



Anesthesia MED441



2- Airway Management and equipment

Objectives

- Describe the applied anatomy of the airway.
- Conduct a preoperative airway assessment .
- Identify a potentially difficult airway.
- Learn about management of airway .
- Become familiar with airway equipment.
- Understand issues around aspiration prophylaxis.
- **This lecture is imp for the OSCE exam**

Color Index:

- Main Text
- 41 Doctor's notes
- 39 Doctor's notes
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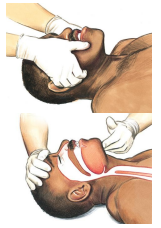
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Case discussion

Airway Control

Manually:

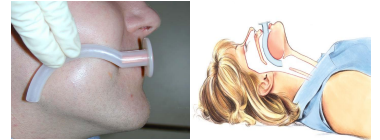
The most imp thing to cause airway obstruction in a comatose patient is the tongue, due to muscle hypotonia. Chin lift is used when we are sure that there is no cervical spine injury to avoid causing quadriplegia to the patient. While jaw thrust is performed in all trauma patients as we are suspecting spinal (cervical) injury.



Oropharyngeal Airway:

Proper size: from the tip of the mouth to the angle of the mandible. **Adult: female (2)(3), Male (3)(4)**

It's plastic, hard insertion Ends at the base of the tongue.
Used in: **comatose** patient (based on Glasgow coma score)
it Cannot be tolerated by semi-conscious patients as it causes: gag reflex, regurgitation and laryngospasm.



Nasopharyngeal Airway:

Size: from tip of nostril to ear lobe.
It's rubber, easy insertion through nostril
Used in: semi-conscious

Contraindications:

1. basal skull fracture (how to know? Otorrhea CSF from ear or bulging raccoon eyes).
2. bleeding disorders or on anticoagulant.



Ambu bag (C-E maneuver):

Give 100% oxygenation Used with all of the above instruments; We use it to ventilate the patient in case of **emergency**.

C-E Maneuver: To perform manual ventilation

C = Ceiling of the mask by the index finger and the thumb.
E= for supporting the jaw (little, ring and middle fingers are E shaped).

BE careful not to press on the soft tissue, especially in pediatrics; because you can cause an obstruction.



Combitube: won't come in the exam

A = esophageal obturator; ventilation into trachea through side openings = B
C = tracheal tube; ventilation through open end if proximal end inserted in trachea
D = pharyngeal cuff; inflated through catheter = E
F = esophageal cuff; inflated through catheter = G
H = teeth marker; blindly insert Combitube until marker is at level of teeth

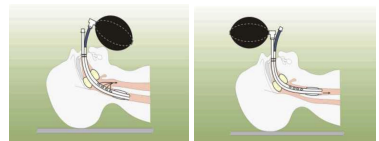
Consists of two tubes fused together.

Not used in real life (was for emergency cases cuz it's easy).

The distal end inserted blindly in the esophagus and Ventilation occur through the holes in the sides.

special device to secure the airway. you can ventilate the patient through the trachea or esophagus. not used anymore.

how to confirm the position of the combitube? check end-tidal co2



Laryngeal Mask Airway: will come in the exam

There are many sizes so make sure to choose the proper size: **ADULT (Female: 3 / male: 4)**

Easy blind insertion with no need for laryngoscope.

Ends at the pharyngeal area & deliver O₂ to larynx & trachea.

Can be used in patients having latex allergy.

Used to open airway in cases of difficult ventilation or intubation.

Criteria for use:

- Patient has to be comatose to avoid gag reflex, regurgitation and laryngospasm
- NOT used in high risk aspiration patients including laparoscopic procedures

Risks for aspiration: full stomach like in trauma patients (not fasting), pregnancy, obese patients.

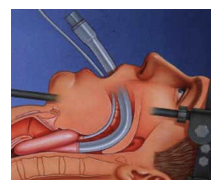
Useful in low risk aspiration patients in day surgeries with propofol + No need for skills or muscle relaxants.

Why we inflate? To provide good sealing for vocal cords and protect from aspiration and regurgitation.

it will cover the glottis and sits in the upper part of the esophagus

Extra: but imp

LMA™ Size*	Patient Selection Guidelines	Maximum Cuff Inflation Volume[ml]
1	Neonates/ infants up to 5 kg	4
1½	Infants 5-10 kg	7
2	Infants/children 10-20 kg	10
2½	Children 20-30 kg	14
3	Children 30-50 kg	20
4	Adults 50-70 kg	30
5	Adults 70-100 kg	40
6	Adults over 100 kg	50



Airway

Anatomy: we will not ask you about the anatomy

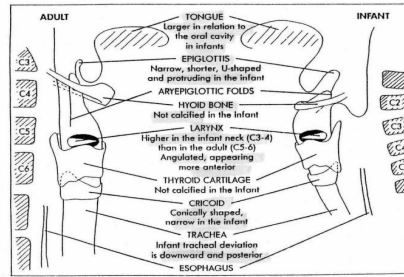
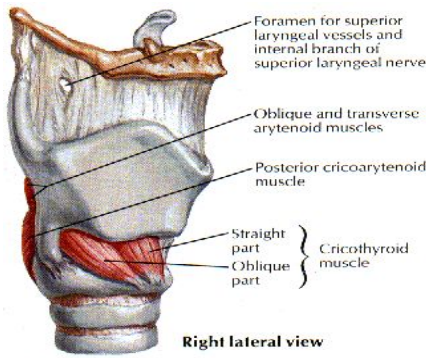
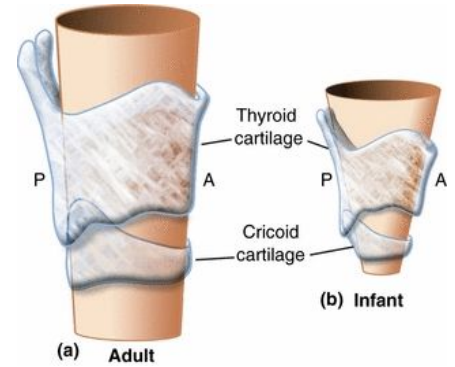


Figure 1. Comparison of adult and infant airway anatomic differences. (From Ho M: The Pediatric Airway. In Ball C, Hughes C, Oh T (eds): The Pediatric Anesthesia Handbook. St. Louis, Mosby Year Book, 1991, p 130. Adapted from Cole CJ, Todres ID: The Pediatric Airway. In Flynn JF, et al (eds): A Practice of Anesthesia for Infants and Children. Orlando, Grune & Stratton, 1986, with permission.)



Innervation:

1. Innervation Vagus n.
2. Superior laryngeal n.
 - External branch: motor to cricothyroid m.
 - Internal branch: sensory larynx above TVC's.
3. Recurrent laryngeal n.
 - Right: subclavian
 - Left: Aortic arch
 - Motor to all other muscles, Sensory to TVC's and trachea.

-intubation in infants is difficult

-the narrowest part of the airway in the infants is in the level of cricoid cartilage

-in infants its funnel shaped bc the cartilage is narrow

Indication of intubation:

- 1- Airway Protection if the patient is unconscious
- 2- Need for Mechanical Ventilation in the intensive care, ER or the OR
- 3- Lung isolation thoracic surgery
- 4- Anticipated decline in clinical status

Management:

1. **History:** ask about any previous history of medical intubation and surgery
 - previous history of difficulty is the best predictor:

Nature of difficulty

Number of trials

Ability to ventilate

Maneuver & equipment used

Complications

- **Medical history :**

DM: chronic DM cause stiffness, HTN, Hypothyroidism / goiter, RA (limited flexion/extension of the neck), SLE, COPD, Bronchial Asthma Bronchiectasis, Burns Dawn Syndrome (atlanto occipital joint stiffness)

- Surgical history.
- Medications and Allergies.
- Last meal.

2. **Obstructive sleep apnea .Hx:** number of pillows, woke up during sleep, Snoring, and sleepy during the day. Cepap ?? To prevent pulmonary HTN and HF.

3. **Predictors of DMV (obese) .** obese, short muscular neck

Vital Signs:

Blood Pressure, Heart Rate, Temperature, and Respiratory Rate, If the patient is obese (BMI & wight).

Airway

TABLE 14.3 LEMON airway assessment method

L = Look externally for anatomic feature that may make intubation difficult.
E = Evaluate the 3-3-2 rule:
 — Mouth opening (3 fingerbreadths)
 — Hyoid–chin distance (3 fingerbreadths)
 — Thyroid cartilage–floor of mouth distance (2 fingerbreadths)
M = Mallampati score:
 — Class I: soft palate, uvula, pillars visible
 — Class II: soft palate, uvula visible
 — Class III: soft palate, base of uvula visible
 — Class IV: hard palate visible
O = Obstruction: examine for partial or complete upper airway obstruction
N = Neck mobility

Management:

4. Examination (LEMON):

Look



Morbid obesity (BMI), Skull, Face, Jaw, Mouth, teeth, and Neck (distended, any mass, goiter or scar affecting the flexion and extension of the neck).

General inspection of pt status: dysmorphic features, distressed, sitting comfortably, upright position or lying down, cyanosis, pale, using accessory muscles, breathing way (intubated, spontaneous), good mouth opening, masses, obese, and obvious congenital anomalies.

Receding Mandible: larynx and vocal cords Highly anterior so when you open with laryngoscope you can't see them.

Protruded upper incisor cause limited vision of the airway.

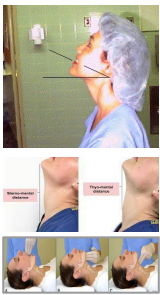
Gum, teeth, lips, tongue external looking of the mouth, and skin.

Dental hygiene is very important because we're doing manipulation around the mouth with laryngoscope and tubes, very bad hygiene might lead to bleeding, easy to fracture teeth.

There is intraoral mass so we have to check for any mass, tumors or any abnormality and to check the skull for hematoma or mass. check for any morbidities: obesity

sometimes plastic surgeons they do tissue expansion to remove scar in the head, it may cause difficulty in intubation

Examination



The 3 joints movements:

1. Atlanto-occipital joint: 15-20 degrees
2. cervical spine: range >90
3. Temporomandibular: Subluxation 1 finger

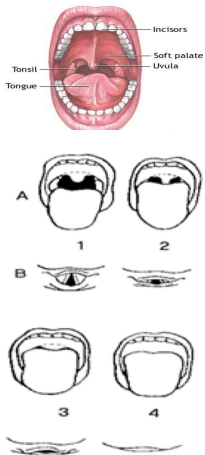
In hyperextended neck from thyroid to chin examine:

- **Thyromental distance > 6.5cm.** (If less they have highly anterior larynx thus indicate difficult intubation)
- **Sternomental Distance > 12.5cm.** (If less than 12.5 (short neck) indicate difficult intubation)
- **Mouth opening: 3 fingers can enter.**

3-3-2 rule: imp for OSCE

- 3 fingers in mouth
- 3 fingers fit from mentum to hyoid cartilage
- 2 fingers fit from the floor of the mouth to the top of thyroid cartilage.

Mallampati



Mallampati test: Patient in sitting position ask him to open mouth & protrude tongue, it helps in detecting tongue size to oral cavity.

Based on the hypothesis that when the base of the tongue is disproportionately large it will overshadow the larynx.

Four grades; 1 and 2 easy to intubate.

- 1: when you see hard palate, soft palate, uvula, tonsils.
- 2: hard palate, soft palate, base of the uvula.
- 3: **hard palate, soft palate and only the tip of the glottis.**
- 4: hard palate only.

Simple easy test, correlates with what is seen during laryngoscopy or Cormack-Lehane grades, but

1- moderate sensitivity and specificity (12% false +ve). Mallampati is Sensitive test but not specific unless combined with other tests or conditions for ex: patient have a submandibular/neck mass, fractured mandible, burn, obese pt, congenital anomaly. But it's sensitive and might give false positive results (patient might be assessed as grade 3 or 4 but later during intubation appear to be very easily intubated),

2- Inter observer variation.

3- Phonation increases false negative view. Just let the patient open his mouth without speaking or saying (AHH).

Obstruction



- Apparent cause e.g. goitre.
- OSA (obstructive sleep apnea).
- Noisy breathing or stridor. indication of obstruction and cause airway difficulty
- Signs of upper airway obstruction Upper airway obstruction = stridor, Lower airway obstruction = wheezing at the end of expiration . snoring or there is mass
- Other causes intraoral mass

Neck mobility



Anterior posterior cervical spinal fixation

Prior condition: Neck instrumentation > (can't extend)

- **Surgery:** Anterior cervical spine fixation: limited flexion & extension might cause difficult intubation (see pic)
- Rheumatoid arthritis (Joints).
- Osteoarthritis.
- Short muscular neck .
- Spondylitis
- Atlanto-occipital dislocation

Airway

5. Investigations.

Routine: CBC, LFTs, Renal profile, and coagulation profile.

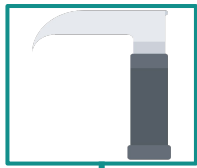
ECG and CXR if >40 years old or obese.

Specific: Blood Gas & PFT if Patient has lung disease or going to thoracic surgery (Lung tumors).

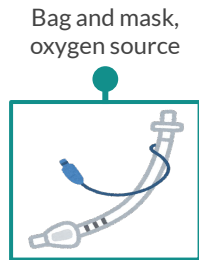
Thoracic inlet X-ray if the patient has goiter

SCA with Hgb >10 okay If < 10 Refer to hematologist

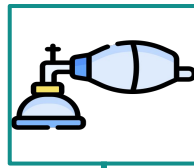
Proper Equipment:



Laryngoscopes
different blades

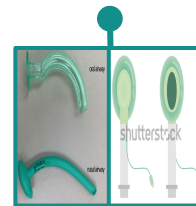


Bag and mask,
oxygen source



ETT different sizes
Female: 7-7.5, Male:
8-8.5, Children: up
to 2.5

Airway adjuncts and LMA



Suction on
in case the patient
vomited to prevent
aspiration or
regurgitation

Positioning for successful intubation:

Sniffing Position: Dr said she don't prefer to do it for babies

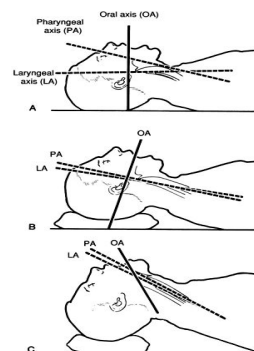
- Alignment of 3 axes or assuming sniffing position **Not done in case of cervical injury** or Subluxation, **clinically it's enough if you do jaw thrust.**
- Any anomaly in these 3 joints: A-O, T-M or C-spine can result in difficult intubation.

There should be alignment of 3 axes (1-oral axis 2- pharyngeal axis 3- laryngeal axis) to be able to visualize the glottis properly.

A- laying in bed without pillow (the 3 axes have different direction)

B- if you put small pillow (the PA and LA are close but the OA is perpendicular on the other axes)

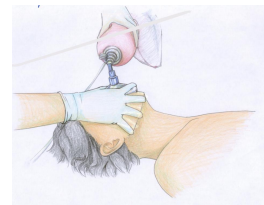
C- if you extend the neck there is some alignment of 3 axes. you can see clearly and intubate



Mask Ventilation:

- Holding the mask using C-E maneuver.
- Induction of anesthesia produces upper airway relaxation and possible collapse.

position the patient properly and check the monitors and you have to preoxygenate the patient.(3-5 min of with 100% oxygen reservoir in lungs during apnea)



Endotracheal Intubation:

Look for epiglottis under the epiglottis you will find the vocal cords.

- If initially not found insert laryngoscope further.
- If this maneuver does not work slowly pull laryngoscope back.

Once epiglottis visualized, push laryngoscope into vallecula and apply traction at 45 degree angle to "push" epiglottis up and out of the way



Airway

Confirm tube position:

Once you connect the ambu bag the bag will be inflated by air coming out of the lung and then when you start to ventilate you will notice some vapor around the tube because the air coming of the lungs is warm. After confirming the tube position fix the tube, usually at 19-20 cm in adults

- Direct visualization of ETT between cords.
- Continuous trace of **capnography** Capnography measures end-tidal CO₂, if there's no CO₂ then most likely this is an esophageal intubation 6- Pulse oximeter/O₂ saturation is never a reliable factor because you already preoxygenate so it will be a 100% for 3-5 minutes before it start to fall.
- 3 point auscultation To ensure that it's equal, bilateral and adequate air entry.
- Bronchoscopy; carina seen.
- Esophageal detector device.
- Other as bilateral chest movement, mist in the tube, CXR In children we might use CXR to confirm the tube position because in children you will hear air entry everywhere.

Intubation

Rapid Sequence Induction: special process for endotracheal intubation in a full stomach patient who has a tendency for aspiration. For emergency pateint with full stomach, increase intraabdominal pressure (intestinal obstruction, pregnant)

Indications:	Technique: IMP for OSCE
<ol style="list-style-type: none">1. GERD2. Last meal less than 6-8 hours3. Pyloric stenosis4. Prevent lung aspiration in all emergency cases5. Emergency cesarean section.6. Full stomach Pregnant, not fasting, trauma, intestinal obstruction, obese, Appendicitis, Acites or any pt of high risk aspiration7. Slow gastric emptying	<ol style="list-style-type: none">1. Preoxygenation for 2-3 mins2. IV induction with sux Succinylcholine, ultrashort acting depolarizing muscle relaxant3. Cricoid pressure When you push the cricoid cartilage (continuous/complete cartilage) you close the esophagus & prevent the passage of food to the trachea4. Intubate, inflate the cuff, confirm position5. Release cricoid and fix the tube

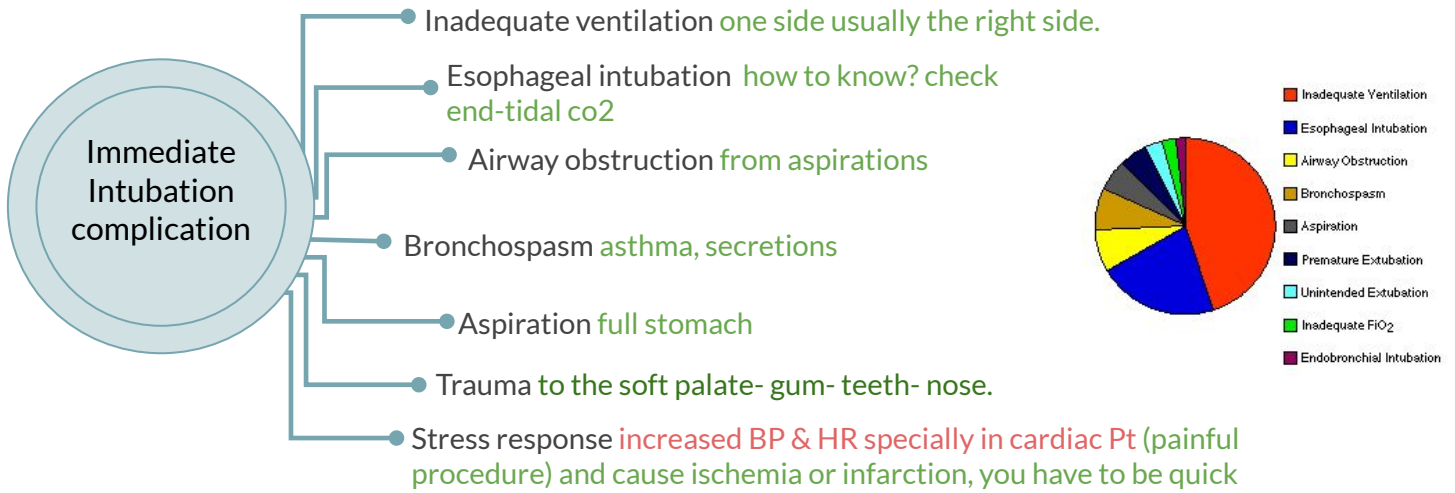
You are unable to visualize the larynx when you perform Rapid sequence intubation next step? ASK for help

Problems with ETT and Cuff: you have to memorize it

- Too long: endobronchial intubation
- Too short: accidental extubation
- Too large: trauma to surrounding tissues.
- Too narrow: increased airway resistance.
- Too soft: kinks
- Too hard: tissue damage.
- Poor curvature: difficult to intubate
- Cuff insufficiently inflated: allows leaking and aspiration.
- Cuff excessively inflated: pressure necrosis
- Prolonged placement: vocal cord granulomas, tracheal stenosis Mainly in ICU patients.

Intubation

Complications of Intubation:



Difficult Airway

Causes:

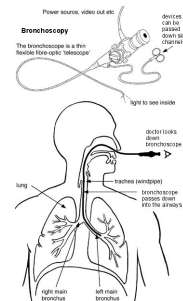
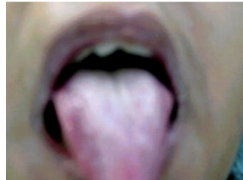
1. Congenital: A lot of pediatric cases, Turner syndrome, Pierre Robin syndrome, Down syndrome: cervical subluxation and mouth atrophy
2. Acquired: Obesity, thyroid/goiter, burn victim, trauma, submandibular mass, fractures, rheumatoid arthritis, surgical procedure around the neck, tumor, cervical surgery



Examples:

- Mallampati grade 3 & 4
- Treacher-Collin syndrome

difficult to intubate (do endotracheal intubation)



Rigid Fiberoptic Scopes:



Bullard



Wu scope



Upsher

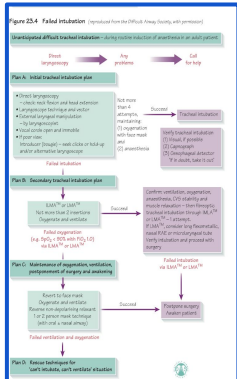
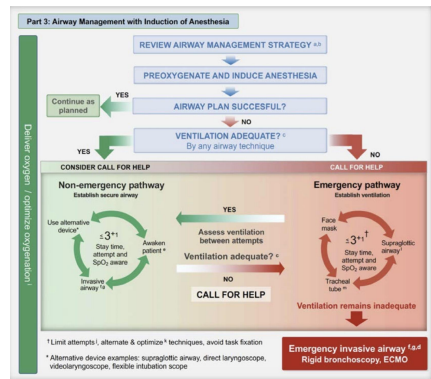
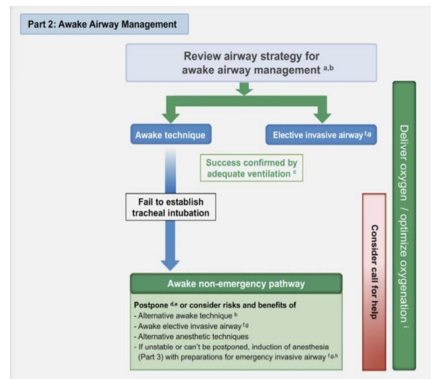
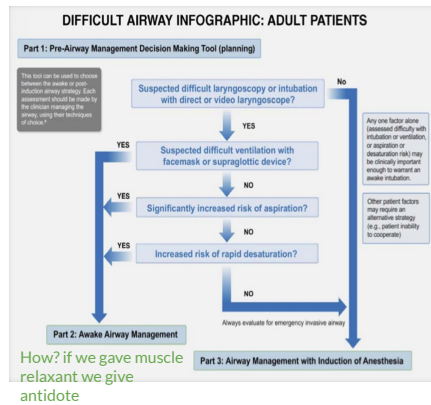
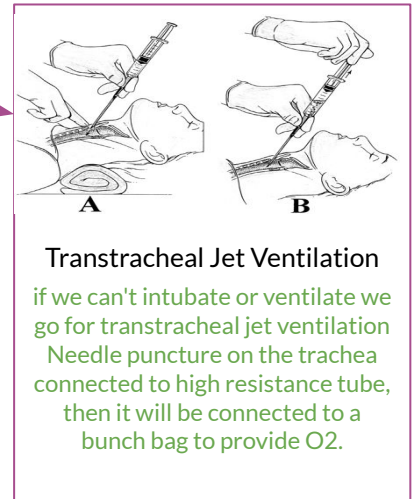
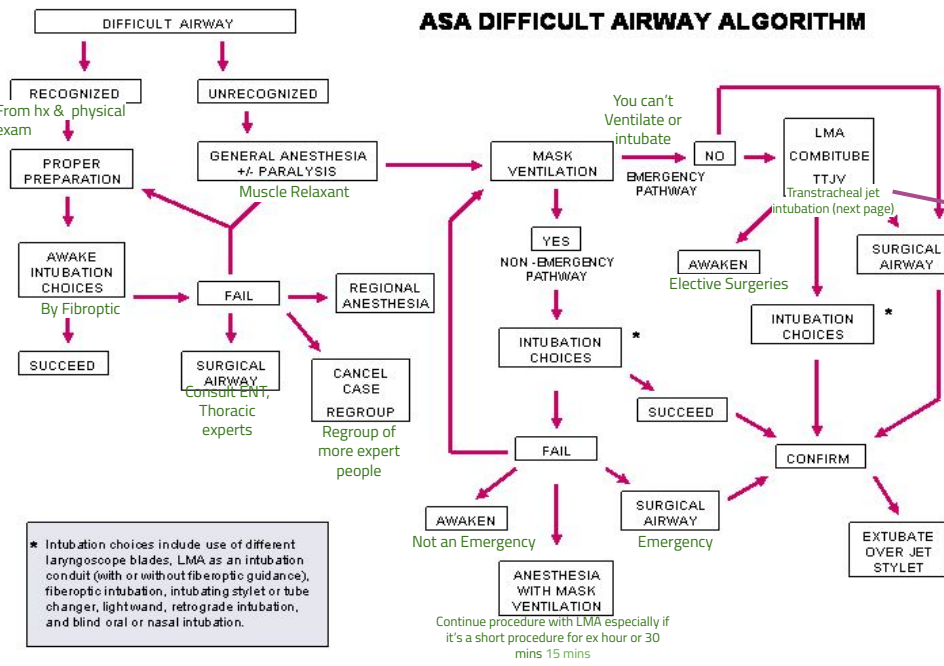


Glidescope
you should know
this one

Difficult Airway

Management of difficult Airway: advanced for your level

- Expected from history, examination: Secure airway while awake under LA
- Unexpected different options: Priority to maintain patent airway and ventilate the patient safely



If you can ventilate but you can't intubate intubate:

1. Change equipment
2. Change pt position
3. Change Person (call another one to try)

Still No? > Can you use Regional? > No? Small procedure (face mask or LMA) or lab choli (unrecognized, elective) reschedule

You gave the medications and you couldn't ventilate and you can't intubate intubate: **CALL FOR HELP**

1. Use LMA, combitube in case of difficulty
2. For thyroid/goiter we can't do it with regional anesthesia it has to be general but if it's for hernia repair and patient have difficult ventilation intubation then we can go for regional anesthesia
3. Emergency pathway if patient is hypoxic and have both difficulty in intubation & ventilation.

Ventilation

1. Spontaneous Ventilation
2. Controlled Ventilation

Pressure cycled and volume cycled ventilator:

volume control: adjust the tidal volume (the amount of air going to the lung with each breath) 4-6 ml/kg . so 70kg → 400ml per each breath

- Tidal Volume 10 mls/kg
- Respiratory rate to maintain normocarbia
- I:E ratio inspiration to expiration ratio. normally the expiratory phase is 2 times longer than the inspiratory phase
- the ratio: 1.2 or more
- PEEP post end expiratory pressure (to keep the alveoli open in case the patient had chest infection, atelectasis or if the patient obese)



Recommendations:

- Adequate airway assessment to pick up expected D.A (difficult airway) to be secured awake.
- Difficult intubation cart always ready.
- Pre oxygenation as a routine. to keep the intrapulmonary oxygen 100%
- Maintenance of oxygenation not the intubation should be your aim.
- Use the technique you are familiar with.
- Always have plans B,C,D in unexpected D.A.

Extubation: General Guidelines

Don't do it unless the patient is stable (Normal & adequate breathing, oxygen saturation is more than 95% , normal HR, BP and temperature and there is no surgical or medical contraindication.



Check that neuromuscular function and hemodynamic status is normal. First minimize anesthetic agent and give full muscle relaxant reversal



Check that the patient is breathing spontaneously with adequate rate and tidal volume



Allow patient to breathe 100% O₂ for 3-5 minutes



Suction secretions from pharynx



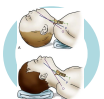
Deflate cuff, remove ETT on inspiration (vocal cords abducted) remove the tube during inspiration to avoid injury to the vocal cord



Ensure patient breathing adequately after extubation



Ensure face mask for O₂ delivery available



Proper positioning of patient during transfer to recovery room, e.g. sniffing position, side lying.

Oxygen Delivery System

Nasal Cannula:

- Deliver low flow oxygen, comfortable for eating and talking especially for children and elderly patients
- inspired oxygen concentration is dependent on the oxygen flow rate, the nasopharyngeal volume and the patient's inspiratory flow rate.

patient cant tolerate above 3L because it can cause dehydration or damage to nasal mucosa

- Increases inspired oxygen concentration by 3-4%.
- Oxygen flow rates greater than 3 liters are poorly tolerated by patients due to drying and crusting of the nasal mucosa



1 L/min:	21%to24%
2 L/min:	25% to 28%
3L/min:	29%to32%
4L/min:	33%to36%
5 L/min:	37% to 40%
6L/min:	41%to44%

Face Mask:

Three types of facemask are available:

Possible SAQ: what're the advantages and disadvantages of each type of airway control e.g: laryngeal airway and venturi

1- Open Facemasks:

- Are the most simple of the designs available.
- They do not provide good control over the oxygen concentration being delivered to the patient causing variability in oxygen treatment.
- A 6l/min flow rate is the minimum necessary to prevent the possibility of rebreathing **imp**. Rebreathing means that O_2 mixes with CO_2
- Maximum inspired oxygen concentration ~ 50-60%. **imp**



2- Venturi Facemasks:

- They should be used in patients with **COPD/emphysema** where accurate oxygen therapy is needed. **imp**
- Arterial blood gases can then be drawn so correlation between oxygen therapy for hypoxemia Normally the body will compensate by high CO_2 and breath but for them the decrease in O_2 (hypoxia) will stimulate them to breathe, So we give them low flow O_2 (24-50%) so that we don't correct the hypoxia and potential risk of CO_2 retention can be made.
- Masks are available for delivering 24%, 28%, 35%, 40%, 50%.



3- Non-rebreathing Face mask:

- Have an attached reservoir bag and one-way valves on the sides of the facemask.
- With flow rates of 10 liters an oxygen concentration of 95% can be achieved.
- These masks provide the highest inspired oxygen concentration for non-intubated patients.
- **Highest O_2 concentration: non-rebreathing + bag**
- eg, Hudson's face mask



- ❖ know the advantages and disadvantages of the laryngeal mask airway and endotracheal tube.

Lecture Quiz

Question 1: What is the most significant disadvantage of the laryngeal mask airway (LMA) over an endotracheal tube?

- A. Failure to provide a competent airway
- B. Risk of pulmonary aspiration
- C. Unreliable replacement
- D. Enhanced risk of tube obstruction

Question 2: If tracheal intubation is difficult after induction of general anesthesia, the most critical factor in electing to continue attempts at oral intubation is ?

- A. Availability of trained assistance
- B. History of successful intubation
- C. Ability to visualize the epiglottis
- D. Ability to provide satisfactory mask ventilation
- E. Low risk aspiration

Question 3: The very first step to aid a patient who is not breathing is to?

- A. Clear the mouth
- B. Administer oxygen
- C. Apply positive ventilation
- D. Open the airway

Question 4: When should a nasopharyngeal airway NOT be used?

- A. Patient has gag reflex
- B. Patient has clear fluid coming from the ears and nose
- C. Patient is not yet comatose
- D. Patient is labored breathing but alive

Question 5: When a patient begins to vomit, it is essential that you have a(n) _____ ready to go at the patient's side?

- A. Suction unit
- B. Oxygen tank
- C. Blood pressure cuff
- D. Pocket mask



Team leader: Rand Aldajani



Team member: Raaoum Jabor



Note Taker: Ghada Alharbi