

A photograph of the Lied Transplant Center building at dusk. The building is a multi-story structure with a brick facade and large windows. The sky is a deep blue, and the building's lights are on. In the foreground, there are trees and a sidewalk. A large, stylized graphic overlay consisting of curved, overlapping bands in shades of blue and white is positioned on the left side of the image.

Airway Management and Ventilation

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Airway/Ventilation Overview

- **Respiratory Assessment**
- **Supplemental Oxygen Delivery**
- **Ventilation Devices**
- **Airway Management**
 - **Basic Adjuncts**
 - **Advanced Adjuncts**



Pearl #1

Airway management is the cornerstone of paramedicine. Successful patient outcome depends on our abilities to maintain an airway and ventilate a patient. We have as little as 6-10 minutes before irreversible brain injury and death result.



Pearl #2

K-I-S-S Principle of Airway Management

Keep it simple... In most circumstances begin with the basics. Just because we arm you with an endotracheal tube and laryngoscope (scalpels in some cases) does not mean that you can forget the basics or become sloppy in their performance.



Respiratory Problems

- **Airway Obstruction**
 - Tongue*
 - FBs
 - Trauma
 - Laryngeal spasm/edema
 - Aspiration
- **Inadequate Ventilation - *rate and/or volume***
 - TBI
 - Overdose
 - Acidosis
 - Muscular dystrophy



Respiratory System Assessment - ABCs

- **A = Airway**
- **B = Breathing**
- **C = Check “A” and “B” again**
 - **Look**
 - **Listen**
 - **Feel**



Pulse Oximetry

- “5th vital sign”
- Measurement of hemoglobin oxygen saturation
- 95 - 100 % normal (vary slightly by source)
- False readings
 - carbon monoxide poisoning
 - high intensity lighting
 - red, black or other dark nail polish
 - absent pulse or diminished perfusion
 - hypovolemia/anemia





Peak Flow Meters

- Provides a numeric indicator of ventilatory flow
- Patient forcefully exhales after a maximal inhalation
- When repeated provides a measure of improved, worsening, or unchanged response to treatment





Supplemental Oxygen Delivery

- **Nasal Cannula**
- **Simple Face Mask**
- **Partial Re-breather Mask**
- **Non Re-breather Mask**
- **Venturi Mask**



Nasal Cannula

- **Delivers low concentration oxygen - 24-44%**
- **Run at 1-6 liters/minute**
- **Contraindicated**
 - **poor respiratory effort**
 - **hypoxia**
 - **apnea**
- **Well tolerated, ideal for patients needing minimal oxygen supplementation or those on long-term oxygen therapy**





Simple Face Mask

- **Delivers 40-60% oxygen concentration**
- **Flow rates of 6-10 liters/minute**
- **Side vents in mask allow for atmospheric gas to mix with oxygen**
- **Flow rates of less than 6 L/min are contraindicated**
- **Flow rates above 10 L/min do not enhance oxygen delivery**



Re-breather Masks

Partial

- Delivers 35-60% oxygen concentration
- Has reservoir bag but only one side port controlled - allows for mixing of exhaled & environmental gases

Nonrebreather

- Delivers 80% upwards to 95% oxygen concentration
- Has reservoir bag and one-way side ports

Flow must be adequate to keep the reservoir bag inflated based on patient RR and depth. Contraindicated for any patient without adequate tidal volume and RR...



Venturi Mask

- Mask able to deliver more precise fraction of inspired oxygen (FiO_2)
- Color coded adapters attached to mask at a corresponding flow rate will deliver a fairly precise concentration of oxygen
- Delivers from 24-50% oxygen
- Recommended for patients breathing on hypoxic drive - COPD





Ventilation Devices

- Mouth-to-Mouth
- Mouth-to-Nose
- Mouth-to-Stoma
- Mouth-to Mask
- Bag-valve Devices
- Demand Valve Device
- Automatic Transport Ventilator



Mouth-To-Mouth

- Inspired air results in the exchange of 4-5% of oxygen, 16-17% is exhaled
- Is not a preferred method due to communicable diseases
- Be aware of spinal injury and open the airway accordingly
- Provide full steady breaths
 - Rescue breathing, without chest compressions
 - Adult – 1 breath every 5-6 seconds (10-12 bpm)
 - Peds – 1 breath every 3-5 seconds (12-20 bpm)
 - CPR with advanced airway
 - 1 breath every 6-8 seconds (8-10 bpm)



Mouth-To-Nose

- **Similar in technique to mouth-to-mouth**
- **May be used if unable to perform mouth-to-mouth due to trauma, etc.**

**Note: mouth-to-mouth-and-nose
technique used in infants**



Mouth-To-Stoma

- **Stoma is a temporary or permanent surgical opening in the neck of a patient who has had a laryngectomy or tracheostomy**
- **The larynx is no longer connected to the trachea**
- **An ETT can be inserted no more than 3-5 inches into trachea**
- **Pediatric mask and bag-valve device may also be used**





Mouth-To-Mask Devices

- **Eliminates direct patient contact**
- **Various brands - mask must be clear**
- **Supplemental oxygen ports available, connect as available**
- **Preferred method of initial ventilation**
- **Use of an OP or NP is indicated**



Bag-Valve Devices

- **Used with a mask, ETT, & other airway devices**
- **Self-inflating bag with reservoir or collecting tubing**
- **Available in adult, pediatric and infant sizes**
- **Major obstacle is creating an effective mask seal and squeezing the bag - may be better suited to 2-3 person use**
- **Remember to attach supplemental oxygen**
- **Use cricoid pressure to prevent gastric insufflation**

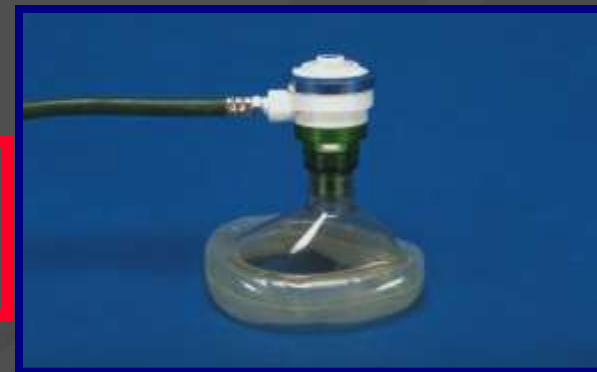




Demand Valves

- Oxygen under high pressure - 50% psi
- Device may be manually triggered or by negative pressure from patients own respiratory effort
- Gastric distention a major problem
- Not recommended for use in patients under 16 years old

Contrary to other sources, I strongly urge you to not use with an ETT!!!





Automatic Transport Ventilators

- **Gaining popularity**
- **Simple to use**
 - **Set Tidal Volume**
 - **Set RR**
- **Most not used on kids under 5-years, consult manufacturer**
- **Contraindicated in airway obstruction or those with increased airway resistance**
 - **COPD**
 - **Pulmonary Edema**
 - **Pneumothorax**





Suction

- **Fixed & portable devices - check your batteries**
- **Soft catheters - soft-tip, narrow & flexible**
- **Rigid catheters - tonsil-tip, yankauer**
- **Never use yankauer blindly**
- **Suction on the way out only - you are depriving your patient of oxygen**
- **Pre-oxygenate your patient first for 2-minutes**
- **Suction should never exceed 10-seconds in adults & 5-seconds in pediatrics**
- **Monitor cardiac rhythm, pulse ox, signs of soft tissue injury, or aspiration**



Manual Airway Maneuvers

- **Head-Tilt/Chin-Lift**
- **Jaw-Thrust**
 - **Modified Jaw-Thrust (no head tilt)**

Always remember that when you do something to open or control an airway, there are implications for the cervical spine - Remember the C-Spine!



Basic Airway Adjuncts

- **Nasopharyngeal Airway**
- **Oropharyngeal Airway**





Nasopharyngeal Airway

Indications

- Semi-conscious, decreased control of upper airway with an intact gag reflex
- Prevention of tissue trauma during frequent nasotracheal suctioning

Contraindications

- Nasal obstruction
- Nasal fracture or suspected maxillofacial or basilar skull fracture
- Patients on anticoagulant therapy
- NOTE - tend not to see used in pediatric patients



NPA - Procedure

- BSI
- Size - measure from tip of nose to the tragus of the ear or angle of the jaw, sizes range from 20-36 FR, 17-20 cm long
- Lubricate the airway and nostril with water soluble lubricant
- Bevel to face septum, gently insert
- If resistance encountered, pull back and re-approach
- Trumpet of airway should come to rest at nostril opening



NPA

Advantages

- Well tolerated in patients with gag reflex
- Quick, easy procedure

Complications

- May precipitate laryngospasm & vomiting - aspiration
- Epistaxis
- Does not isolate & protect the lower airway



Oropharyngeal Airway

Indications

- Designed to prevent the tongue from obstructing the glottis
- Patient must be unconscious or have an absent gag reflex
- **NOTE - commonly used as a bite stick following ETT**
 - Very important story...

Contraindications

- Presence of gag reflex
- Oropharyngeal injuries



OPA Procedure

- **BSI**
- **Size - measure from corner of mouth to angle of jaw**
- **Suction**
- **Insert**
 - **Rotational - 180-degrees**
 - **Tongue Blade (preferred method for pediatrics)**
- **Be sure that the tongue is not forced into the airway causing obstruction**
- **Good placement - patient easily ventilated with good breath sounds and rise/fall of chest**



OPA

Advantages

- Maintains an open airway from the #1 cause of obstruction
- Provides for easy access to suction
- Serves as a bite block
- Relatively easy procedure

Complications

- Incorrect size of airway may cause obstruction
- May stimulate gag reflex - vomiting - aspiration
- Does not protect lower airway
- Possible injuries to teeth or soft tissue



Advanced Airway Management

- **Endotracheal Intubation**
 - Oral
 - Nasotracheal
 - Transillumination
 - Digital
 - Trauma In-line Intubation
 - RSI
- **Esophageal Tracheal Combitube**
- **Laryngeal Mask Airway (LMA)**
- **Pharyngo-Tracheal Lumen Airway**
- **EOA/EGTA**
- **Direct Laryngoscopy**
- **Surgical Airways**
 - **Needle Cricothyroidotomy**
 - **Surgical (open) Cricothyroidotomy**



Endotracheal Intubation

- Provides for definitive airway protection
- Requires more training than other airway procedures and must be practiced often to maintain proficiency
- High potential for complication





Endotracheal Intubation Equipment

- Laryngoscope
- Endotracheal Tube
- 10 mL Syringe
- Stylet
- Bag-valve-mask device
- Suction
- Bite block
- Magill forceps
- Tape/Tube holder
- ETCO₂ Detector (capnography)
- Esophageal Detector Device (EDD)





Laryngoscope

- **Instrument used to visualize the vocal cords/glottic opening**
- **Consists of handle and blade**
 - **Straight Blade (Miller, Wisconsin)**
 - **Curved Blade (MacIntosh)**
- **Blades may be reusable or disposable**
- **Light needs to be bright & tight**
- **Have extra batteries and bulbs**



Straight Blade

Designed to fit under/past the epiglottis and physically manipulate the epiglottis out of the way thereby allowing visualization of the vocal cords and glottic opening





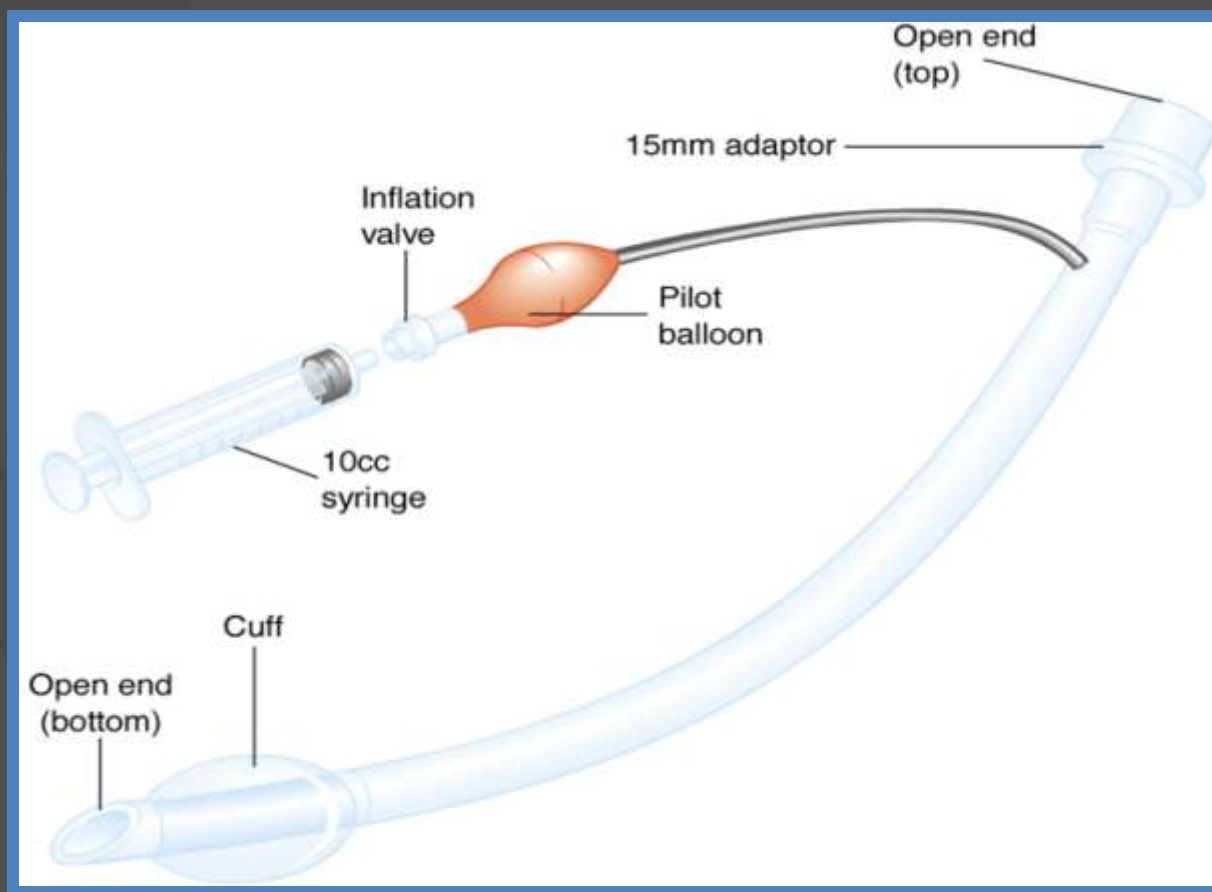
Curved Blade

Designed for the tip of the blade to fit into the vallecula. Lifting or applying pressure here shortens ligamentous attachments to the epiglottis thereby lifting it out of the way so that visualization of the vocal cords and glottic opening may be appreciated.





Endotracheal Tubes



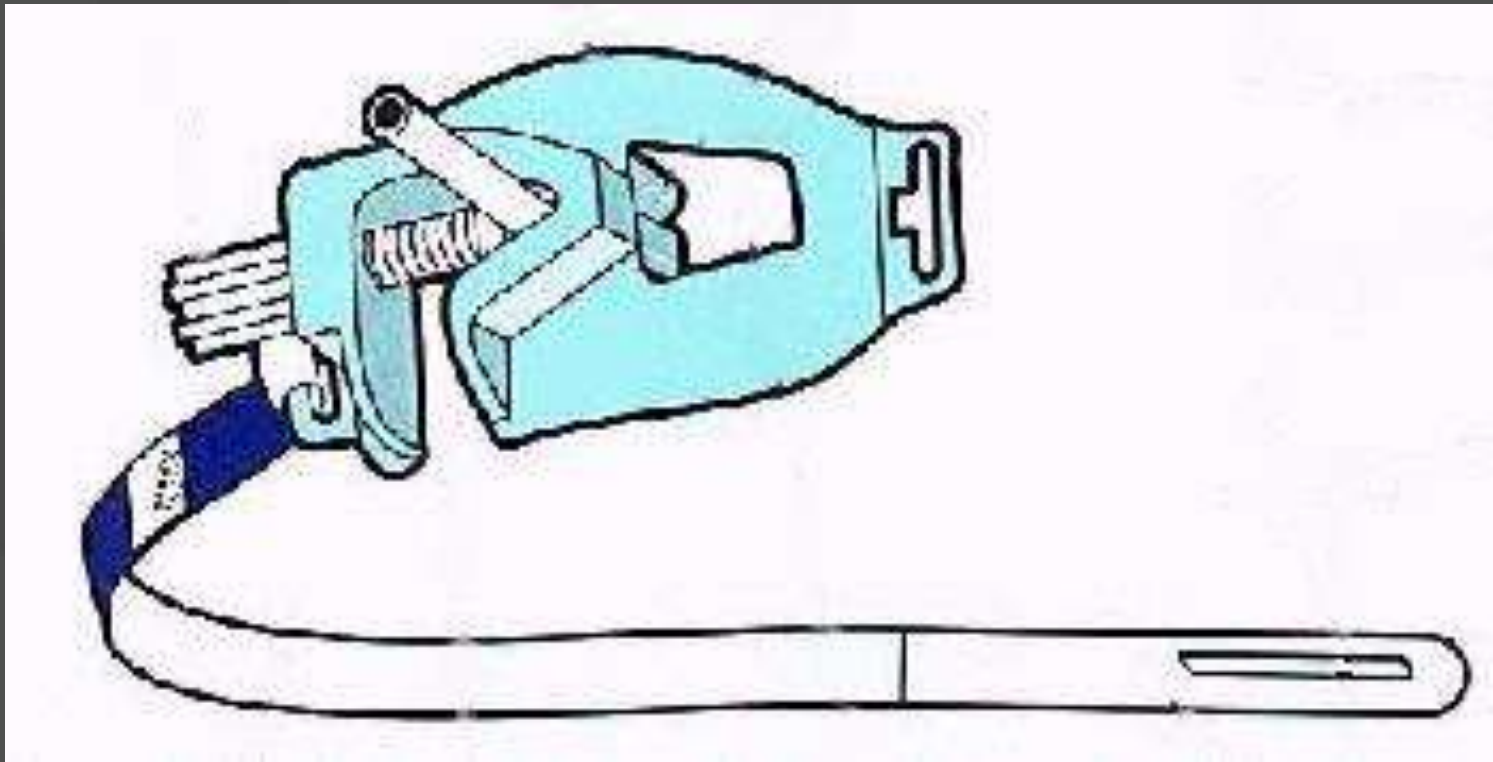


Stylet and Syringe





Tube-Holding Device



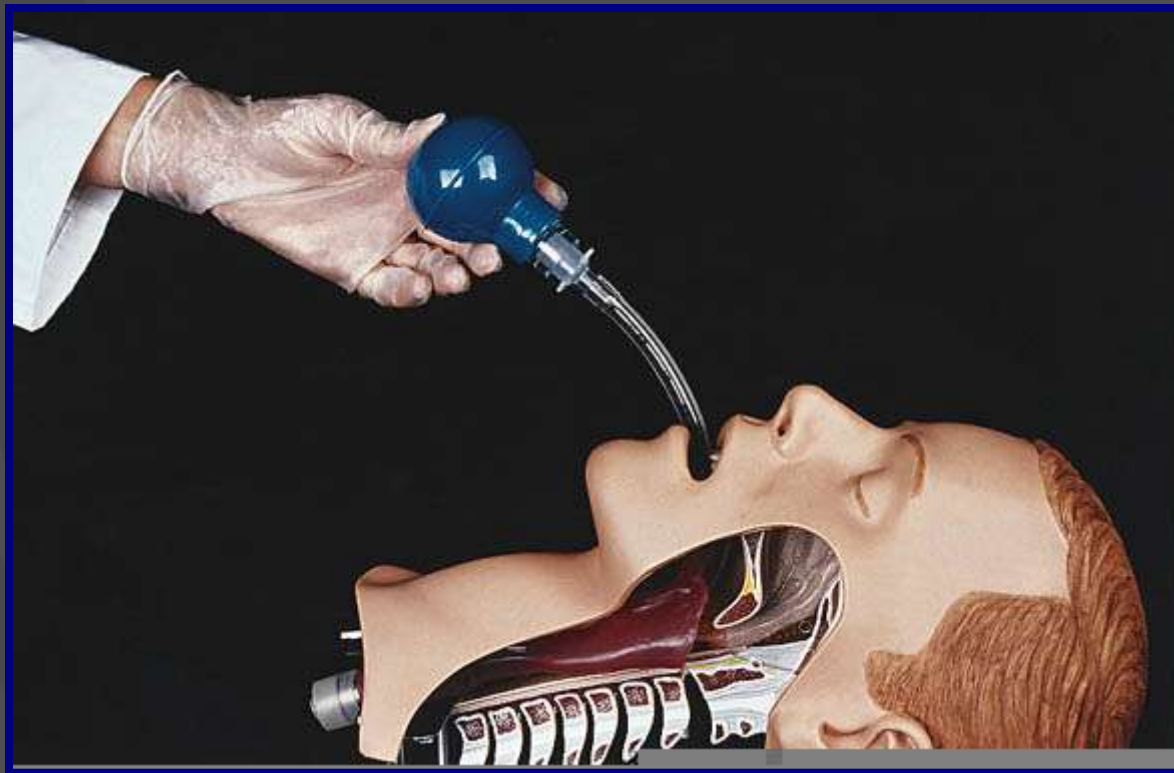


Magill Forceps





Esophageal Detection Device





Capnography - ETCO₂ Detection





Indications for ETI

- Patient unable to protect his/her own airway - absent gag reflex
- Need for prolonged artificial ventilation
- Prevents gastric insufflation
- Allows for PEEP and higher pressure ventilation as needed
- Provides a route for emergency medication administration when IV not possible

Intubation is done not only to ventilate but to isolate the lower airway to prevent aspiration...



ETI - Contraindications

- **Conscious, alert patient with intact gag reflex (without RSI)**
- **Patients with quickly and easily reversible conditions - diabetic, drug OD**
- **C-Spine injury - must modify technique**
- **Epiglottitis - unless imminent airway failure**
- **You are not trained or authorized to perform procedure**



ETI

Advantages

- Isolates trachea
- Impedes gastric distention
- Eliminates need for mask seal
- Direct route for pulmonary suction
- Alternate medication route

Disadvantages

- Requires considerable training/experience
- Specialized equipment required
- Bypasses upper airway functions (warming, filtering, humidifying)



ETI Complications

- **Equipment Malfunction**
- **Airway Trauma**
- **Hypoxia - limit attempts to 30-seconds**
- **Unrecognized esophageal intubation**
- **Endobronchial intubation - mainstem**
- **Barotrauma**
- **Vocal cord damage - voice changes**
- **Increased ICP in head injuries**
- **Vagal stimulation (bradycardia, hypotension)**



Esophageal Placement – BAD!

- Absence of chest rise & breath sounds
- Gurgling sounds over epigastrium
- Abdominal distention
- Absence of breath condensation
- Persistent air leak despite cuff inflation
- Cyanosis and patient deterioration
- Phonation
- No color change on ETCO_2 detector
- Low/falling pulse oximetry



Sniffing Position

- Raise the head approximately 10cm with a pillow
- Lift the chin to the point of extreme flexion of the neck





Orotracheal Intubation Procedure

- **BSI**
- **Position the patient - supine/head neutral**
- **Hyperventilate patient for 2-minutes with OPA/BVD**
- **Assemble and check equipment**
 - **Laryngoscope - handle/blade**
 - **ETT - size/cuff/lubricate**
 - **Stylet**
 - **10 mL Syringe**
 - **Bite block - OPA, other**
 - **Magill forceps - as indicated**
 - **Benzocaine spray, LTA, any other drugs**
 - **EDD and/or ETCO₂**
 - **Stethoscope**
 - **Suction**



Orotracheal Intubation Procedure

- Position patient as needed
- Remove dentures
- Sellick's maneuver - cricoid pressure - Why?
- Hold the laryngoscope in left hand - Why?
- Enter right side of mouth and move tongue to left, advancing to base of tongue
- Visualize the epiglottis - are you using a curved or a straight blade?



Orotracheal Intubation Procedure

Straight Blade

Advance the blade past the epiglottis and manually lift it with tip of blade so that you can visualize the vocal cords and glottic opening

Curved Blade

At the base of the tongue, advance tip of blade into the vallecula, apply upward and away pressure to lift epiglottis allowing visualization of vocal cords and glottic opening



Orotracheal Intubation Procedure

- Remember to lift up and away - do not use teeth as a fulcrum - you are not prying!!!
- If vomitus or secretions noted, suction
- Upon visualization of the vocal cords/glottic opening, holding the ETT in your right hand, pass the tube through the right corner of mouth and advance tip through vocal cords until the cuff disappears

You must see the cords and you must see the tube pass the cords - this is the best way of knowing you are where you want to be...



Orotracheal Intubation Procedure

- Remove stylet if used
- While holding onto the tube - **never let go** - assess placement with an EDD as applicable
- Inflate cuff with 5-10 mL of air and remove syringe from inflation valve
- Confirm placement by listening over the epigastrium and then bilateral lung fields
- If available, utilize ETCO₂ detector to monitor for any changes
- Hyperventilate with 100% oxygen
- Secure tube in place and insert bite block
- Reassess tube placement with any patient movement



What should you do if there are absent or diminished breath sounds or if there is any doubt about tube placement?





Confirming Placement

- **Direct visualization**
- **Chest rise and fall**
- **Auscultation - epigastrium and lungs**
- **Tube condensation**
- **Patient color change or change in condition**
- **EDD and ETCO₂ detectors**
- **Pulse oximetry**



ETI Documentation

- Who did it
- With what was it done
- Where was it done
- When was it done
- Why was it performed

Also include at least 3 specific assessments
you made to confirm placement...

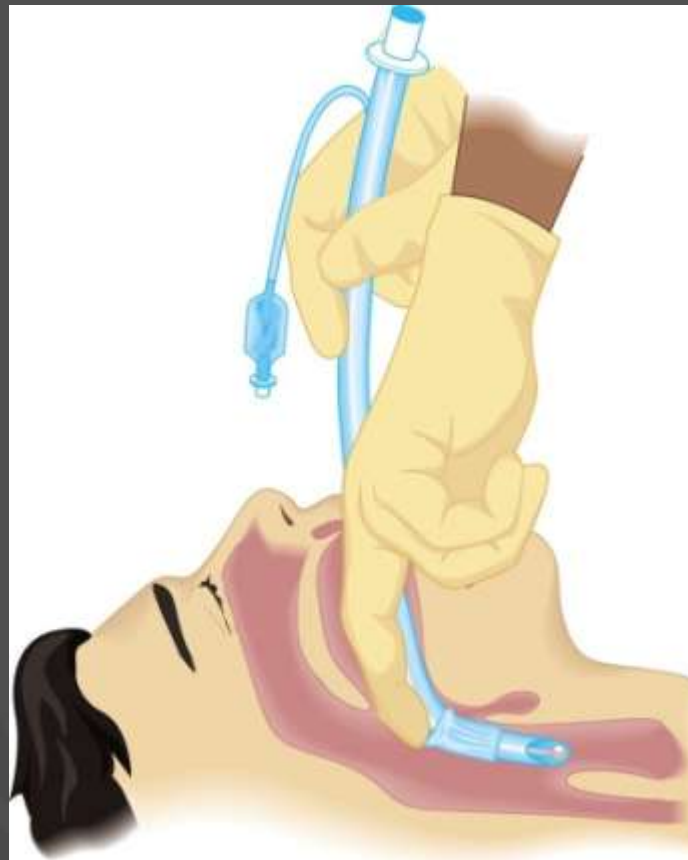


Transillumination ETI



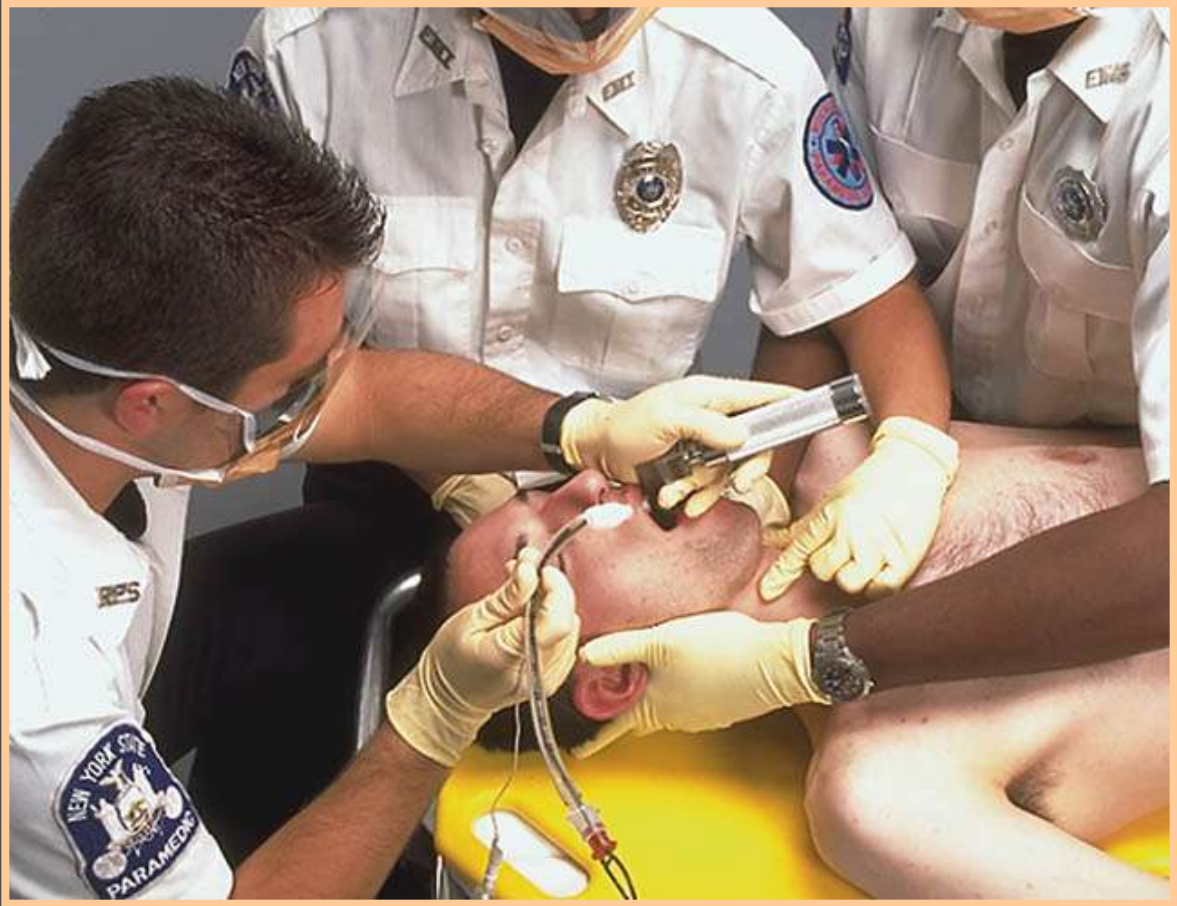


Digital ETI



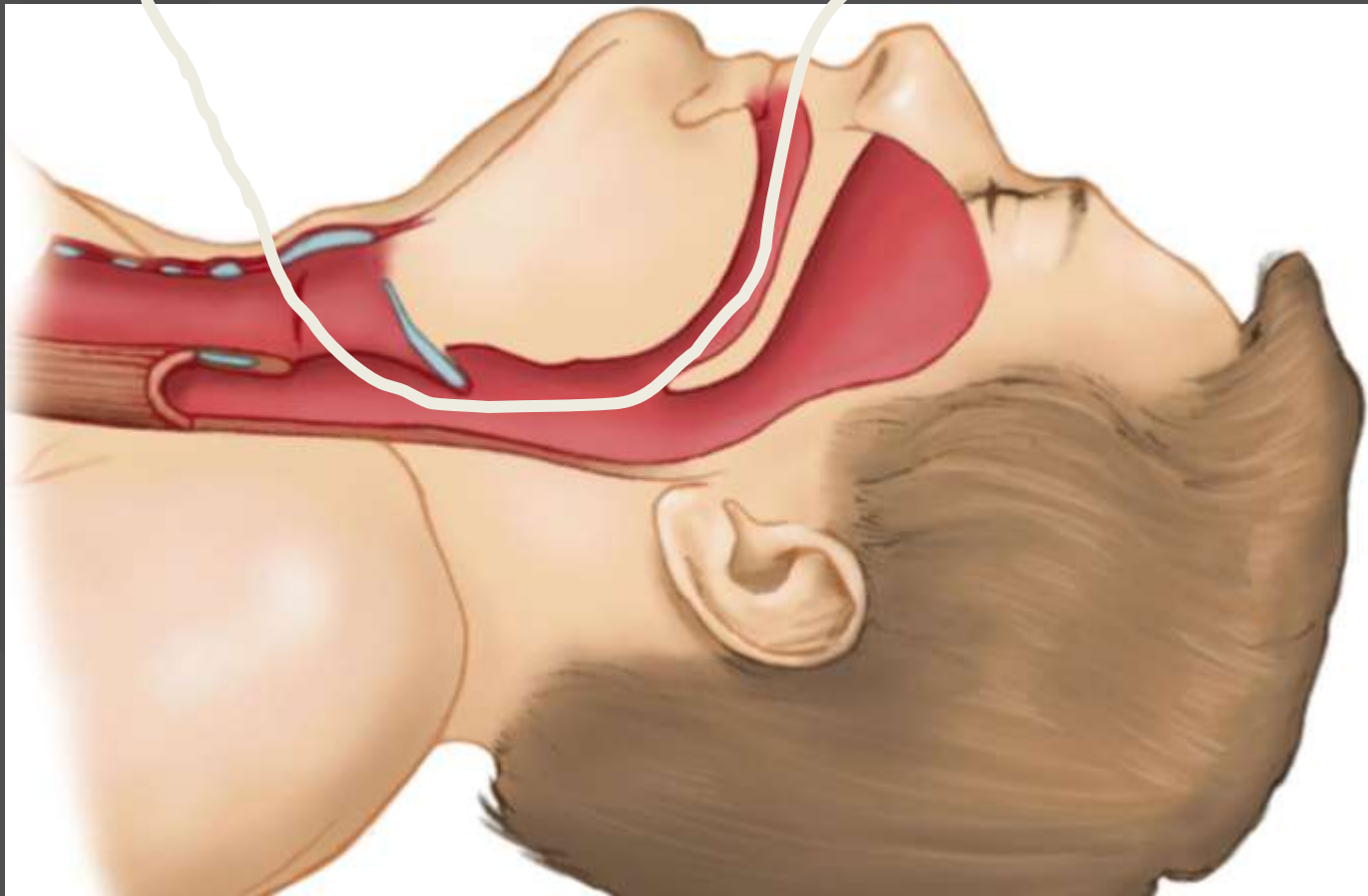


In-line Intubation





Retrograde ETI





Pediatric Intubation

- **Straight blade preferred**
- **Tube size - $(\text{age in years} + 16) / 4$**
- **Under 8 = no cuff (this is changing)**
- **Note black glottic markers on tube**
- **Greater vagal tone - bradycardia**
- **Follow other steps as for any intubation**





Nasotracheal Intubation

- **Blind procedure without direct visualization**
- **Is a time consuming procedure that requires patience, skill, and a lot of luck**
- **Patient must also have some respiratory effort**
- **Utilized when orotracheal intubation is not possible due to various reasons**
- **Equipment is same as that used for oral route**



Nasotracheal Intubation - Indications

- Possible spinal injury
- Clenched teeth
- Fractured jaw or other oral trauma
- Obesity
- Arthritis or condition limiting ability to position patient





Nasotracheal Intubation - Contraindications

- **Suspected nasal fractures**
- **Suspected basilar skull fractures**
- **Nasal septal deviation or nasal obstruction**
- **Respiratory arrest**
- **Unresponsive without gag reflex**



Nasotracheal Intubation

Advantages

- Neutral position of head/neck
- Limited gag response
- Tube not able to be bitten

Disadvantages

- More difficult and time consuming
- More traumatic
- Greater risk of infection
- Greater chance of improper placement



Nasotracheal Intubation - Procedure

- **Select larger nostril - usually the right**
- **Listen to proximal end of tube for breathing**
- **Do not force the tube**
- **As patient inhales, advance the tube...**





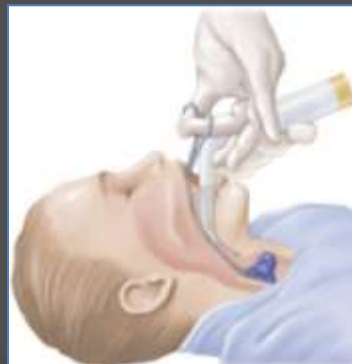
Field Extubation

- Rare for medics to extubate in the field
- Successful reintubation may be more difficult than initial attempts
- Confirm optimal patient response warranting extubation
- Be armed with suction
- Deflate cuff
- Remove tube upon exhalation or have patient cough



Direct Laryngoscopy

- **Used to visualize foreign bodies for removal**
- **Utilize Magill forceps to remove object**
- **Use only after basic life support maneuvers have failed**
- **Visualization is identical to that used for ETI**





Surgical Airways

- **Needle Cricothyroidotomy (percutaneous transtracheal ventilation)**
- **Surgical Cricothyroidotomy (open)**
- **Use only as a last resort**
- **Highly invasive and prone to complications**





Surgical Airway Indications

- Intubation and ventilation not possible by other means
- Massive facial trauma most common need
- Total upper airway obstruction
 - epiglottitis
 - burns
 - FB
 - anaphylaxis



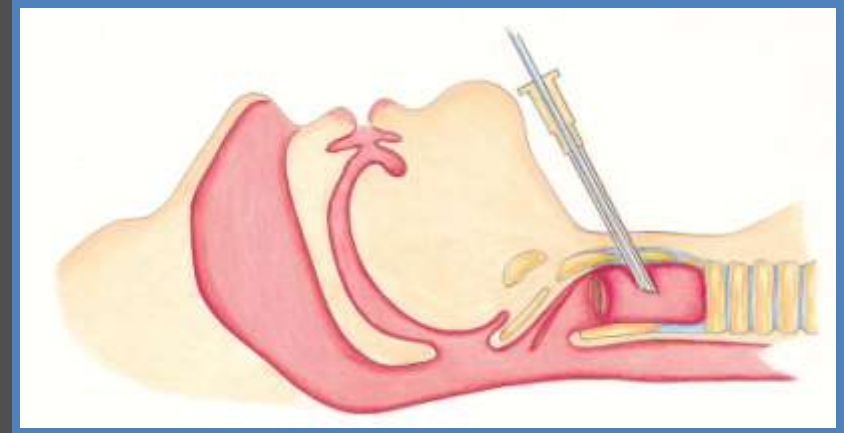
Surgical Airway - Contraindications

- Inability to identify anatomical landmarks
- Crush injury to larynx/trachea
- Tracheal transection
- Lack of skill/knowledge/training
- Age - under 12 needle, over 12 surgical desirable
- Anatomical abnormalities
 - trauma
 - tumor
 - subglottic stenosis



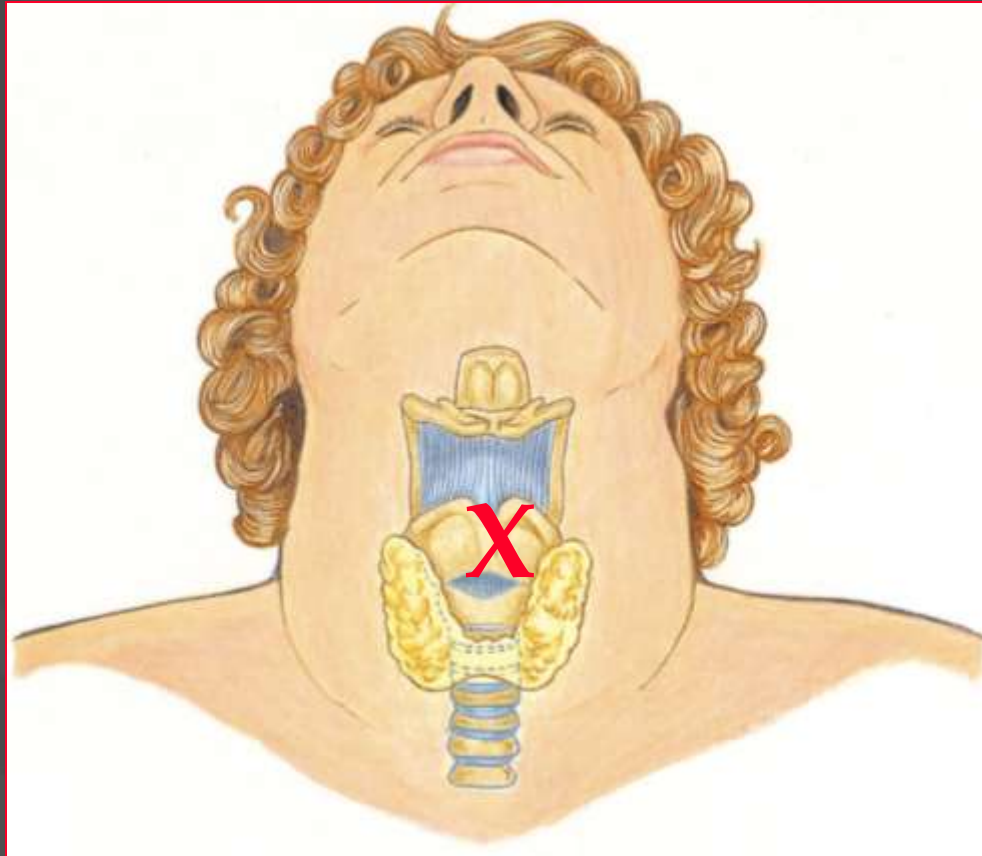
Needle Cric Equipment

- BSI
- Angiocath
 - 14-16 gauge - Adult
 - 18 gauge - Pediatric
- 10 mL Syringe
- #3.0 mm ETT adapter
- Y-connector
- Oxygen Tubing
- Oxygen source - 50 psi



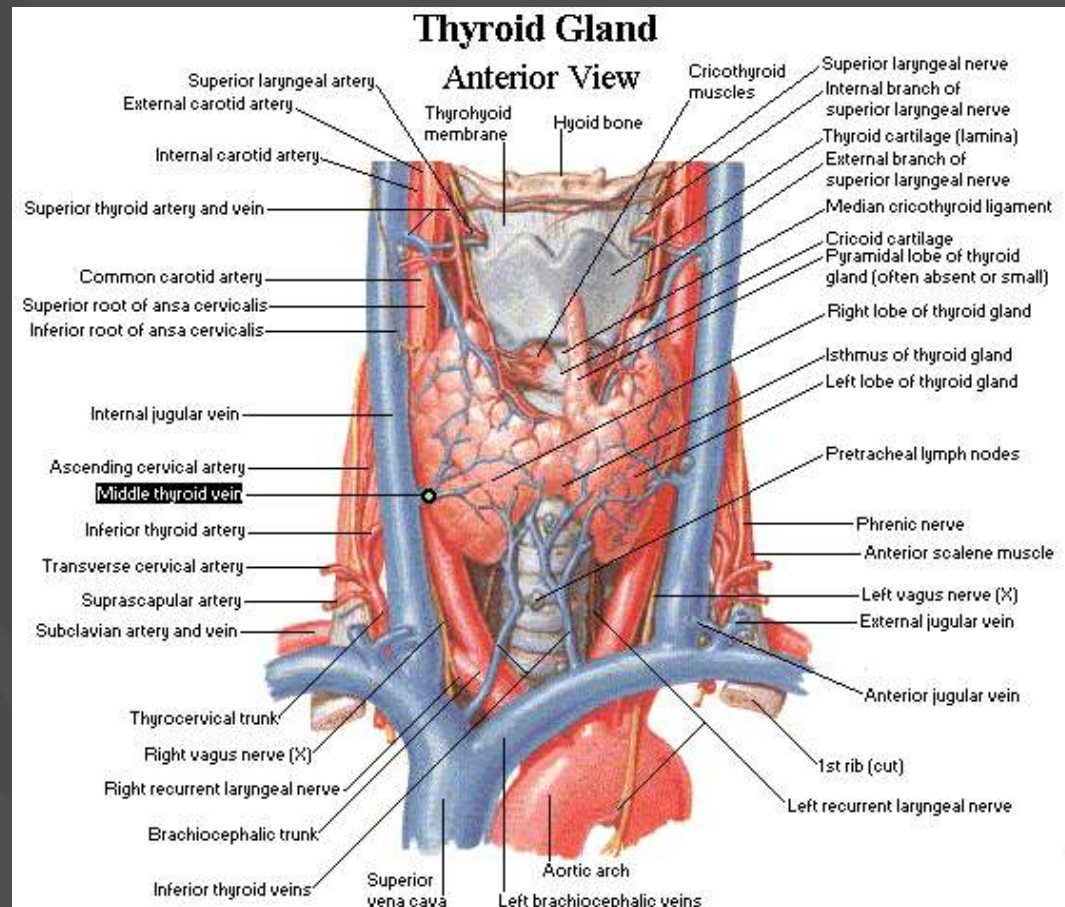


Landmarks





Anterior Neck Anatomy



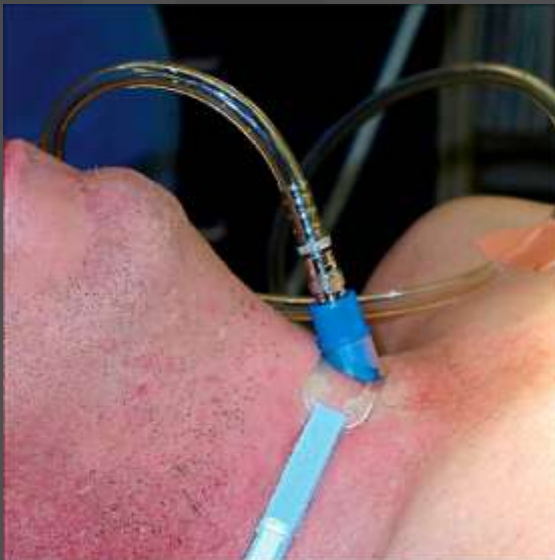
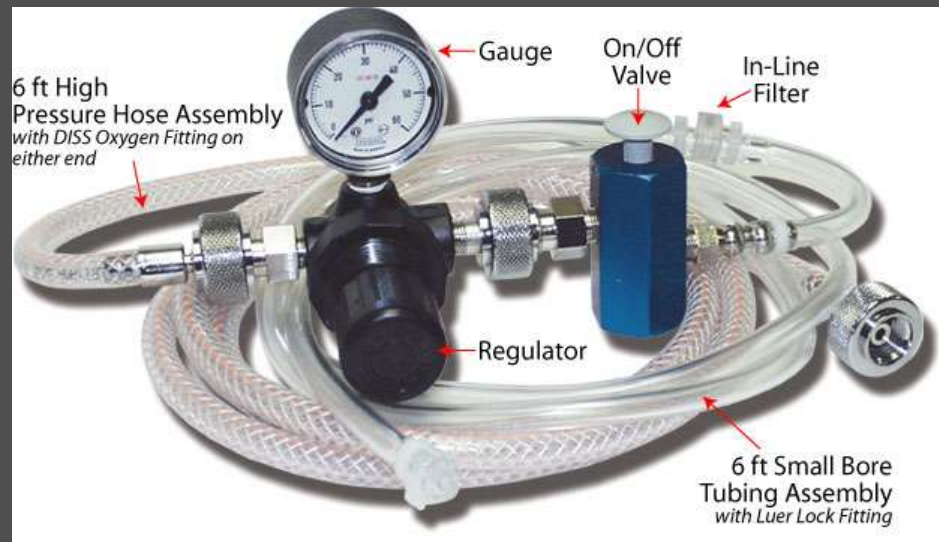


Needle Cric Procedure

- **BSI**
- **Position patient - supine, neutral**
- **Identify landmarks**
 - **thyroid cartilage**
 - **cricoid cartilage**
 - **cricothyroid membrane**
- **Assemble equipment**
- **Cleanse neck - alcohol & betadine**
- **Insert needle at a 45-degree angle caudally while aspirating syringe**
- **Advance catheter and secure in place**
- **Attach tubing, jet ventilator - ratio 1:2**



Transtracheal Jet Ventilation





Needle Cric Complications

- **Barotrauma from overinflation**
- **Hemorrhage**
- **Subcutaneous emphysema**
- **Laryngeal trauma**
- **Airway obstruction - bleeding, SQ emphysema**
- **Hypoventilation - misplacement, improper use of equipment**



Surgical Cric Equipment

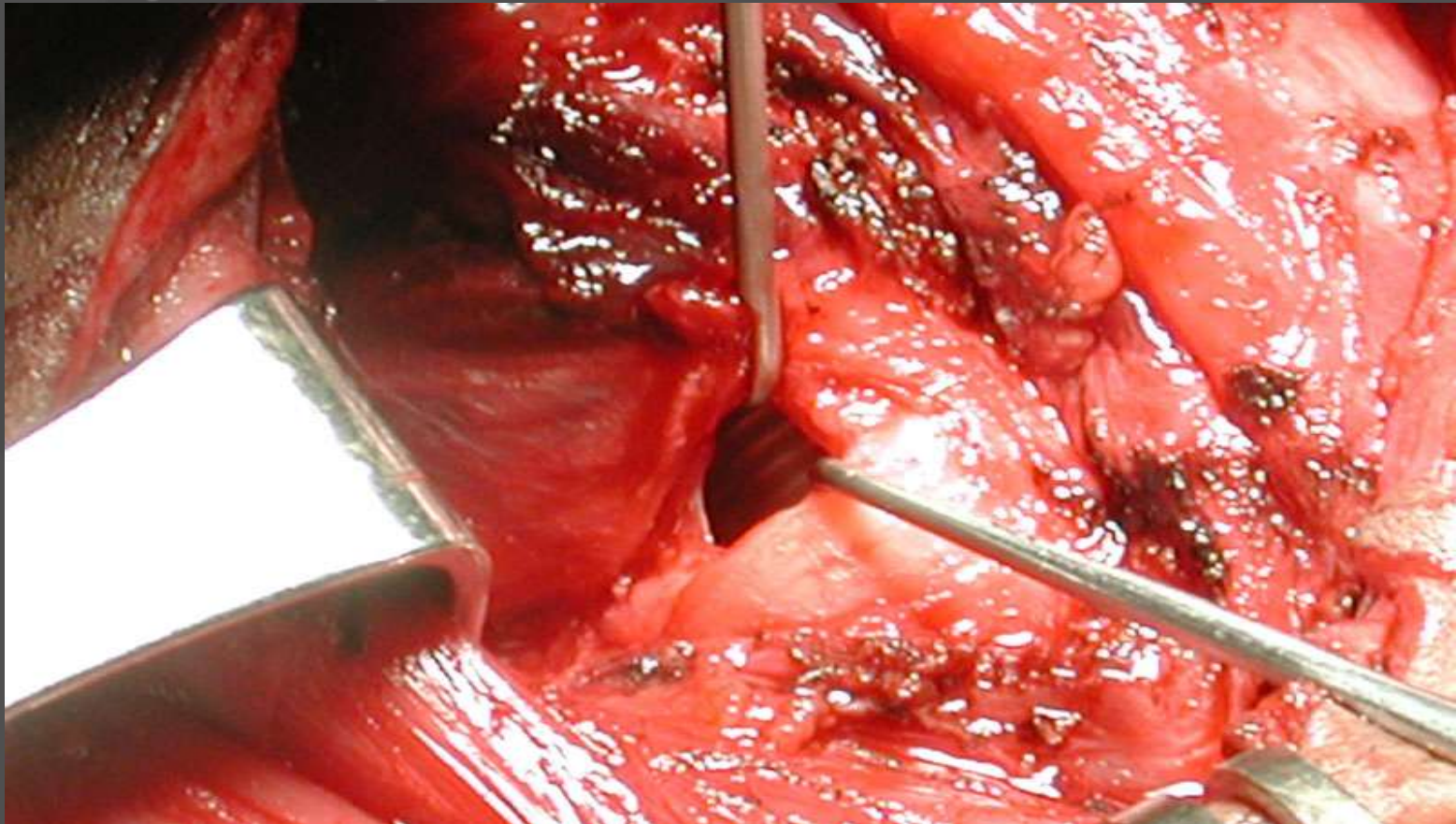
- Scalpel
- 4x4's
- Hemostat
- Endotracheal Tube/Shiley (trach tube)





SURGICAL AIRWAY

Cricothyrotomy





Surgical Cric Procedure

- **Indications, contraindications, and most aspects of the procedure mirror that of the needle cric**
- **Make a midline vertical incision 1-2 cm in length over the cricothyroid membrane**
- **Find membrane and make a 1 cm horizontal incision to penetrate lumen of trachea**
- **Insert handle of scalpel, finger, or curved hemostat to maintain and spread opening**
- **Insert cuffed ETT or shiley, inflate and secure**
- **Assess placement**



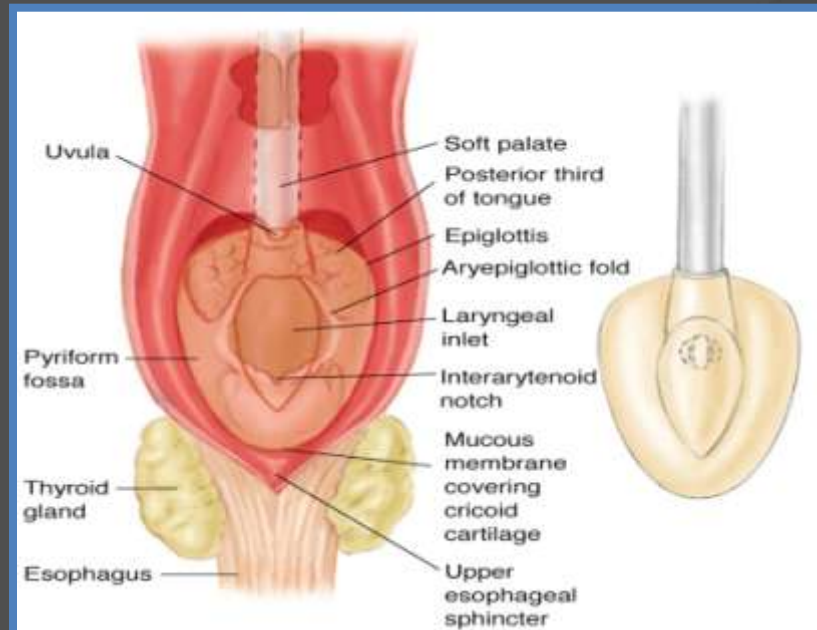
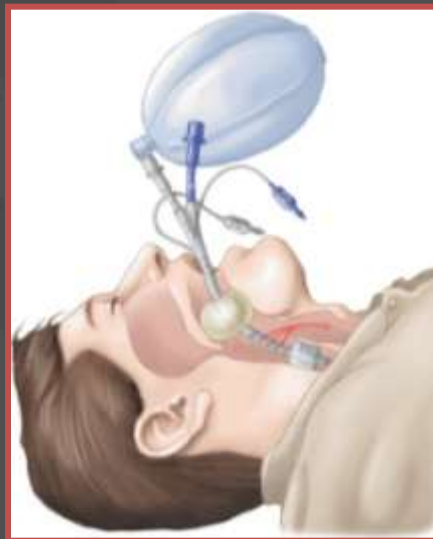
CRICOTHYROTOMY

Surgical Technique





- Esophageal Tracheal CombiTube
- Laryngeal Mask Airway (LMA)
- King Airway Device
- Pharyngeal-Tracheal Lumen Airway (PtL)
- Esophageal Gastric Tube Airway (EGTA)
- Esophageal Obturator Airway (EOA)





The prize that you are seeking...



