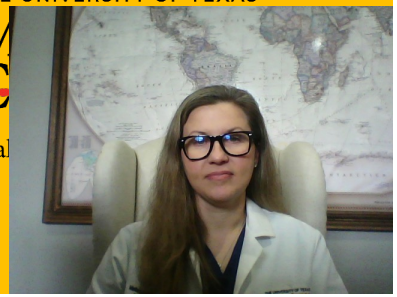
Airway Equipment, Management of Devices, and Procedures

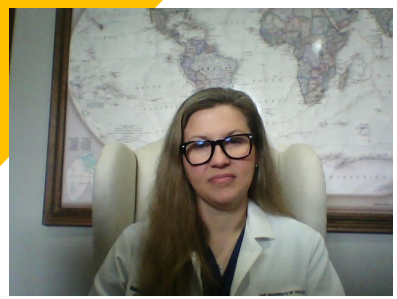
Melissa Puskac, DNAP MS CRNA

THE UNIVERSITY OF TEXAS



Disclosures

- I have no conflicts of interest to disclose.

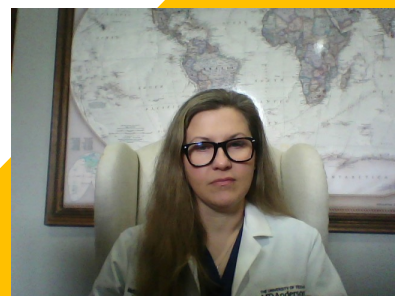


Objectives

1. Discuss advanced airway assessment relevant to anesthesia practice.

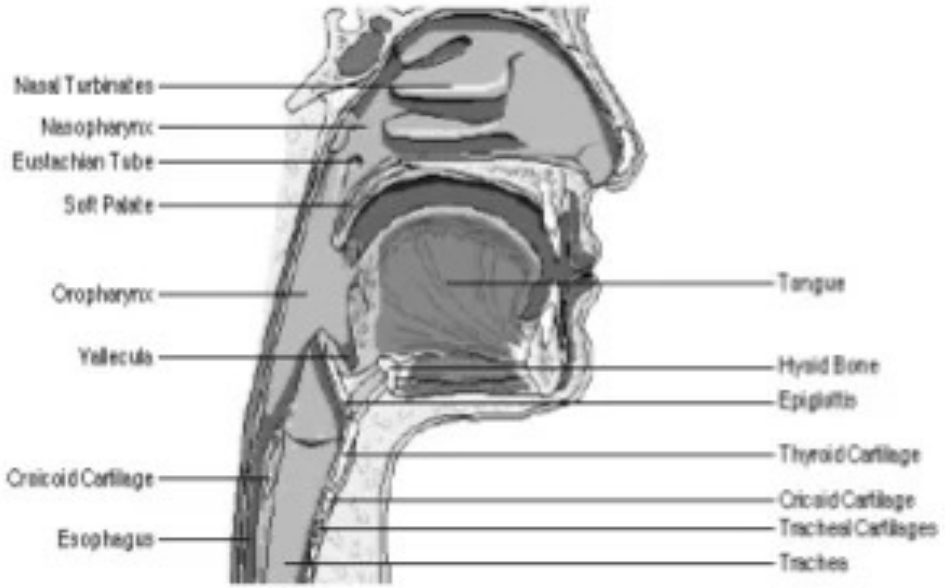
2. Discuss airway equipment relevant to anesthesia practice.

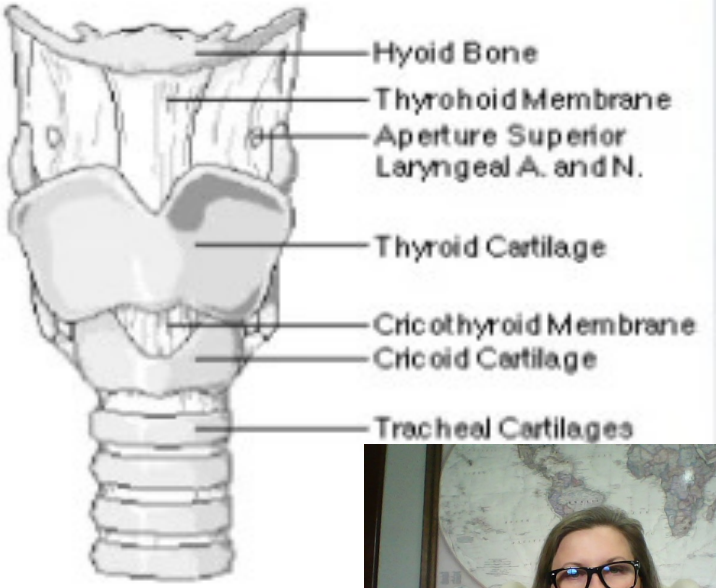
3. Discuss airway management concepts, airway blocks, and procedures.

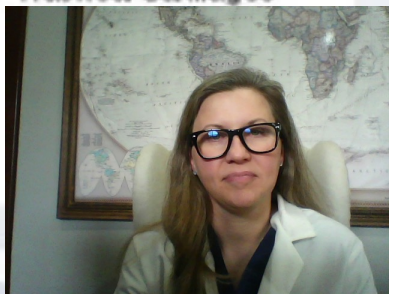


Airway Assessment

Anatomy of oropharynex and larynx

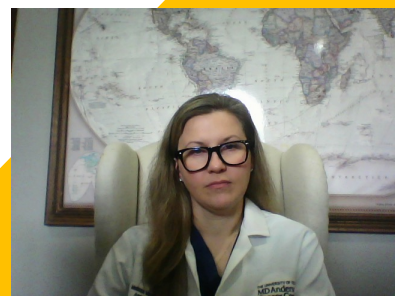






Airway Assessment Tools

- Neck Circumference
- Thyromental Distance
- Atlanto-occipital joint mobility
- Mallampati Airway Classification
- Mandibular Protrusion
- Interincisor Gap
- Previous Difficult Airway
- Ultrasonography of the Airway

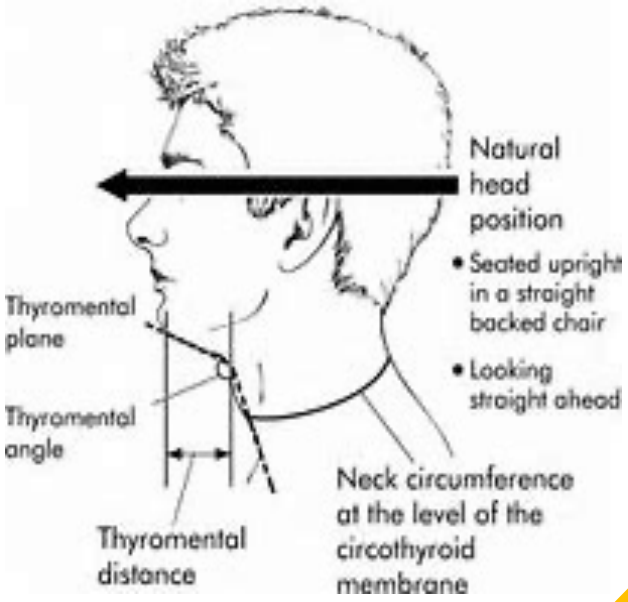


Neck Circumference

- Greater than 43 cm or 17 in circumferentially at the thyroid cartilage,
- Is a strong predictor of intubation difficulty.

Thyromental Distance

- Thyromental space of < 3 finger breaths suggests tongue displacement may be limited during direct laryngoscopy.
- Conversely, assessment of a long TMD (greater than 9 cm) may also indicate a potentially difficult laryngoscopy and intubation.



Atlanto-Occipital Joint Mobility

- **Provides the highest degree of mobility in the neck, with the full range of neck flexion and extension varying from 90 to 165 degrees**
- **The best way to assess the patient's level of extension is with the patient seated in an upright neutral position; lift the head back with chin up as far as possible.**

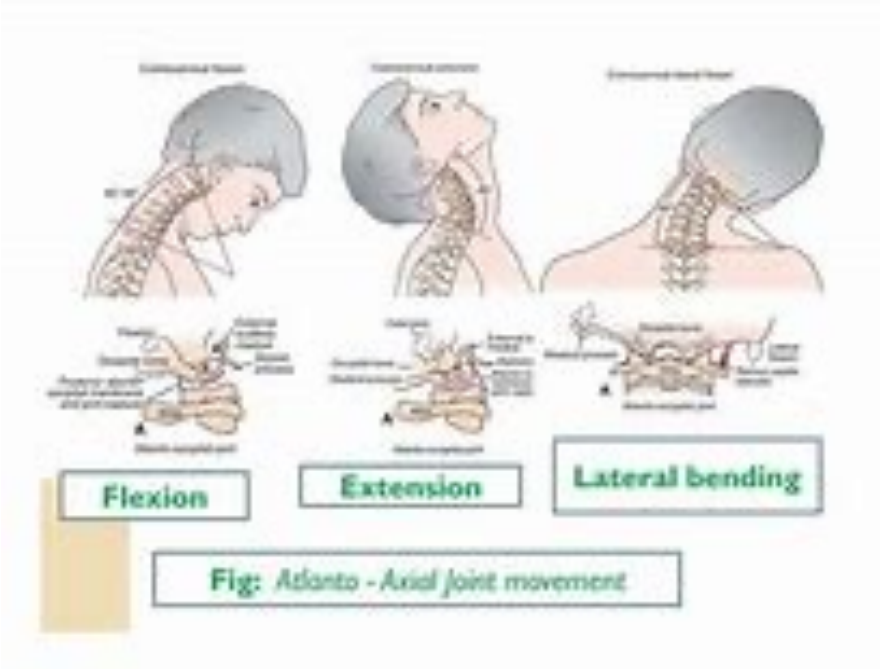
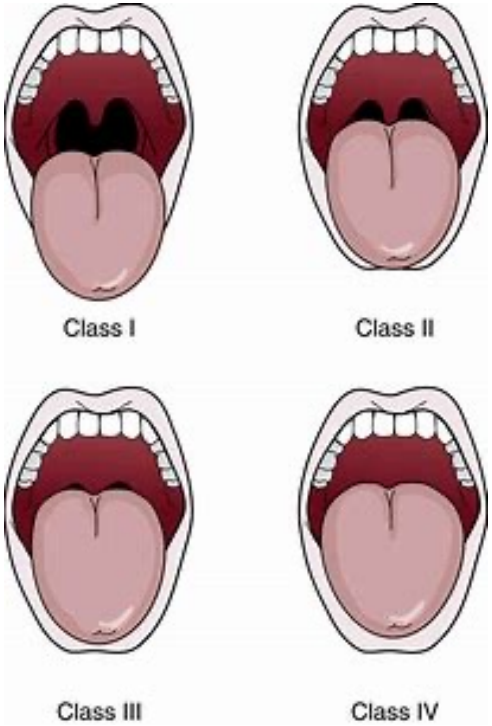
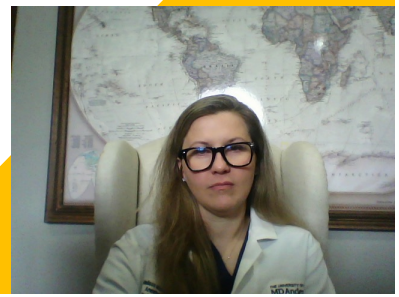


Fig: *Atlanto - Axial joint movement*

Mallampati Airway Classification

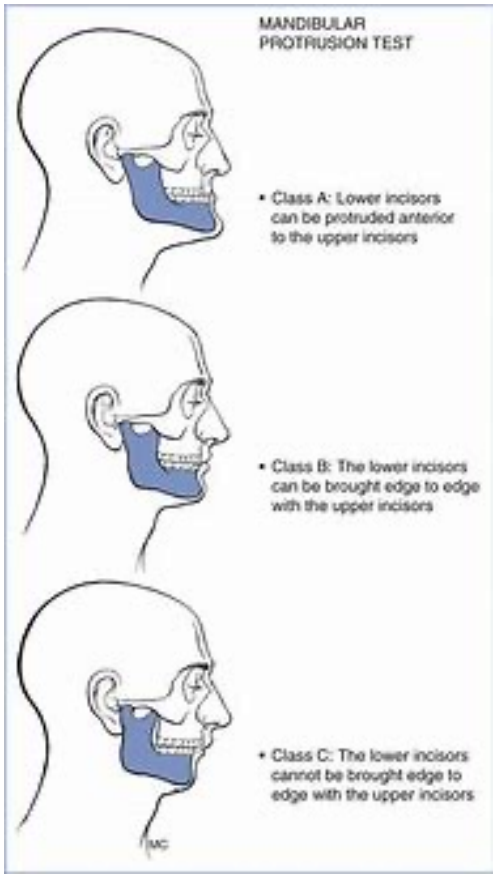
- A quick external assessment of the patient's mouth opening and oropharyngeal structures.
- Four classes of visualization.
- To perform this assessment, the patient is instructed to sit upright, extend the neck, open the mouth as much as possible and protrude the tongue, and avoid phonation.





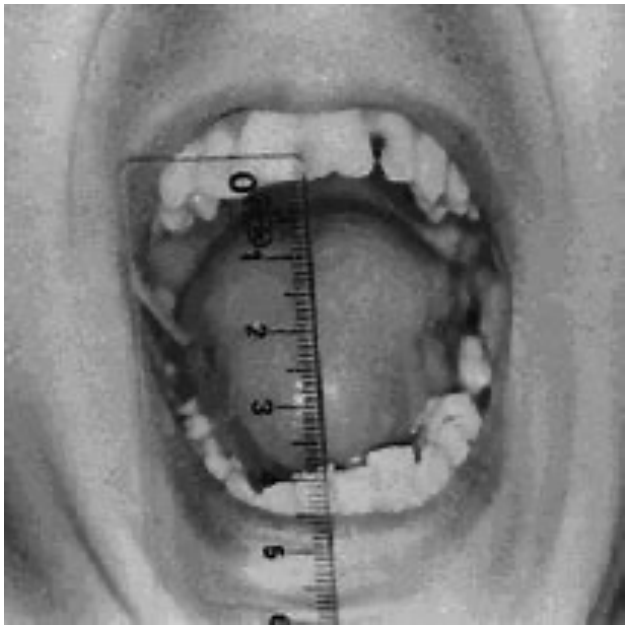
Mandibular Protrusion

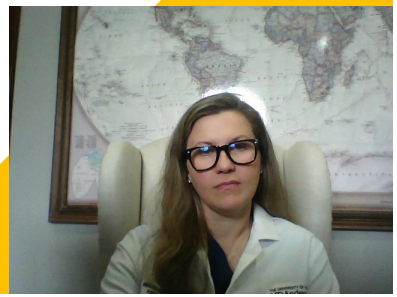
- **This assessment demonstrates the patient's ability to extend the mandibular incisors anteriorly and past the maxillary incisors.**
- **Primary purpose: To assess the mobility of the patient 's TMJ function and forward subluxation of the jaw.**
- **Made up of three classes: *Class* A, *Class* B, *Class* C.**



Interincisor Gap (Mouth Opening)

- **2-3 average fingerbreadths, or a minimum of 4 cm.**
- **A small interincisor gap can cause difficulty with laryngoscopy and supraglottic airway device placement.**
- **This risk is further potentiated if the patient has loose or awkward teeth.**





CONDITIONS ASSOCIATED WITH DIFFICULT AIRWAY MANAGEMENT

Pathologic Conditions	Features Affecting Airway Management
Acquired Conditions	
Epiglottitis	Epiglottal and laryngeal edema
Laryngotracheobronchitis (croup)	Laryngeal and subglottic edema
Rheumatoid arthritis	Limited cervical spine range of motion, atlantoaxial instability, temporomandibular joint ankyloses, cricoarytenoid arthritis
Carcinoma of the tongue, larynx , or thyroid	Altered airway anatomy, stenosis, fixation of larynx or surrounding tissues
Trauma	Head, neck, facial tissues can be distorted by trauma, edema, hemorrhage. Any bony structure can be unstable. Laryngeal structures can be damaged or distorted
Radiation	Edema, fixation of tissue, friable tissue, impaired lymphatic drainage
Morbid obesity	Thick neck with redundant tissue, large to sleep apnea

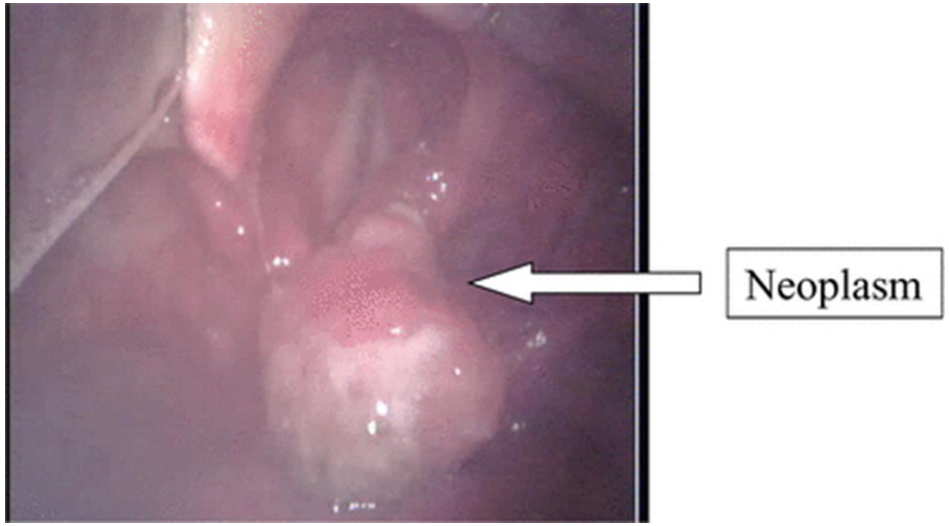
CONDITIONS ASSOCIATED WITH DIFFICULT AIRWAY MANAGEMENT

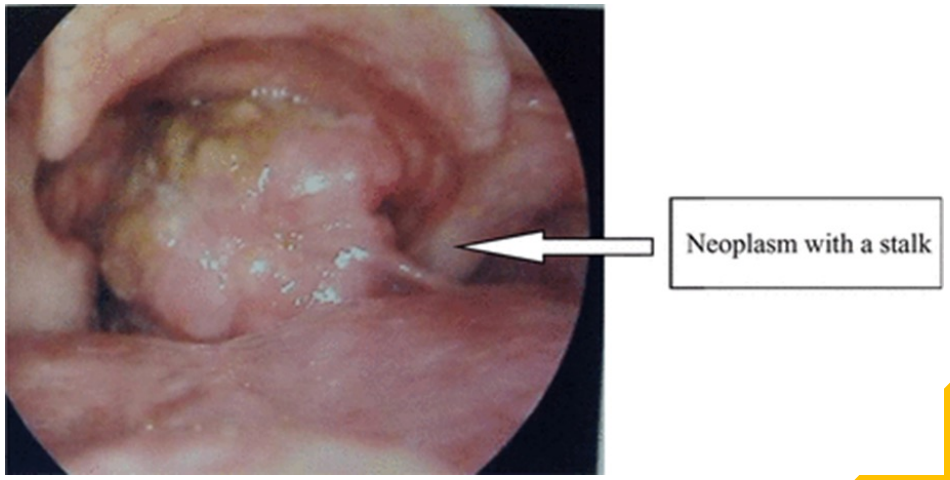
Pathologic Conditions	Features Affecting Airway Management
Congenital Conditions	
Pierre Robin sequence	Cleft palate, retrognathia , micrognathia, glossoptosis
Treacher Collins syndrome	Mandibular & zygomatic hypoplasia, choanal atresia
Goldenhar syndrome	Hemifacial macrosomia; mandibular hypoplasia; vertebrae maybe incomplete , fused or underdeveloped
Klippel-Feil syndrome	Fusion of two or more cervical vertebrae, limited neck range of motion, short neck
Down syndrome	Macroglossia, microcephaly, cervical spine abnormalities, obstructive sleep apnea, dental anomalies
Hurler syndrome and Hunter syndrome	Macroglossia, odontoid hypoplasia, dwarfism, dental anomalies, stiff joints, obstructive airway respiratory infections
Beckwith-Wiedemann syndrome	Macroglossia, microcephaly
Cri du chat syndrome	Microcephaly, retrognathia, micrognathia

Angioedema

- **Type I Hypersensitivity Reaction**
- **Manifests within minutes**
- **Airway obstruction from edema of the tongue, oropharynx, and larynx**

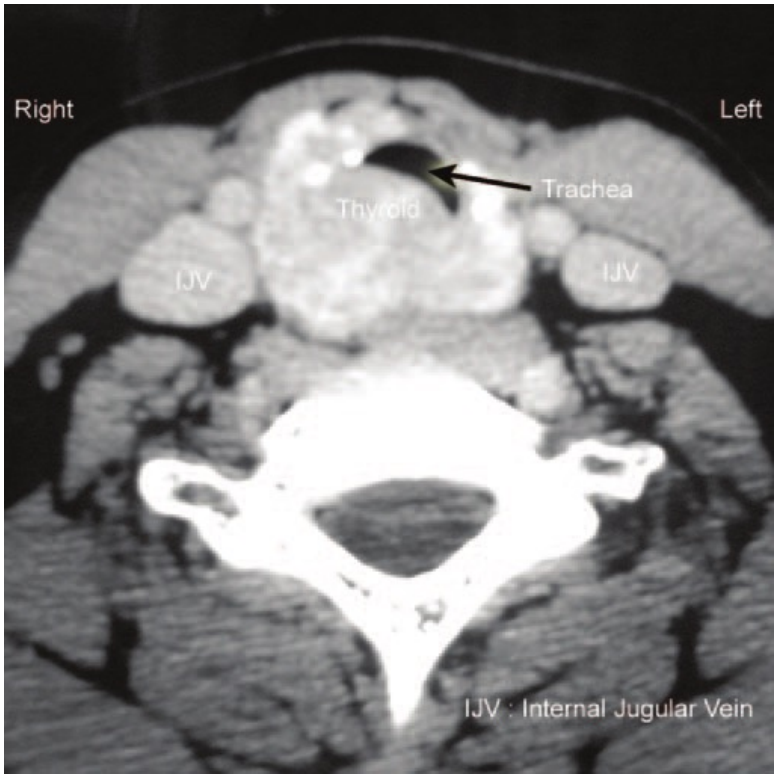
Supraglottic tumors

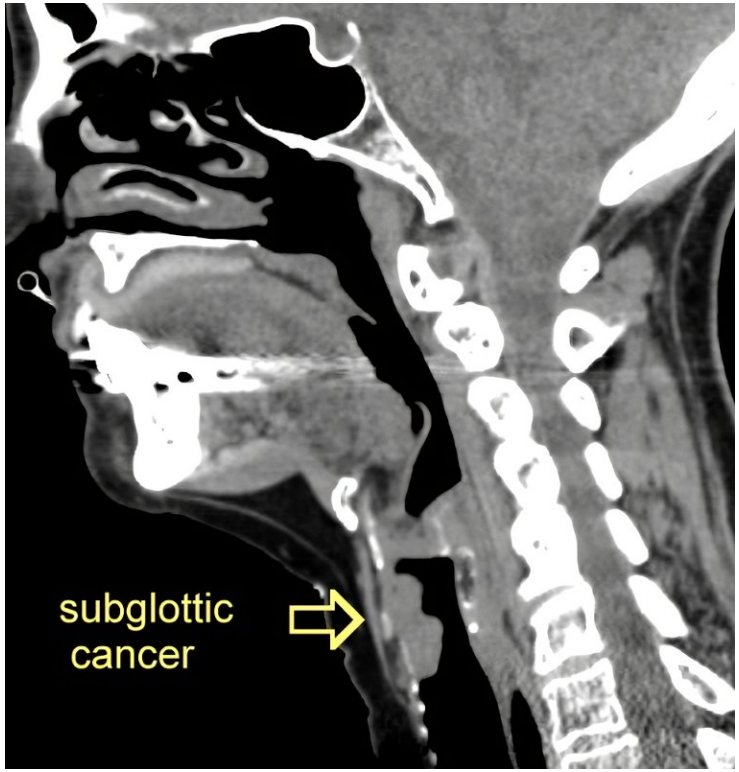




Airway Assessment

Subglottic Masses





Airway Equipment and Management of Devices

MD ANDERSON CANCER CENTER

Oxygen Delivery Devices

- Nasal Cannulas
- Simple Facemasks
- Nonrebreather Facemasks
- Anesthesia Facemasks
- Anesthesia Circle System
- Supraglottic Airway Devices (SADs)

Oxygen Delivery Devices

- **Nasal Cannulas**
  - Provide FiO2 of approximately 24% at 1L flow
  - FiO2 ↑'s by about 4% per additional L
- **Simple Facemasks**
  - Provides a reservoir for O2 delivery of approximately 100-200mL
  - Recommended range 5-8L/min
  - Approximately 40% FiO2 at 5L and up to 60% FiO2 at 8L

Oxygen Delivery Devices

- **Non-Rebreather Facemasks**
  - Provides a reservoir of 600mL-1000mL
  - Requires 10-15L/min flow
  - Provides FiO2 concentrations of 80-90%
  - If adequate O2 is not flowing it creates high risk of rebreathing CO2

- **Anesthesia Facemasks**
  - Single use clear plastic mask that contains a body, a seal, and a connection point
  - Provides O2 delivery for spontaneous breathing, assisted spontaneous ventilation, and controlled ventilation via positive pressure ventilation when a good contact seal is made
  - Aggressive positive pressure ventilation can lead to gastric distention, vomiting, and aspiration

Anesthesia Circle System

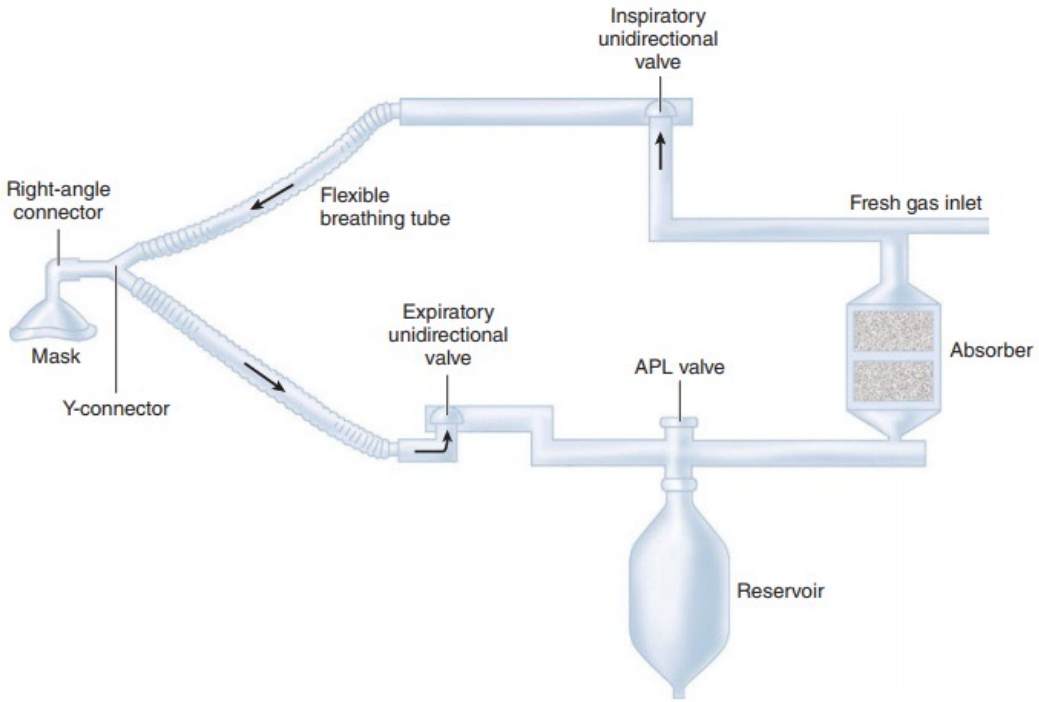


FIGURE 3–8 A circle system. APL, adjustable pressure-limiting (valve).

Oxygen Delivery Devices

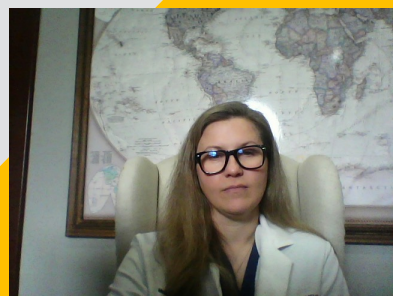
- **Supraglottic Airway Devices (SADs)**
  - Airway adjuncts that provide ventilation above the glottic opening
  - Includes: Laryngeal Mask Airways (LMAs), King Laryngeal Tube Airways, Ambu Airways, and many other models

Indications for use of a Supraglottic Airway Device

- Rescue Ventilation for Difficult Mask Ventilation or Failed Intubation
- Alternative to Endotracheal Intubation for Elective Surgery
- Conduit to Facilitate Intubation

Types of Supraglottic Airway Devices

- Basic Laryngeal Mask Airway
- Second Generation SADs
- Intubating SADs
- Supraglottic Tubes

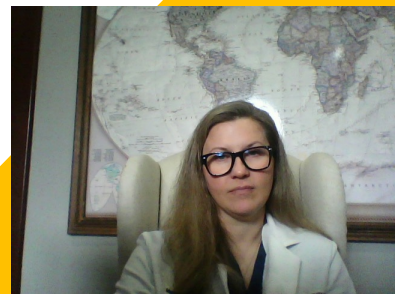


Basic LMA

- **Single-use or Reusable Models**
- **Least Expensive LMA product**
- **Inflatable Cuff**

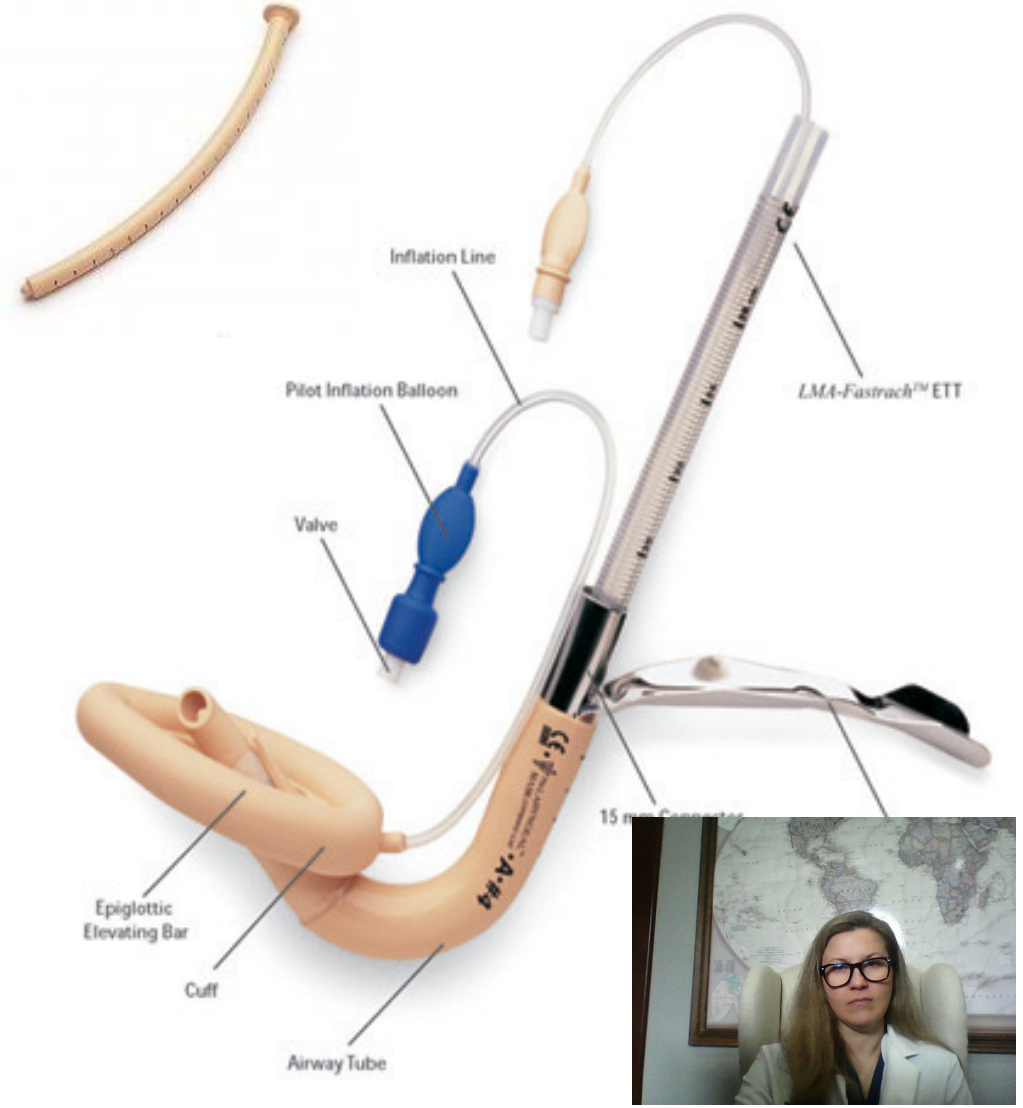
Second Generation SADs

- **Channel for Gastric Decompression**
- **Reinforced Tips**
- **Improved Cuff Design**
- **More Rigid Design**



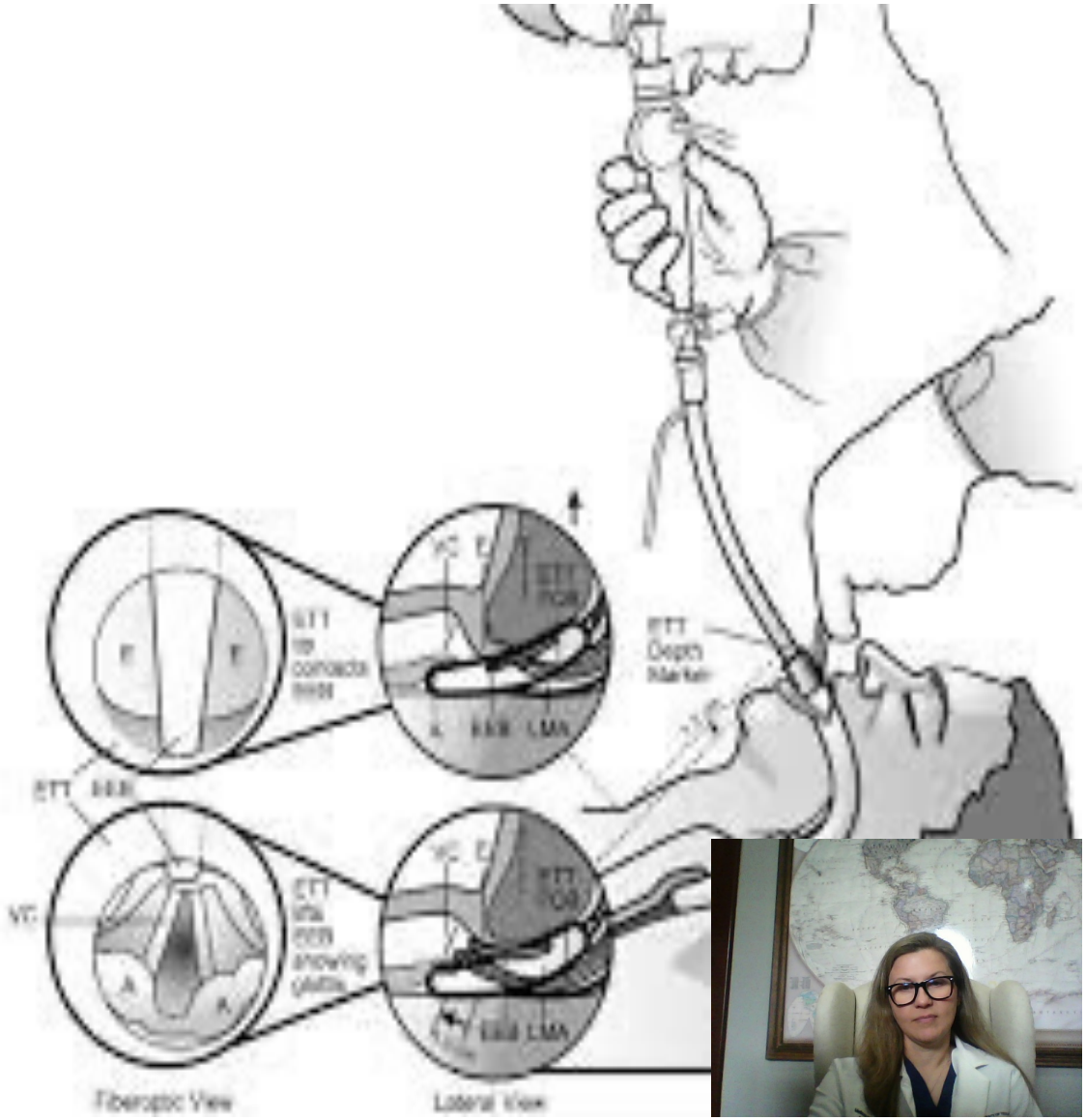
Intubating SADs

- **Provides Supraglottic Ventilation and Facilitates Either Blind or Flexible Endoscopic Guided Intubation**
- **Indicated When Difficult Facemask Ventilation and/or Intubation Occur, but Supraglottic Ventilation is Adequate**



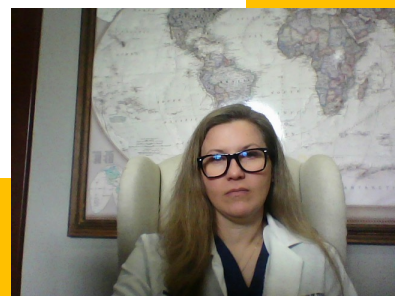
Intubating SADs

- **Flexible Endoscopic Intubation can also be achieved through LMA**
- **Does not need to be a “Fast Trach” or “Intubating LMA”, but it can be.**
- **Seat LMA, load ETT over endoscope, advance scope through LMA and into glottic opening, pass ETT through glottic opening, remove endoscope, slide LMA over ETT and remove LMA, verify ETT did not move with endoscope.**



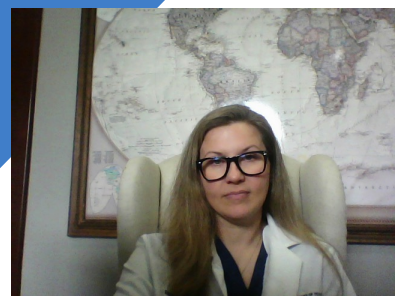
Supraglottic Tubes

- Placed blindly into the mouth and positioned into the esophagus
- Distal balloon to occlude the esophagus
- Larger proximal balloon to occlude the posterior oropharynx
- Ventilation port between balloons



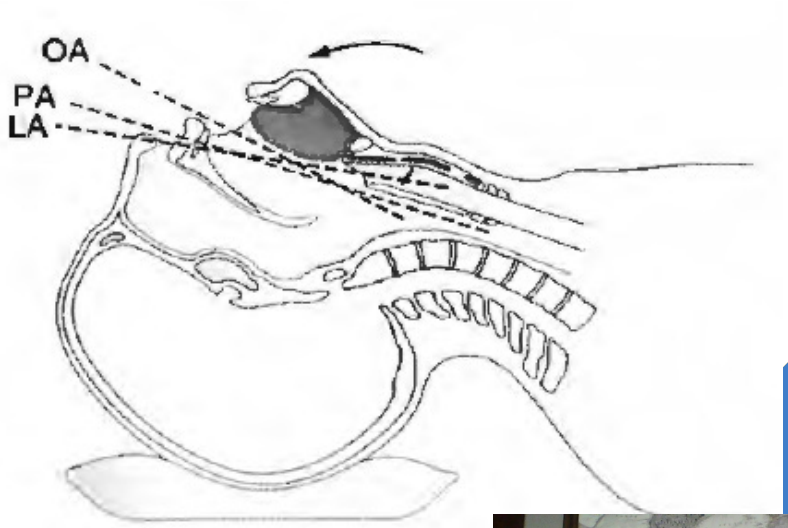
Intubation Devices

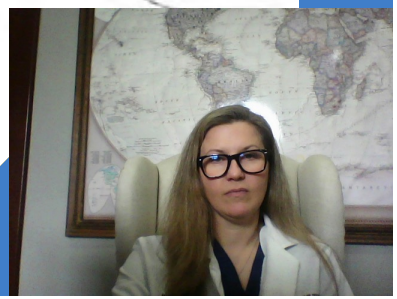
- Direct Laryngoscopes
- Video Laryngoscopes
- Intubating Stylets
- Flexible Intubating Endoscopes



Direct Laryngoscopy

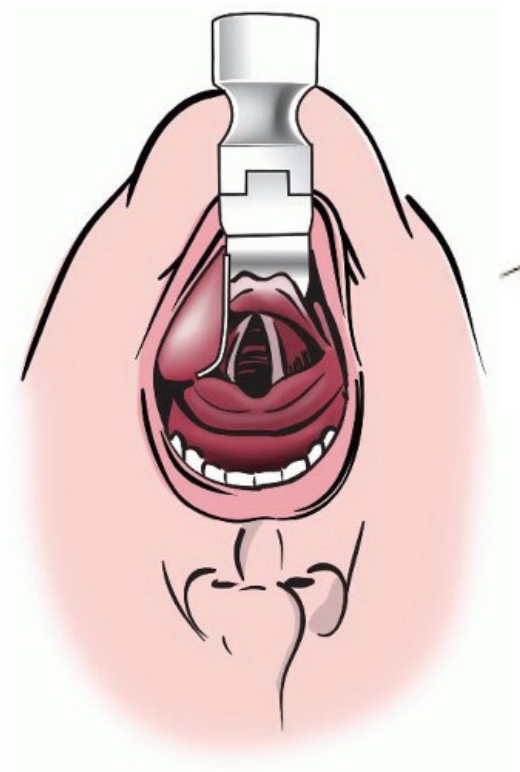
- Macintosh or Miller Blade
- Optimal head and neck position are key
- Align tragus of ear with sternum
- “Sniffing Position” to align oral, pharyngeal, and laryngeal axes
- Preoxygenation and Denitrogenation

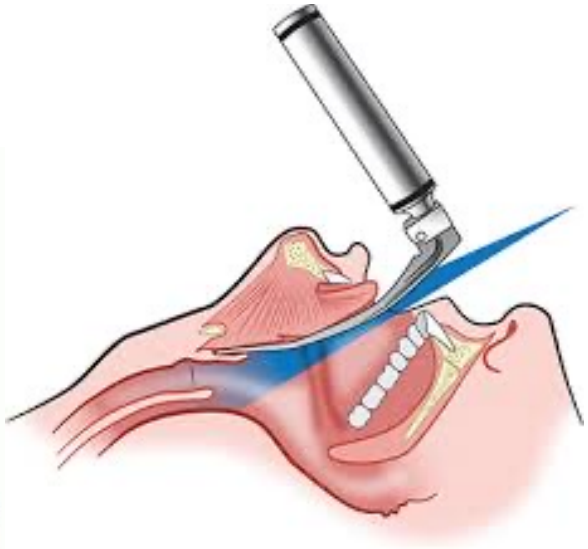


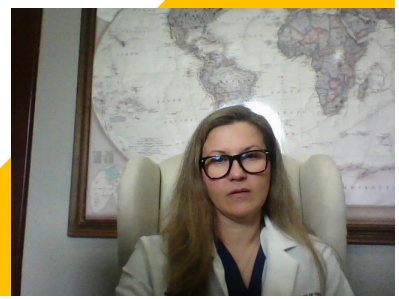


Direct Laryngoscopy

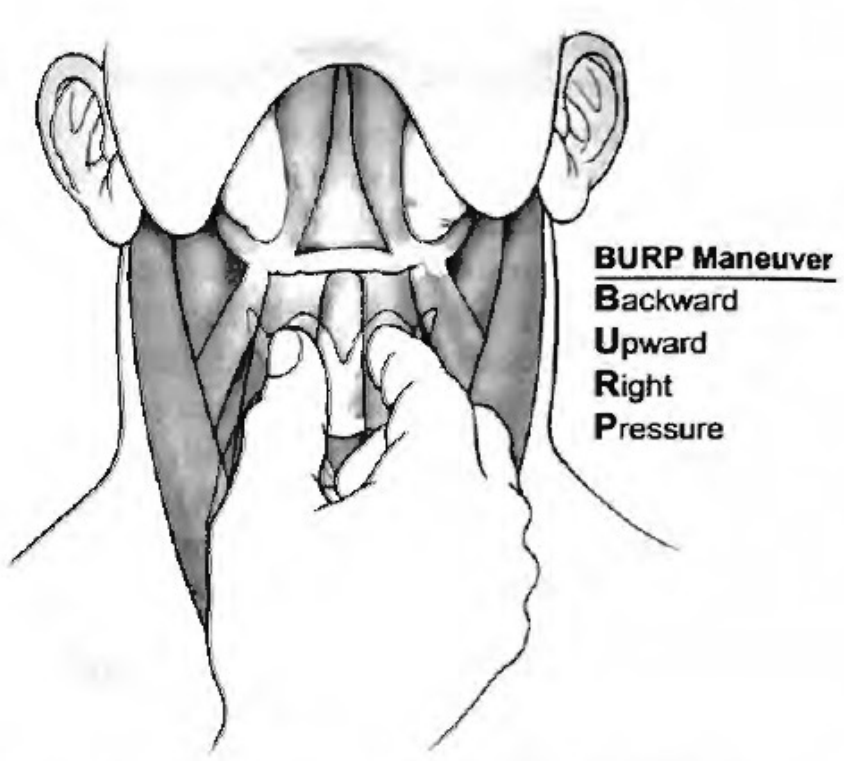
- Performed by displacing tongue from right to left
- Advancing laryngoscope into the hypopharynx
- Elevating the epiglottis using a curved or straight blade in the operators left hand

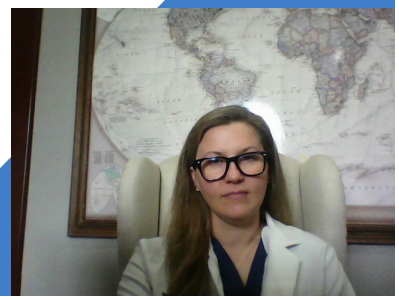






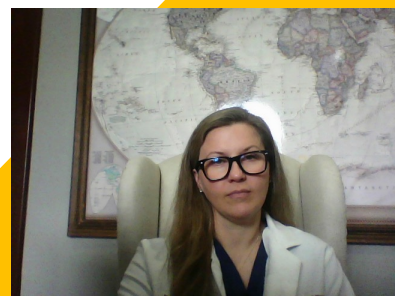
Direct Laryngoscopy





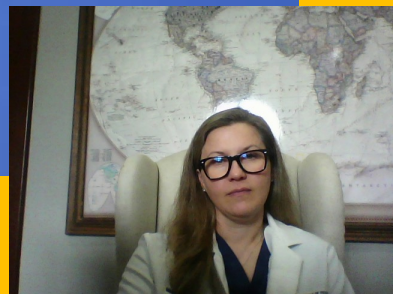
Video Laryngoscopy

- Contains a light source and distal micro video camera on the end of device
- Enables transmission of video images to an external viewing screen
- Good choice for anticipated difficult airway or rescue strategy



Video Laryngoscopy

- Blade designs similar to standard Macintosh & Miller blades
- Some designs are hyperangulated with blade tip curvature of 60deg
- Anatomically shaped with a channel
- Introduced midline and then advanced into the hypopharynx under visualization from video monitor
- Rigid stylets are available to help achieve hyperangulation of tube to match blade path



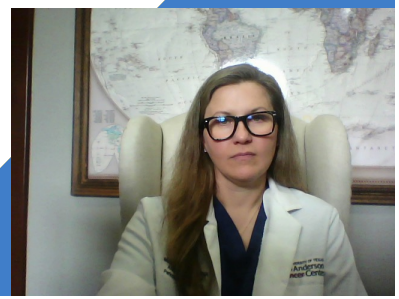
Video Laryngoscopy

Advantages

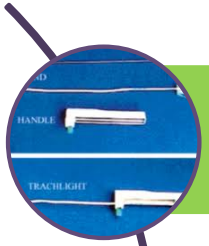
- Magnification of Airway
- Provides visualization impossible to see during direct laryngoscopy
- Recording capabilities for teaching and research

Disadvantages

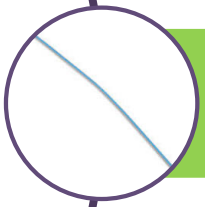
- Cost $5k-10k or >
- Obstructed view of airway structures by blood, secretions, or debris
- Oral or pharyngeal injuries can occur due to indirect ETT visualization during advancement



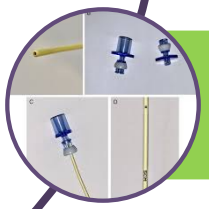
Intubation Stylets



Trachlight (Light Wand)



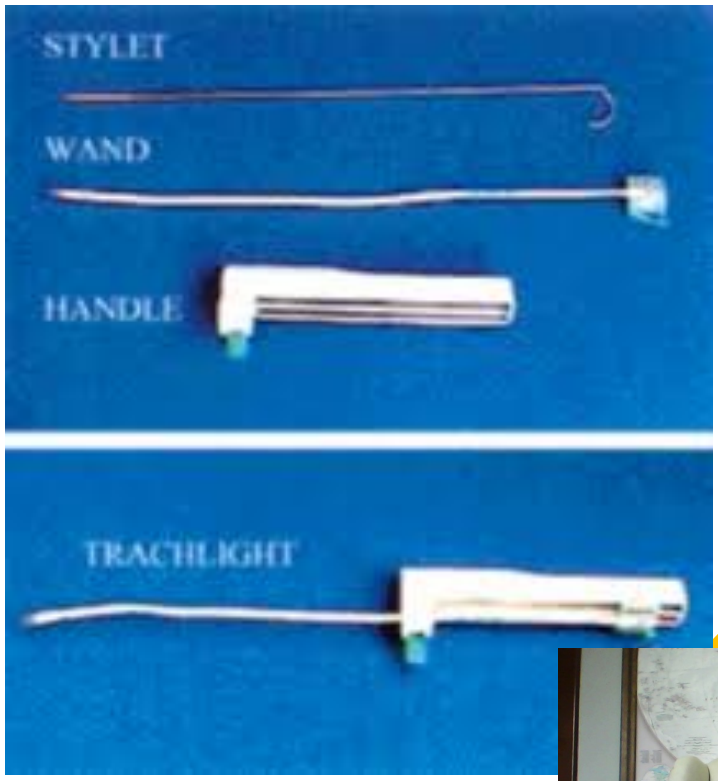
Eschmann Stylet (Bougie)



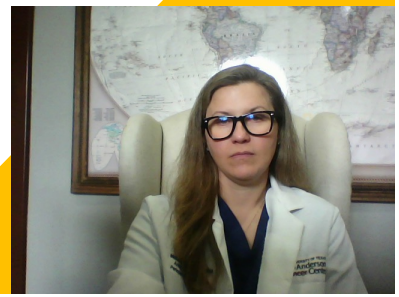
Airway Exchange Catheters (AECs)

Trachlight (Light Wand)

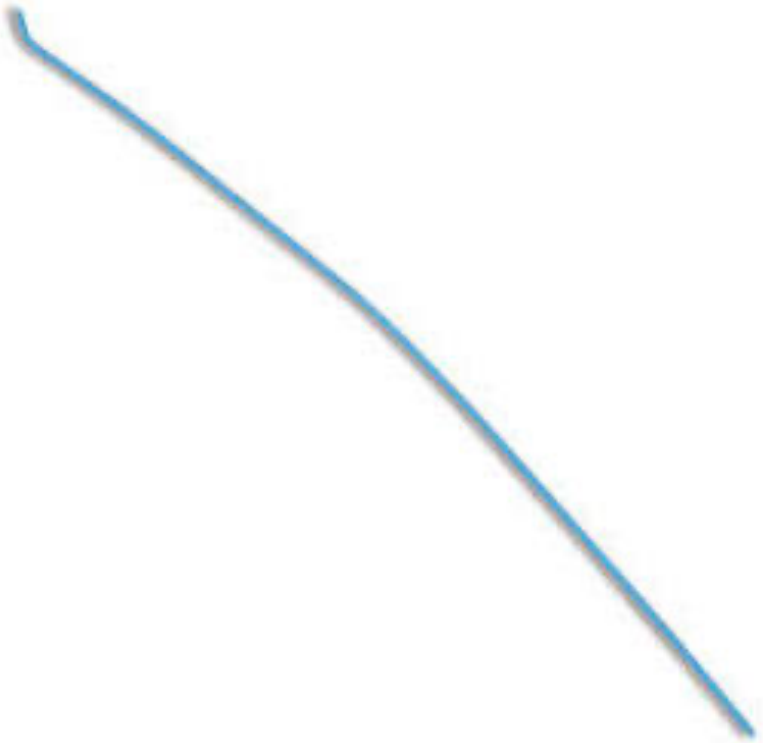
- Lighted handle attached to wand and inserted into ETT
- Inserted into mouth blindly, advanced and rotated toward anterior neck
- Well-defined circumscribed glow should be seen midline in anterior neck
- Contraindicated in upper airway anomaly, foreign body, tumor, polyps, epiglottitis, laryngeal trauma, or soft tissue injury



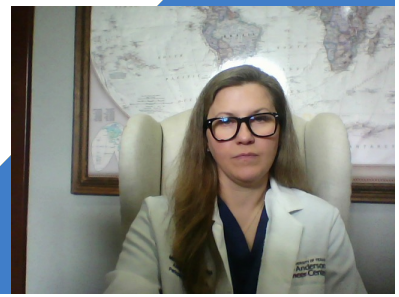
Trachlight



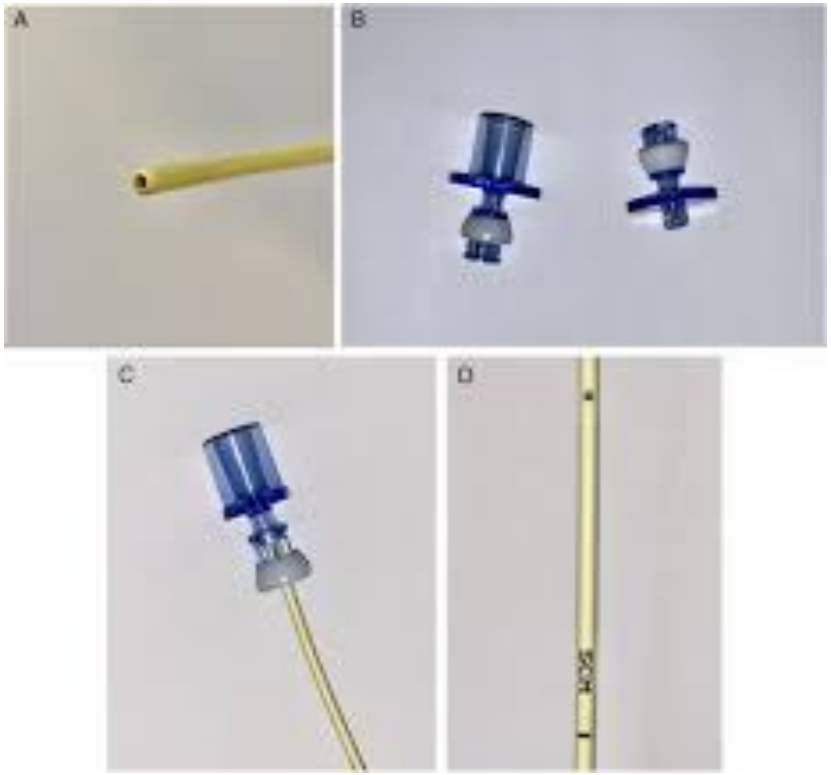
Eschmann Stylet (Bougie)



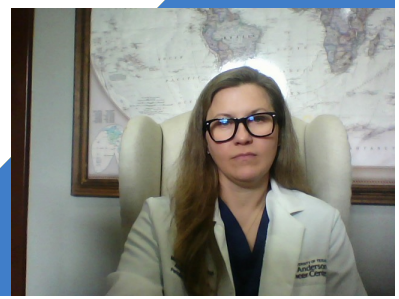
- 15Fr flexible intubation stylet
- 60cm in length
- 40-degree bend at distal tip



Airway Exchange Catheters (AECs)



- Used to interchange ETTs or to extubate over
- Available in multiple sizes and lengths 8fr -45cm, 11fr -83cm, 14fr -83cm, & 19fr -83cm
- Adaptors can allow jet ventilation or bag ventilation



Exchanging a SLT to a DLT over AECs

MD ANDERSON CANCER CENTER

Frova

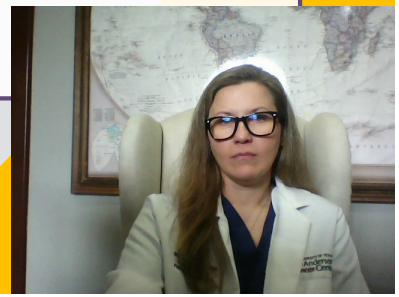
- AEC
- Angulated tip similar to Bougie
- Allows for jet or bag ventilation

Soft Tipped Airway Exchange Catheter

- **AEC with extra firm top and soft tip**
- **Soft tip is portion is purple, firm portion is teal**
- **Ideally used for patients with an anastomosis in the airway or for high risk for airway perforation if exchange catheter can't be prevented**

Flexible Intubating Endoscopes

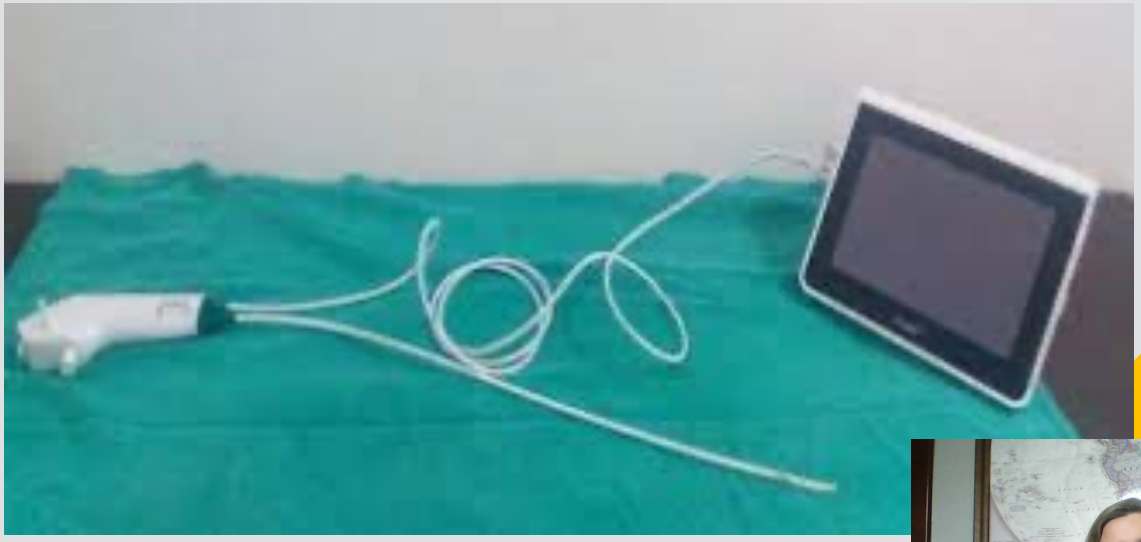
- Distal camera with LED lights or fiberoptic light sources that transmit images to an external screen
- Working channel to instill local anesthetic and a port for suction or supplemental O2
- Handle contains a lever to control the distal tip of the scope

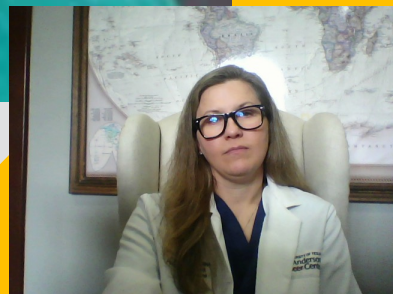


Storz Flexible Endoscope

Ambu aScope

- **Disposable**
- **Adult & Pediatric Sizes**
- **Utilizes Ambu monitor**

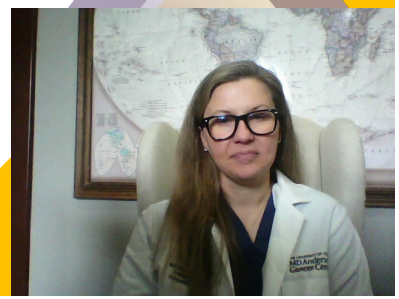




Olympus Bronchoscope Tower

- Plugged into external light source
- Screen mounted on tower
- Multiple scopes available
- Better optics for bronchoscopy

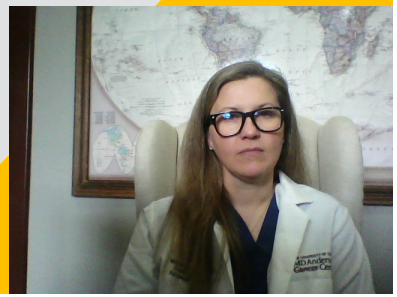
Airway Procedures



MD ANDERSON CANCER CENTER

Airway Procedures

- ❑ Flexible endoscopic intubation
- ❑ Awake intubation
- ❑ Airway Blocks
- ❑ Emergency Neck Access



Indications for Flexible Endoscopic Intubation

- Anticipated Difficult Airway
- Cervical Spine Immobilization
- Anatomic Abnormalities of the Upper Airway
- Failed Intubation Attempt with Maintained Mask Ventilation
- Surgery to the Face or Jaw
- Physiologic Difficult Airway

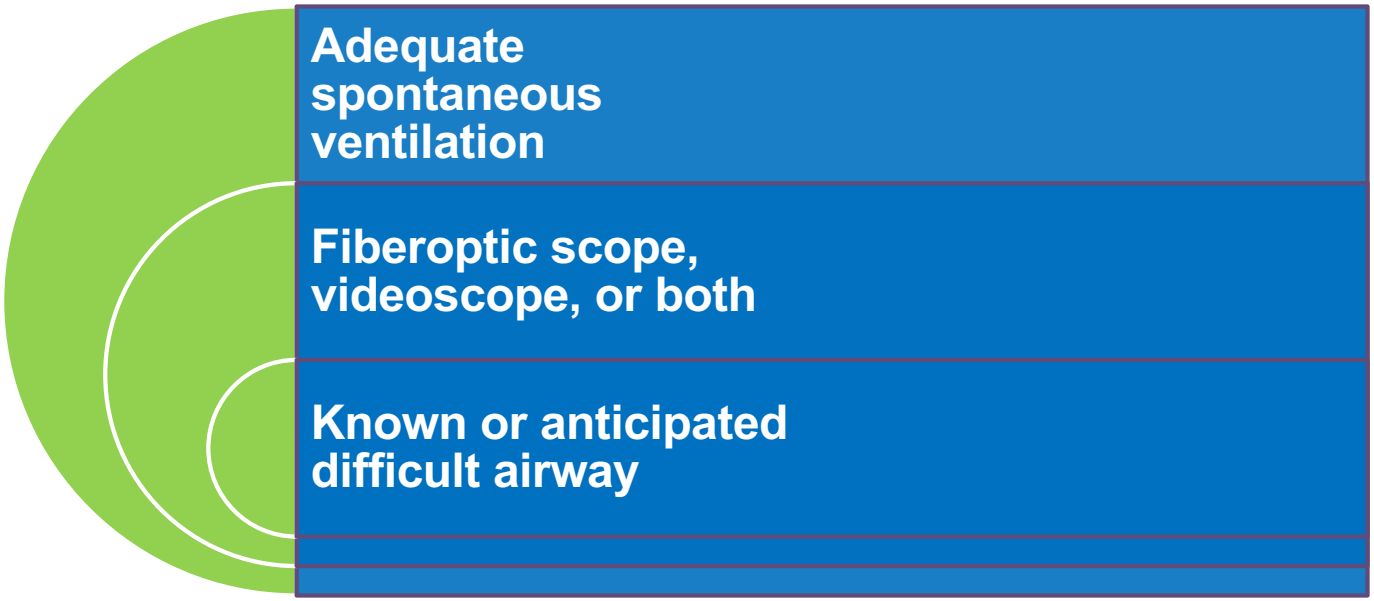
Steps to Flexible Endoscopic Intubation

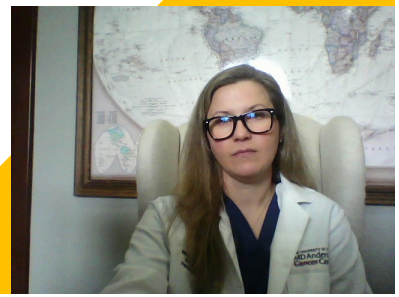
1. Load lubricated ETT onto scope
2. Insert scope and advance to posterior pharynx
3. Advance tip of scope into glottic opening
4. Advance ETT downward into the trachea

Limitations with Flexible Endoscopic Intubation

- Impaired visualization from fogging, blood, or secretions
- Epiglottitis, Laryngotracheitis, or Bacterial Tracheitis
- Airway Burns
- Airway Trauma
- Lack of Patient Cooperation
- Hypoxic Situations

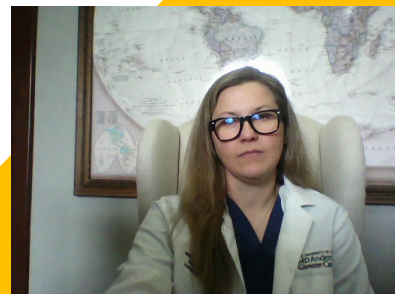
Awake Intubation





Benefits of Awake Intubation

- Pharyngeal Muscle Tone is Maintained
- Spontaneous Ventilation is Uninterrupted
- Laryngeal Anatomy Remains in Primary Location
- Aspiration is less likely
- Neurological Symptoms can be monitored



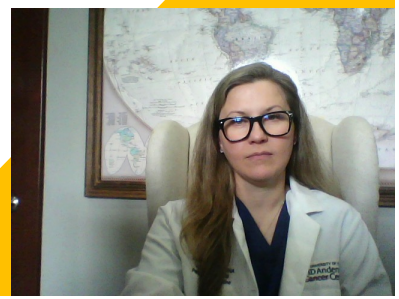
Preparation for Awake Intubation

MD ANDERSON CANCER CENTER

- Prepare patient- regarding what to expect
- Dry secretions- antisialagogue, gauze pads, suction
- Anesthesia- nerve blocks, topical, or a combination. IV sedation may be titrated as well if appr

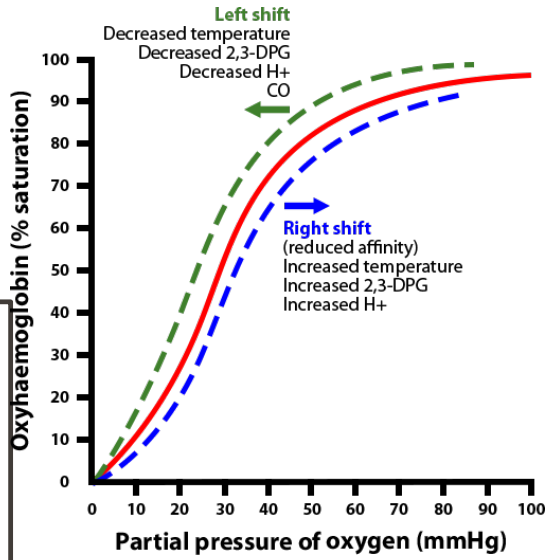
MEDICATIONS THAT FACILITATE AIRWAY ANESTHESIA

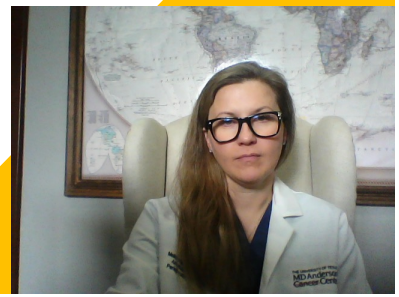
- Lidocaine
- Prilocaine
- Benzocaine
- Oxymetazoline Vs. Phenylephrine
- Sedation
- Glycopyrolate



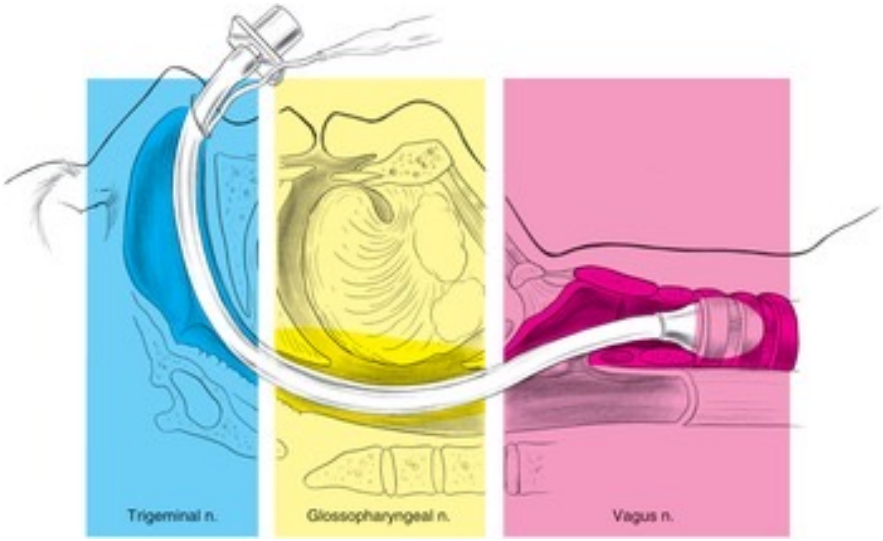
METHEMOGLOBINEMIA

- A hereditary or acquired (most common) condition
- the iron within hemoglobin is oxidized from the ferrous form (Fe2+) to the ferric form (Fe3+) which has a decreased affinity for oxygen, and a resulting decreased oxygen transport and unloading of oxygen to tissues and cells.
- This causes a leftward shift in the Oxyhemoglobin dissociation curve
- S/S: headache, mental status changes, anxiety, fatigue, exercise intolerance, shortness of breath, seizures, coma, and/or death
- Tx: methylene blue in a 1-2 mg/kg IV dose over 5-10 minutes

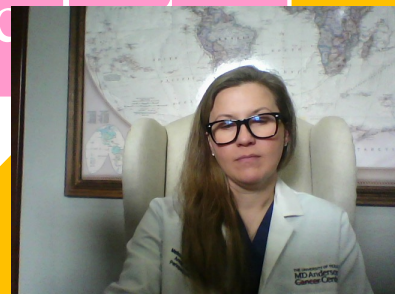




Airway Blocks: Topical Anesthesia



- Nasal Topicalization
- Oral Topicalization
- Laryngeal Topic



Airway Blocks

- ❑ Glossopharyngeal
- ❑ Transtranstracheal
- ❑ Superior Laryngeal

Airway Blocks: Glossopharyngeal Block

Goal

- To anesthetize the lingual branch of the glossopharyngeal nerve

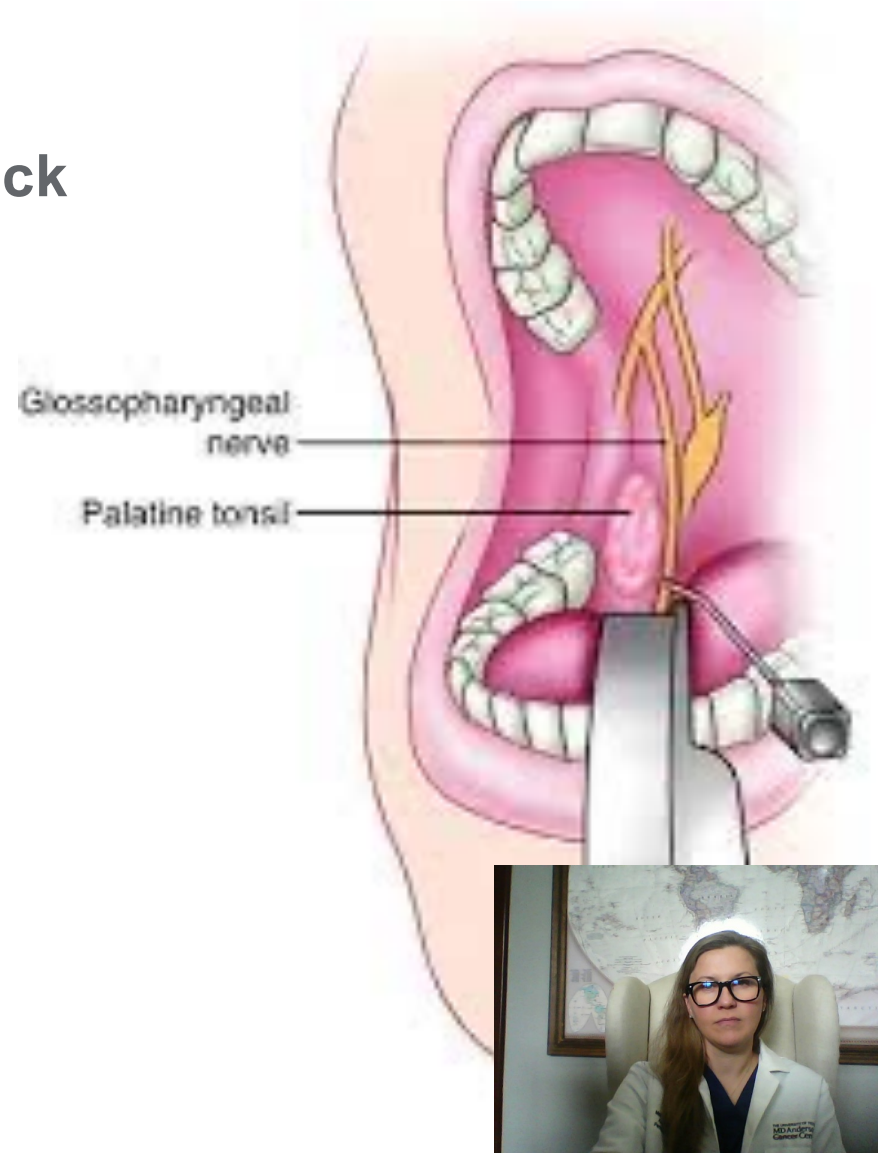
Administer

- 1-2 ml of 2% lidocaine, then repeat on the opposite side

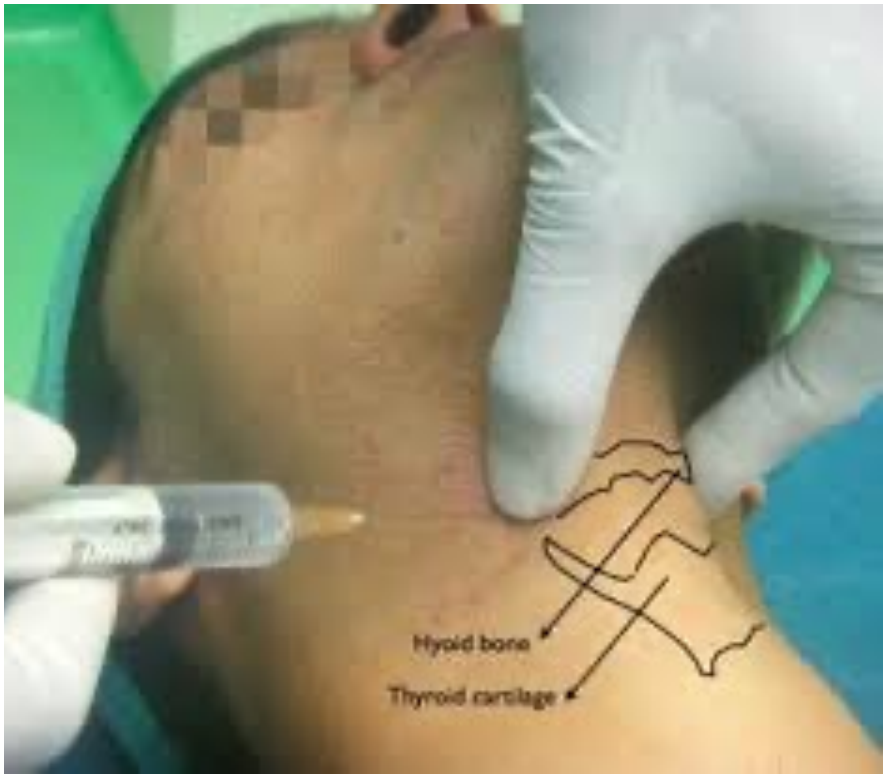
Caution

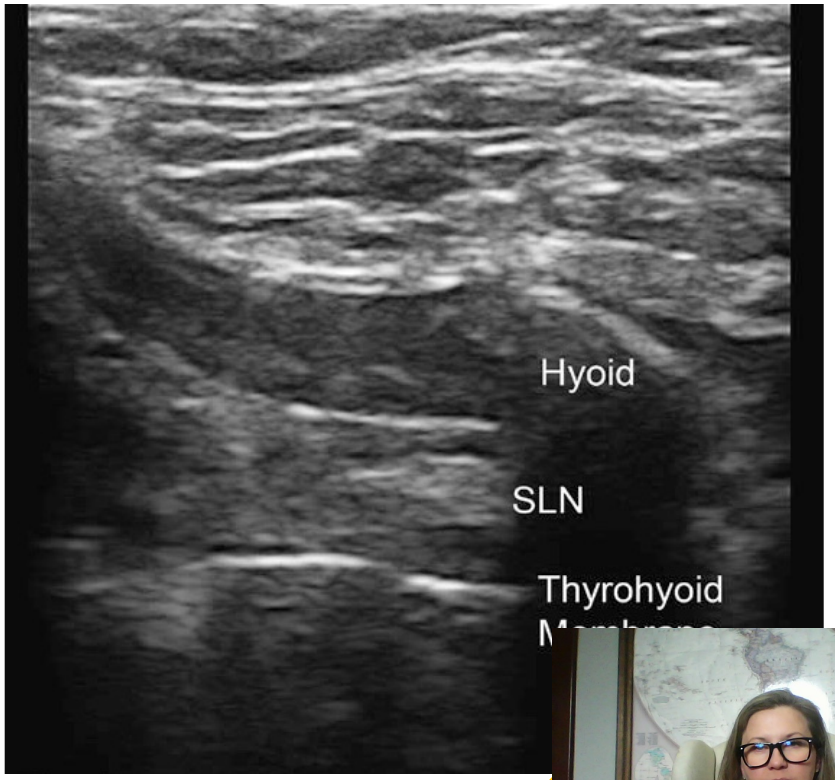
Aspirate air: Too deep

Aspirate blood: Potentially in the carotid

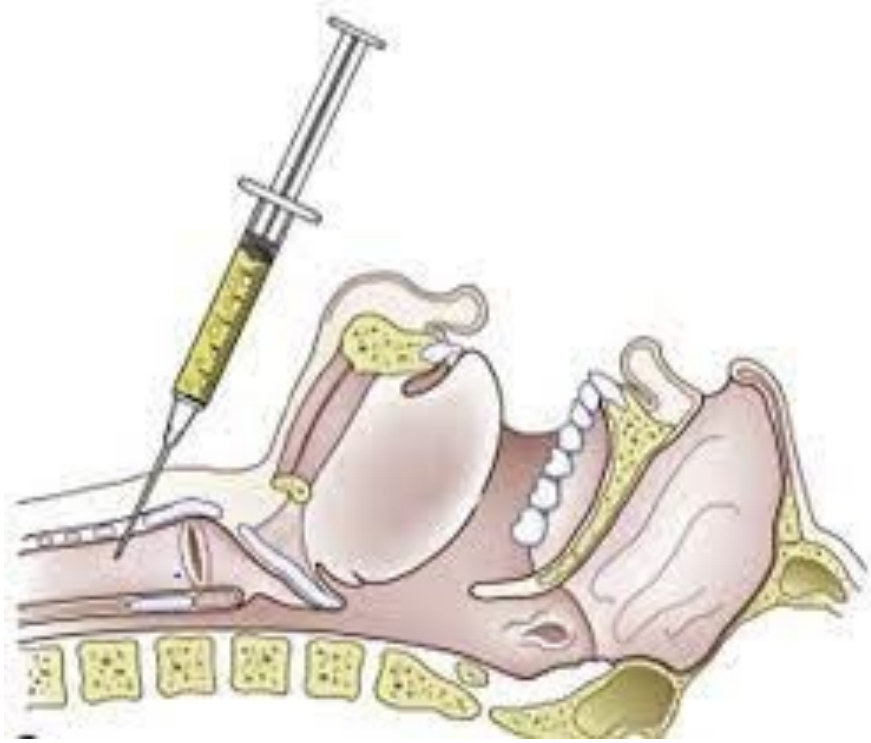


Airway Blocks: Superior Laryngeal Nerve Block





Airway Blocks: Transtracheal Block



Goal

- To anesthetize the vocal cords and upper trachea by injecting local anesthetic through the cricothyroid membrane

Administer

- 3-5 mL of either 2% or 4% lidocaine

Caution

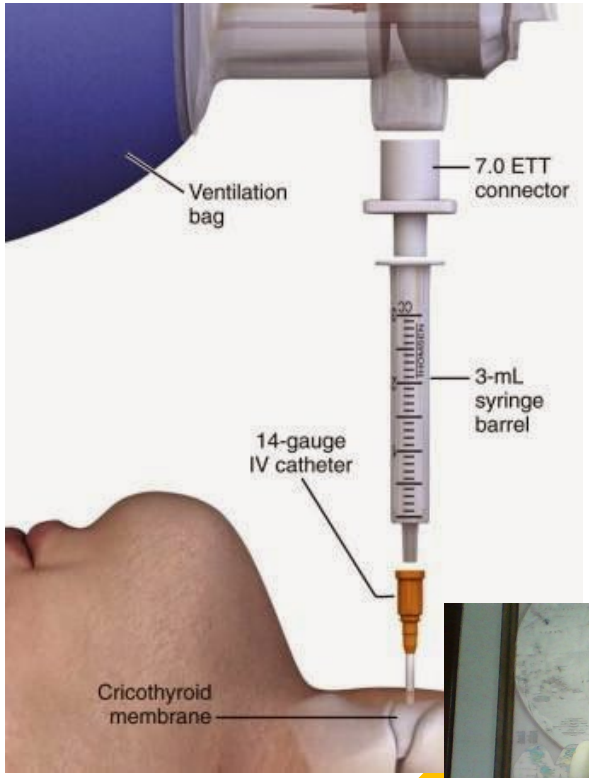
Stabilize the needle or remove it over a catheter so as not to tear the tra
mucosa if the patient coughs.

Subglottic Interventions & Emergency Neck Access

- **Needle Cricothyrotomy**
- **Surgical Cricothyrotomy**
- **Tracheotomy**

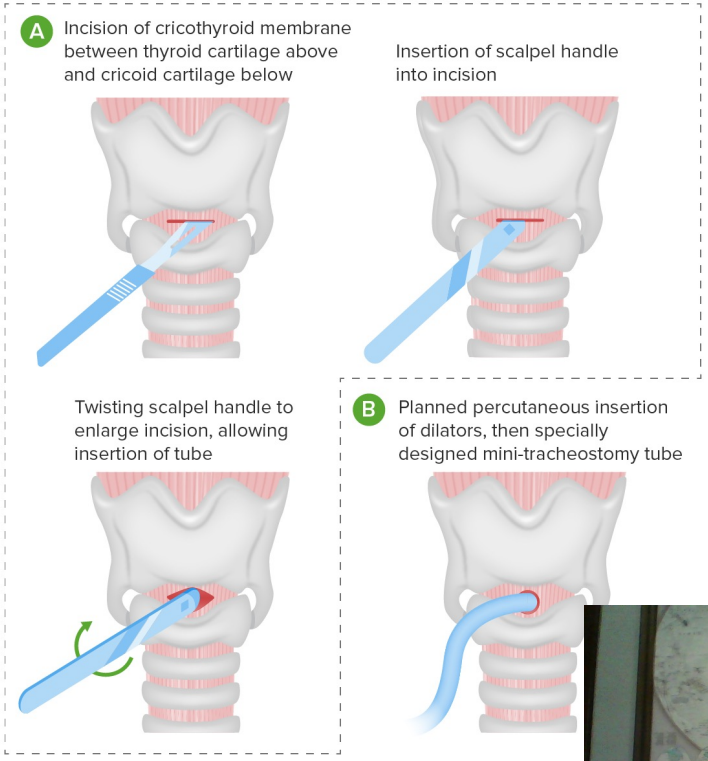
Needle Cricothrotomy

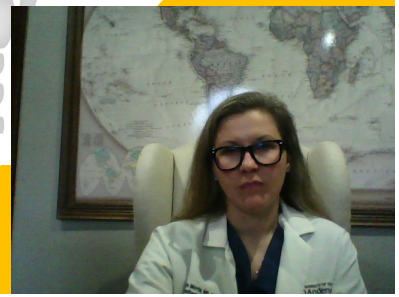
- ❑ Locate the cricothyroid membrane
- ❑ Pierce the membrane with angiocath directed at 30-45deg caudally
- ❑ Advance until air is aspirated
- ❑ Remove needle
- ❑ Attach 3ml syringe directly to angiocath, then attache 7.0 ETT adaptor to syringe
- ❑ Attach BVM to ETT adaptor



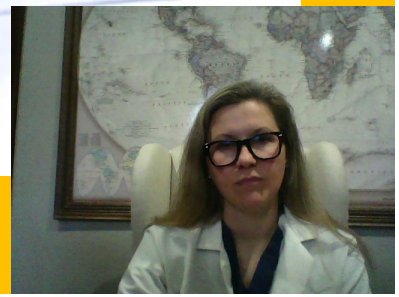
Surgical Cricothyrotomy – Four step approach

- ❑ **Identify the landmarks**
- ❑ **Make a 1-2 cm HORIZONTAL stab incision through both the skin and cricothyroid membrane.**
- ❑ **BEFORE removing the scalpel, insert a tracheal hook and direct it caudally.**
- ❑ **Insert the tracheostomy tube through the incision into the trachea.**





Emergency Tracheotomy



Airway Complications

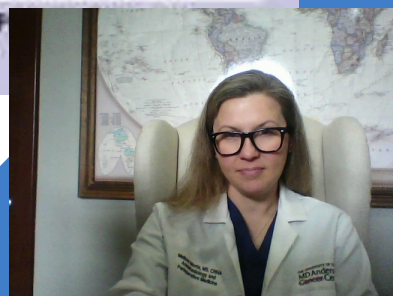
MD ANDERSON CANCER CENTER

Airway Complications

- Laryngospasm
- Bronchospasm & Bronchoconstriction
- Hemorrhage in the Airway
- Airway Trauma
- Vomiting & Aspiration
- Acute Pulmonary Edema
- Mucus Plug
- Esophageal Intubation
- Endobronchial Intubation
- Pulmonary Embolism
- Pneumothorax
- Airway Fire
- Upper Airway Edema
- Recurrent Laryngeal Nerve Damage
- Postoperative Stridor
- Vocal Cord Granulomas, Lesions, or Tumors
- Lingual Ton Hyperplasia

Laryngospasm

- **Sustained exaggerated physiologic response caused by involuntary closure of the vocal cords**
- **Causes: secretions, foreign material, light anesthesia, painful stimuli, hypocalcemia, vagal hypertonicity, and/ or upper airway infection**
- **Intrinsic laryngeal muscles involved include: lateral cricoarytenoid and thyroarytenoid (from recurrent laryngeal nerve) and the cricothyroid muscles (from external branch of superior laryngeal nerve)**



Signs & Symptoms of Laryngospasm

- Stridorous Breath (partial spasm)
- No Breath Sounds (complete spasm)
- Use of Accessory Muscles
- Absence of Air Movement with Muscle Effort
- Paradoxical Thoracic Movement
- Airway Obstruction
- Decreasing Oxygen Saturation
- Absent Capnogram
- Bradycardia (late sign)

Management of Laryngospasm

- Provide Fio_2 100%
- Place an oral airway and confirm airway patency
- Jaw thrust with pressure posterior to mandibular angle ("laryngospasm notch")
- Manual ventilation with continuous positive airway pressure (15–30 cm H_2O)
- For persistent, inadequate ventilation and/or oxygenation
  1. Administer succinylcholine
     a. Adult dose 0.1–0.5 mg/kg IV
     b. Pediatric dose 1–2 mg/kg IV, 3–4 mg/kg IM (administer atropine 0.02 mg/kg with succinylcholine to avoid bradycardia in young pediatric patients)
  2. If succinylcholine is contraindicated, administer rocuronium 1.0–1.2 mg/kg IV
- Continue application of positive pressure until laryngospasm breaks and ventilation is verified
- Monitor for negative pressure pulmonary edema

Larson C.P., Jaffe R.A. (2017) Laryngospasm: The Silent Menace. In: Practical
https://doi.org/10.1007/978-3-319-42866-6_5

Review

- ❑ Airway Assessment Tools
- ❑ Importance of Appropriate Airway Assessment
- ❑ Variety of Airway Equipment and Options
- ❑ Airway Procedures
- ❑ Airway Complications

Thank you

Questions?

Melissa Puskac
mpuskac@mdanderson.org

References

Hagberg, C., Artime, C., & Aziz, M. (2018). Hagberg and Benumof's airway management (Fourth edition).

Hung, O. R. & Murphy, M. (2019, January 20). Context Sensitive Airway Management. Anesthesia Key. Retrieved April 11, 2021, from https://aneskey.com/context-sensitive-airway-management

Hung, O. R. & Murphy, M. (2019, January 20). Airway Management in a Patient with Angioedema. Anesthesia Key. Retrieved April 11, 2021, from https://aneskey.com/airway-management-in-a-patient-with-angioedema

Nagelhout, J., & Elisha, S. (2017). Nurse anesthesia (6th ed.). Elsevier.

ResearchGate.net. (n.d.). Rules for Evaluating Airway Score. Retrieved April 26, 2021 from https://www.researchgate.net/figure/Rules-for-Evaluating-Airway-Score_tbl1_234020179

Zhang, X., & Wenxian L.. (2013). Misguidance of peroral rigid laryngoscopy in assessment of difficult airway: two comparable cases in microlaryngeal surgery. BMJ Publishing Group

THE UNIVERSITY OF TEXAS
MD Anderson Cancer Center

mdanderson.org

1-877-632-6789

Making Cancer History®