guiding tracheal intubation.***

***Note: it does not protect against aspiration of gastric contents.***

# ***COBRA peri-laryngeal airway (PLA)***

## ***Consists of :***

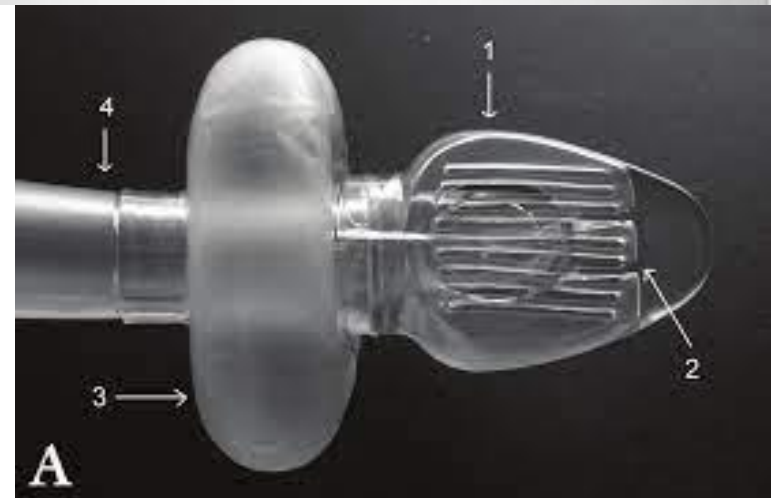
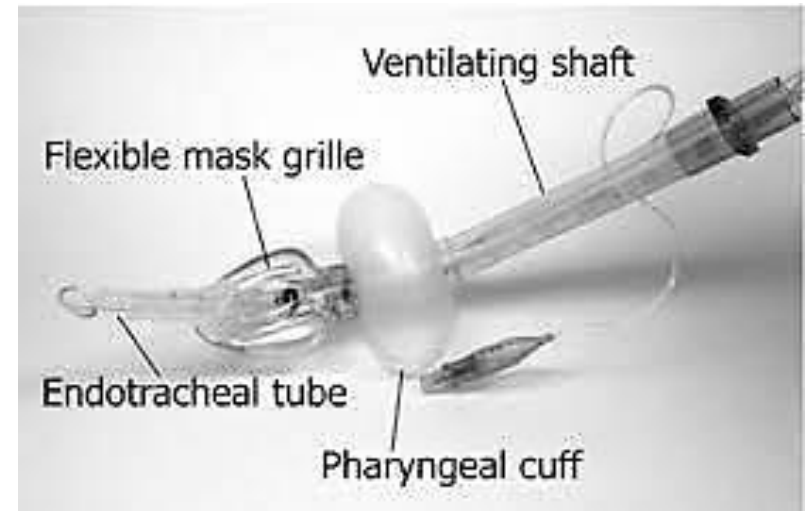
- 1. Large ventilation tube.***
- 2. Proximal large hypopharyngeal cuff, that seals the oropharynx connected to a pilot balloon.***
- 3. Smaller flattened and slotted soft plastic. It's distal end rests in the esophageal inlet. It holds the epiglottis and the slots face the laryngeal inlet. They are soft enough to allow passage of a tracheal tube.***



# ***COBRA peri-laryngeal airway (PLA)***

## ***Notes:***

- 1. The slots (Grill) are soft enough to allow passage of a tracheal tube .***
- 2. Allows both spontaneous and controlled ventilation.***
- 3. They do not protect against aspiration.***
- 4. Available in 8 sizes ,the pediatric version has a distal gas sampling port to minimize dead space.***
- 5- COBRA PLUS models has a temperature probe for core temperature measurement.***



# *Other supra-glottic airways*

## *Combi-tube airway:*

- *Has double lumens, a narrower gastric lumen for suction or passage of gastric tube, and a wider distally blind lumen for ventilation.*
- *Has a large pharyngeal and a small esophageal cuff.*
- *Multiple openings in the ventilation channel facing the laryngeal opening in between the two cuffs for ventilating the lungs.*



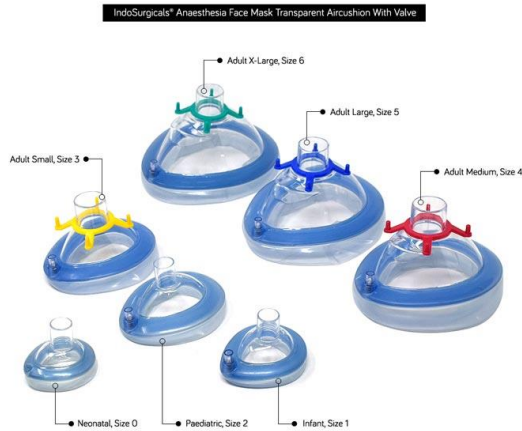
# *Masks and Oxygen delivery devices*

## *Face masks:*

- *The body rests on an **air-filled cuff** that fits the face , with a large dead-space up to 200ml.*
- *Some pediatric designs do not have a cuff, e.g. **Randell-baker** ,with minimal dead-space.*
- *The proximal end has a 22mm inlet connector.*
- *Made of transparent **silicone** or **plastic** or non-transparent **rubber**.*
- *Some designs have **clamps** for harness attachment.*
- *Inappropriate size can cause trauma to the eyes and facial nerves.*

# Masks and Oxygen delivery devices

## Face masks:

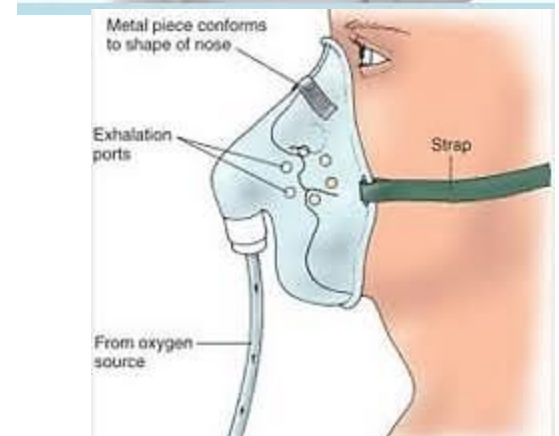


# *Masks and Oxygen delivery devices*

*Nasal masks (inhalers):  
Used during dental chair anesthesia.*

*Variable performance  
(medium concentration ;MC):*

- *Used to deliver oxygen-enriched air to the patient.*
- *Has a plastic body with side holes on both sides, a port connected to oxygen source and elastic band to fix it to the face. Some designs has an oxygen reservoir bag.*





# ***Masks and Oxygen delivery devices***

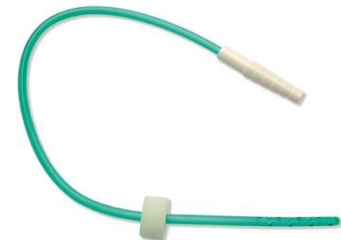
## ***Nasal cannulae:***

- ***Ideal for long-term O<sub>2</sub> therapy i.e. better tolerated.***
- ***At 2-4 L/min this delivers FiO<sub>2</sub> of 28-36% ,higher rates are uncomfortable.***



## ***Nasal catheters:***

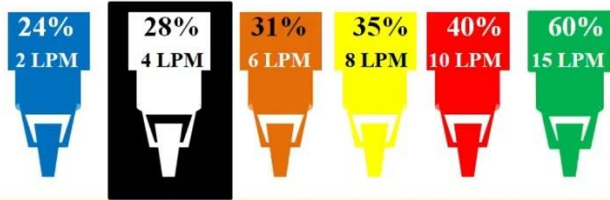
- ***Single lumen catheter lodged into the nostril a foam collar.***



# *Masks and Oxygen delivery devices*

*Fixed-performance devices  
(VENTURI MASKS):*

## Venturi Mask



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