MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

Primary Care Paramedicine

Module:10
Section:02

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

AIRWAY ASSESSMENT

Case 01

- You have responded to a 28 y/o M patient with an ALOC
- You find him on the couch snoring, friends called 911 because they are unable to wake him.
- What are looking for on initial assessment?
- What is your approach to this patient?
- What historic and physical exam findings are priority assessment details?

Case 02

- On scene with a 65 y/o male patient with SOB
- He is too short of breath to talk
- His wife is present, she called 911.
- What does your initial assessment include in terms of priority items?
- What findings help you determine the severity of his symptoms?

Case 04

- You are on scene with a 9 y/o M patient that is having an apparent allergic reaction.
- Hx of being stung by a bee 30 min ago
- Only symptom is local hives/itchy red skin at the site of the sting.
- Transport time is one hour.
- How do you monitor him enroute to hospital?
- How might the airway become involved?

Case 04

Does this patient have an issue with his airway?

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

COMPONENTS OF THE AIRWAY ASSESSMENT

Scene Assessment

- Medications
- Home oxygen devices
- Allergens (animals, plants etc)

Primary Assessment

- Is the airway patent?
- Is breathing adequate?
- Look, listen and feel.
- If patient is not breathing
  - Open the airway
  - Assist ventilations as necessary

Primary Assessment

History

SAMPLE	OPQRST-ASPN
Signs and **S**ymptoms	**O**nset
Allergies	**P**rovokes or **P**alliates
Medications	**Q**uality
Past medical history	**R**egion, **R**adiation, **R**eferral
Last oral intake	**S**everity
Events preceding the incident	**T**reatment
	Associated **S**ymptoms
	Pertinent **N**egatives

Inspection (Look)

- Skin color
- Patient's position
- Dyspnea
- Modified forms of respiration
- Rate
- Pattern
- Mentation

Modified Forms of Respiration

- Coughing
  - Forceful exhalation of large volume of air from lungs
  - Protects airway from irritants
- Sneezing
  - Forceful exhalation from nose
  - Caused by nasal irritation
- Hiccoughing
  - Spasmodic contraction of diaphragm
  - Occasionally associated with inferior myocardial infarction

Modified Forms of Respiration

- Sighing
  - Slow deep involuntary inspiration and expiration
  - Re-expands the alveoli
- Grunting
  - Forceful expiration against partially closed glottis
  - Usually an indication of respiratory distress

Respiratory Patterns

Table 2-2 Breathing Patterns

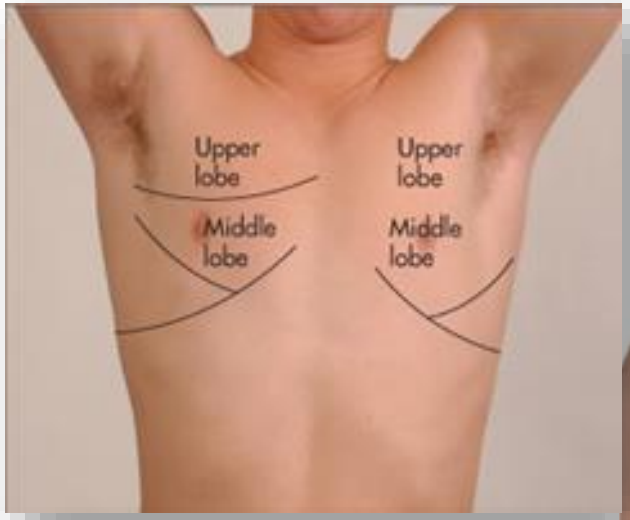
	Condition	Description	Causes
	Eupnea	Normal breathing rate and pattern	
	Tachypnea	Increased respiratory rate	Fever, anxiety, exercise, shock
	Bradypnea	Decreased respiratory rate	Sleep, drugs, metabolic disorder, head injury, stroke
	Apnea	Absence of breathing	Deceased patient, head injury, stroke
	Hyperpnea	Normal rate, but deep respirations	Emotional stress, diabetic ketoacidosis
	Cheyne-Stokes	Gradual increases and decreases in respirations with periods of apnea	Increasing intracranial pressure, brain stem injury
	Biot's	Rapid, deep respirations (gasps) with short pauses between sets	Spinal meningitis, many CNS causes, head injury
	Kussmaul's	Tachypnea and hyperpnea	Renal failure, metabolic acidosis, diabetic ketoacidosis
	Apneustic	Prolonged inspiratory phase with shortened expiratory phase	Lesion in brain stem

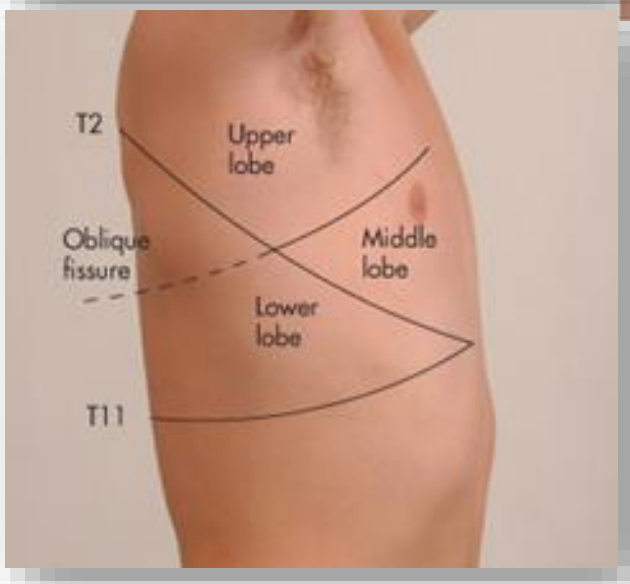
Auscultation (Listen)

- Listen at the mouth and nose for adequate air movement.
- Listen with a stethoscope for normal or abnormal air movement
  - Right and left apices
  - Right and left bases
  - Right and left back or midaxillary
- Posterior surface is preferable
  - Heart sounds do not interfere

MEDAVIE HealthEd ÉduSanté

Auscultation



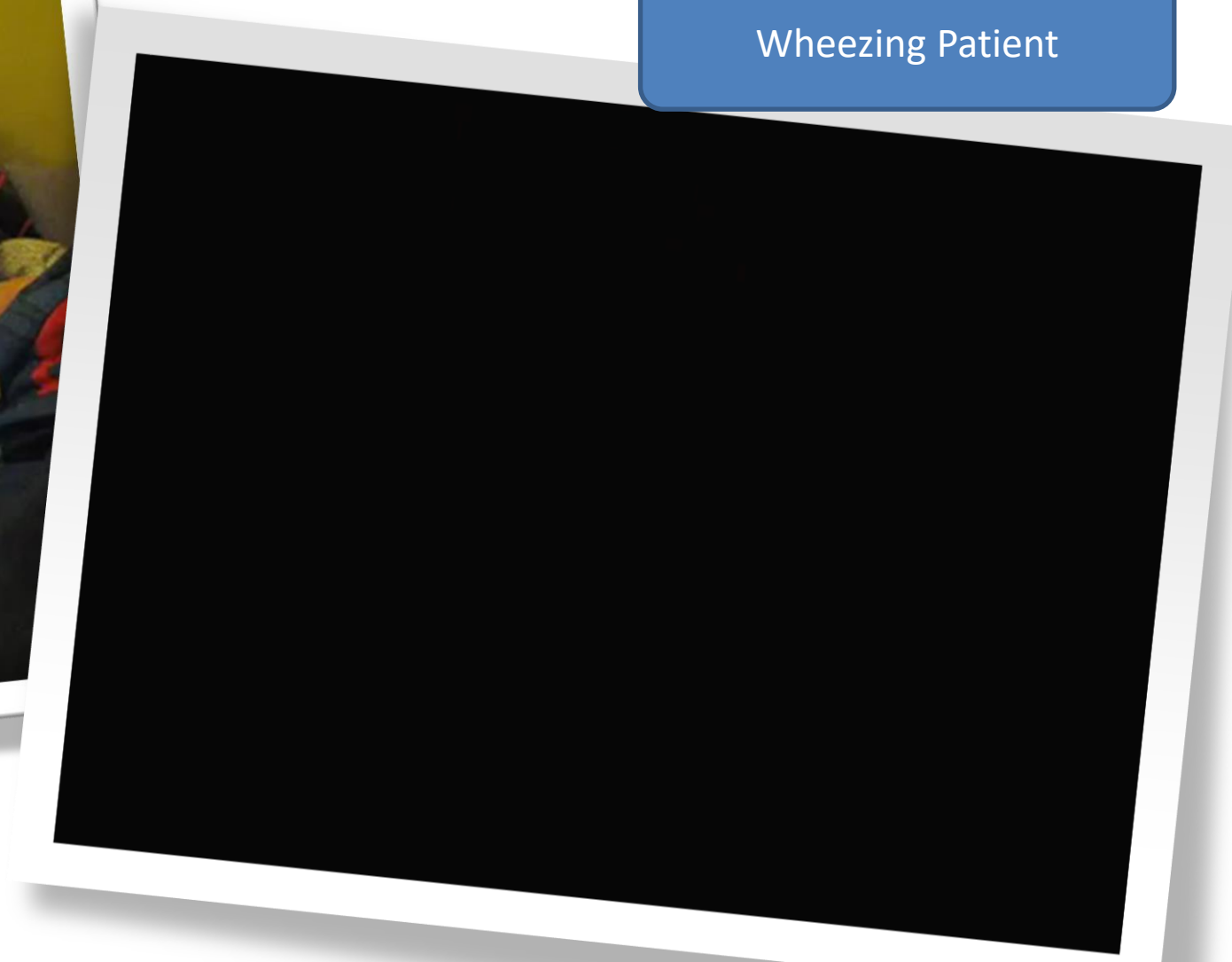


Airflow Compromise

- Snoring
  - Partial airway obstruction by the tongue
- Gurgling
  - Accumulation of fluid in airway
- Stridor
  - Associated with laryngeal edema or constriction
- Wheezing
  - Associated with bronchiolar constriction
- Quiet
  - Ominous finding indicating a serious problem

Airflow Compromise

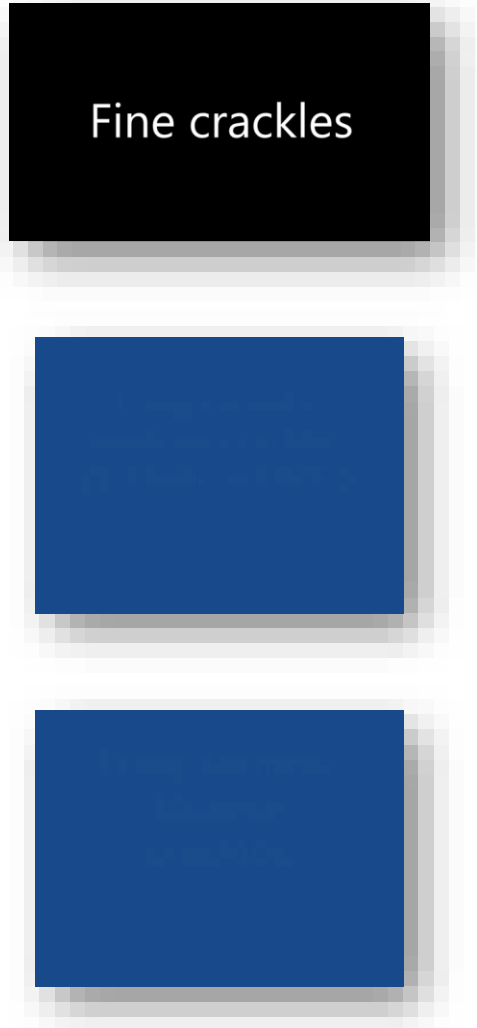
Stridor Patient



Wheezing Patient

Compromise of Gas Exchange

- Crackles
  - Fine bubbling noises heard on inspiration
  - Associated with fluid in smaller bronchioles
- Rhonchi
  - Coarse rattling noise heard on inspiration
  - Associated with inflammation, mucous or fluid in the bronchioles



Palpation (Feel)

- Air movement through mouth and nose
- Palpate chest for rise and fall
- Palpate chest wall
  - Tenderness
  - Symmetry
  - Abnormal motion
  - Crepitus
  - Subcutaneous emphysema
- Assess for compliance

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

OXYGEN ADMINISTRATION

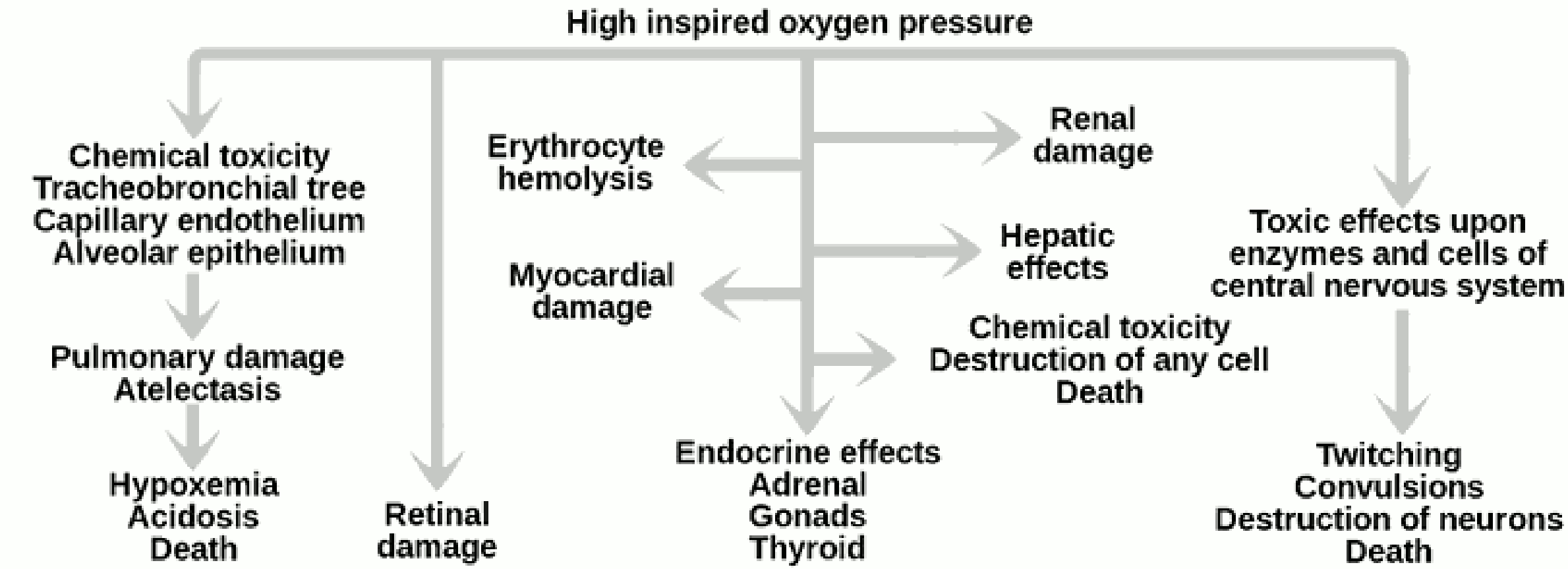
Hazards of Oxygen

- Aids in combustion
  - Explosive when mixed with petroleum
- Colorless, odorless, tasteless and dry
- Pressurized cylinders
- May depress respiratory drive in COPD Patients
- Oxygen Toxicity in divers/hyperbarics
- Free radicals/hyperoxia

Oxygen Toxicity

- Severe hyperoxia caused by breathing O_2 at elevated partial pressures and high concentrations. (FiO_2 > 50%)
- The high concentration of oxygen damages cells and causes a physiological change within the body
- Oxygen can form superoxide anions (free radicals)
- Free-radicals can harm DNA and other structures.
- Many inherent defences against such damage but at higher concentrations of free oxygen, these systems are eventually overwhelmed
- When the rate of damage to cell membranes exceeds the capacity of systems which control or repair it cell damage and cell death then results.

Oxygen Toxicity



Oxygen Regulators

- Reduce free flow (2000 psi) to a useable 40 -70 psi and provides control over the flow rate

Bourdon Regulator Styles

Compensated Flow

Oxygen Cylinders

- Come in a variety of sizes
- Should be stored appropriately
- Not designed to be left standing upright with out the use of a holder or storage device

Safety Systems

- P.I.N Index Safety System
  - Typically seen on the D, Super D and E

- Thread Standard
  - Usually seen on the M

Safety Systems

- Humidified Oxygen
  - Should be used when O_2 administration exceeds 30 minutes

Oxygen Tank Duration

$$Time = \frac{\left(Tank\ Pressure\ (psi) - Safe\ Residual\ (psi)\right) X\ Cylinder\ Factor\ \left(\frac{L}{psi}\right)}{Flow\ Rate\ \left(\frac{L}{min}\right)}$$

Safe Residual Volume

500 psi

Tank Cylinder Factors

D = 0.16

E = 0.28

M = 1.56

Tank Set Up

- Select tank
- Remove protective seal
- Open valve briefly to clean
- Attach regulator and tighten
- Open tank valve
- Ensure there is NO air leaking
  - Correct if present
- Attach desired oxygen delivery device
- Adjust flow rate to desired setting

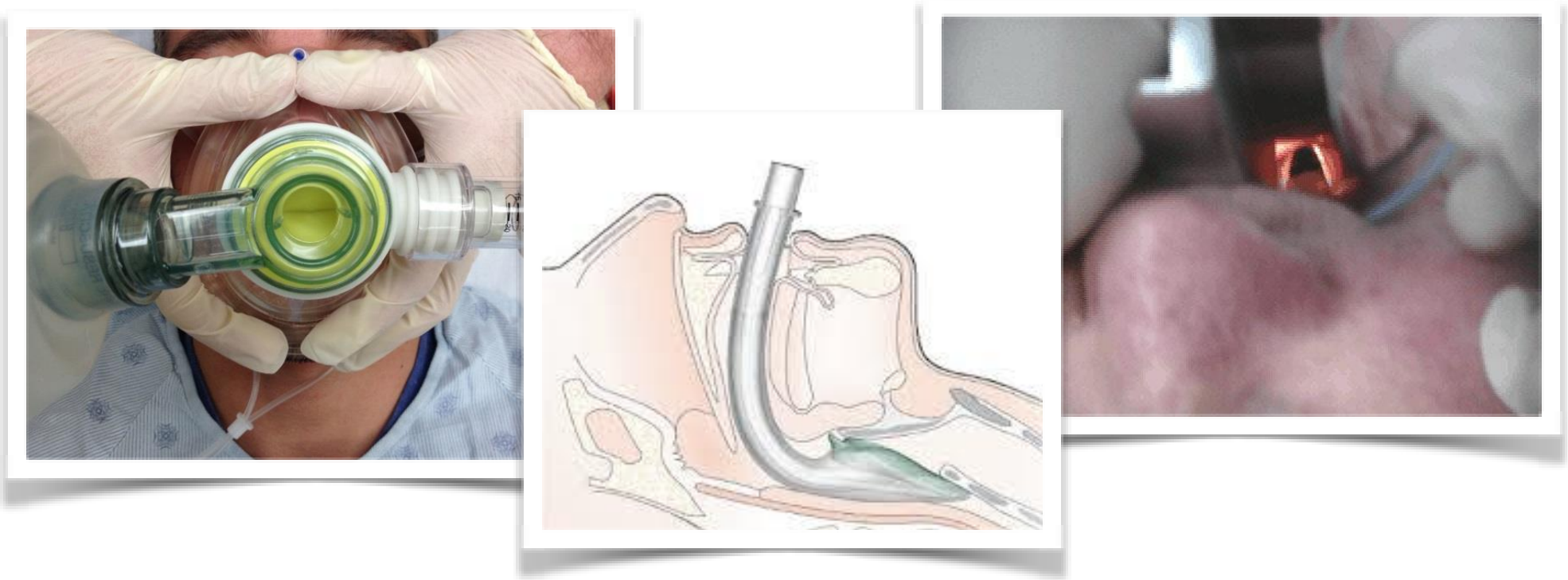
MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

OXYGEN DELIVERY DEVICES

The Goal

OXYGEN DELIVERY/VENTILATION!!!



...by any means: HFO, BMV, EGD, ETT

Patients don't die from Acute Plastic Deficiency Syndrome (APDS)

Oxygen Masks

- For patients breathing on their own and able to maintain their own airway:
  - High Flow Masks
    - Requires a specific flow rate to achieve the desired concentrations (nasal cannula, simple face mask, venturi mask, nebulizer)
  - High Concentration Masks
    - Will provide the same concentration despite the flow rate (non-rebreather)

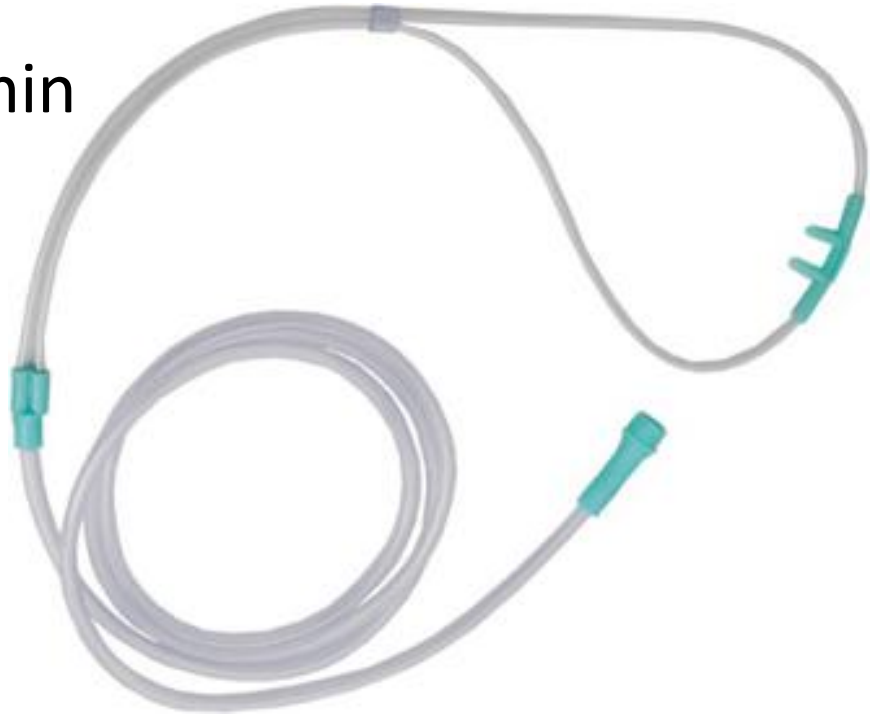
Oxygen Therapy

Low Flow Nasal Cannula (LFNC)

Type: High flow (low to medium concentration)

Percentage: 24 - 44%

Flow Rate: 1 - 6 L/min



Simple Face Mask

Type: High flow (medium concentration)

Percentage: 40 - 60%

Flow Rate: 6 - 10 L/min

Venturi mask (controlled concentration)

Type: High flow (low to medium concentration)

Percentage: 24, 28, 31, 35, 40, 50%

Flow Rate: 2 - 10 L/min

- Each tip has provides a different concentration
- Each tip requires a specific flow rate

Nebulizer (aerosol) mask

Type: High flow (medium concentration)

Percentage: 40 - 60%

Flow Rate: 6 - 10 L/min

- Has container to add saline and/or medication to become aerosolized prior to inhalation

Oxygen Therapy

Non-rebreather mask

Type: High concentration

Percentage: 90 - 100%

Flow Rate: 12 - 15 L/min

Oxygen Masks

- For apneic or dyspneic (**<10 or >30 bpm**) patients that need assistance with ventilations:
  - Positive pressure aids
    - Pocket mask (with or without oxygen)
    - Bag valve mask
    - Demand valve devices
    - Transport ventilators

Pediatrics Oxygenation

- Adequate oxygenation is the hallmark of pediatric patient care
- Ranges from blow-by to high concentration mask
- Patient may be reluctant
  - Demonstrate on yourself
  - Enlist parent or caregiver
  - Resort to blow-by

Pediatrics Oxygenation

- Try various techniques to overcome the child's fear

Oxygen Therapy

Pocket Mask

Type: Medium to high concentration

Percentage: 16% without O_2

50% @ 10 L/min

55 - 85% @ 15 L/min

Flow Rate: 10 - 15 L/min for oxygen

Oxygen Therapy

Bag Valve Mask (BVM)

Type: High concentration

Percentage: 90 - 100%

Flow Rate: 10 - 15 L/min for oxygen

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

AIRWAY MANAGEMENT

Airway Management

- Airway preservation and restoration are essential in dealing with the critically ill patient.
- Steps to airway management
  - Patient positioning
  - Opening the airway (manual airway positions)
  - Suctioning
  - Airway adjuncts
  - Ventilation
  - Supraglottic devices

First Principles

- 25 y/o F that has OD on heroin
- You arrive to find her surrounded by bystanders
- She has sonorous respirations

Patient Positioning

- The patient who requires basic airway maneuvers to be performed should be placed supine on the flattest surface available at the beginning of resuscitation.
- Patients who require cervical spine immobilization and are placed on a backboard should be secured to this board tightly enough so they will not slide or fall if the board is turned on its side to allow gravity to affect the drainage of vomitus or secretions.

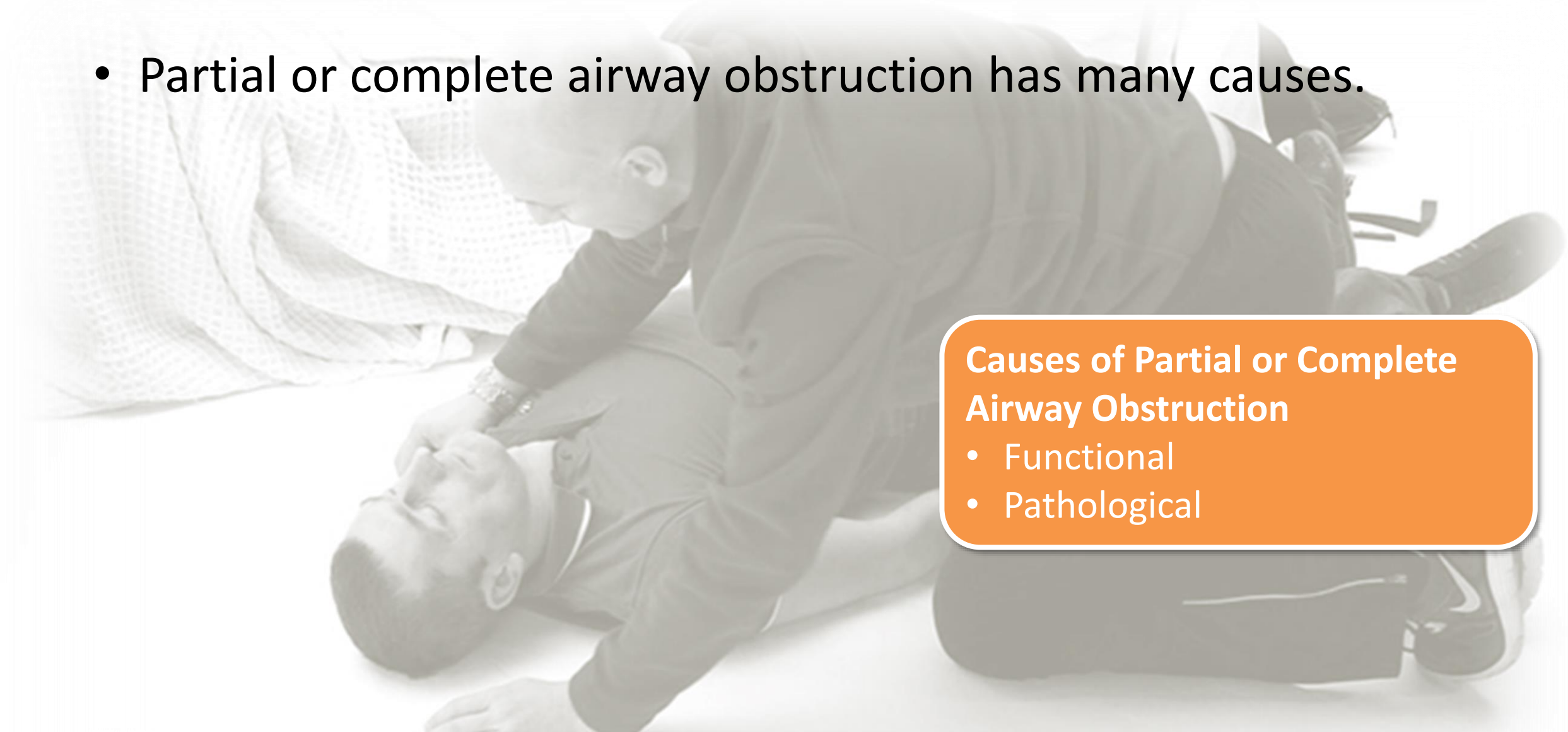
MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

MANUAL AIRWAY POSITIONS

Manual Airway Positioning

- Partial or complete airway obstruction has many causes.



Causes of Partial or Complete Airway Obstruction

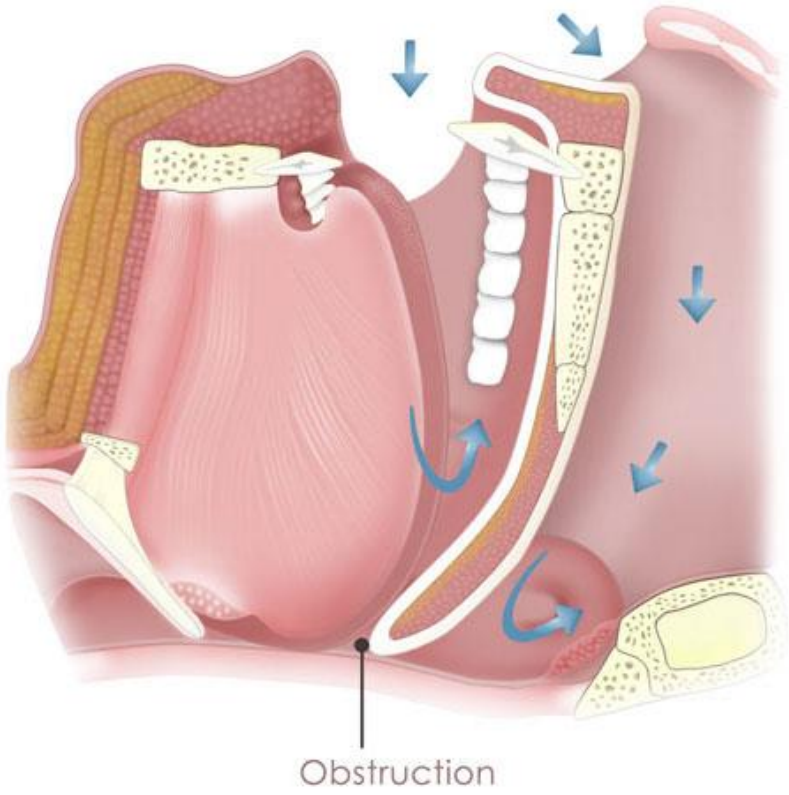
- Functional
- Pathological

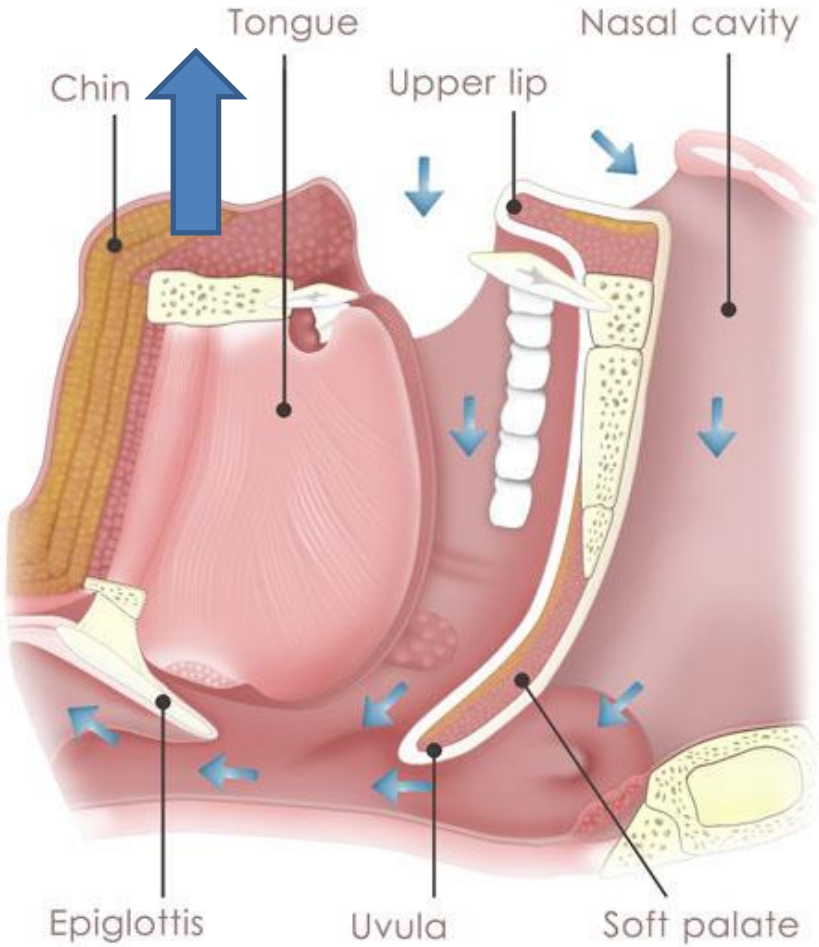
Recognition of a Functional Upper Airway Obstruction

- Snoring respiratory efforts
- Rocking, asynchronous chest/abdomen rise
- Little exhaled breath to feel
- Indrawing
- Apnea

Functional Upper Airway Obstruction

- What is the correction?





Airway Opening Maneuvers

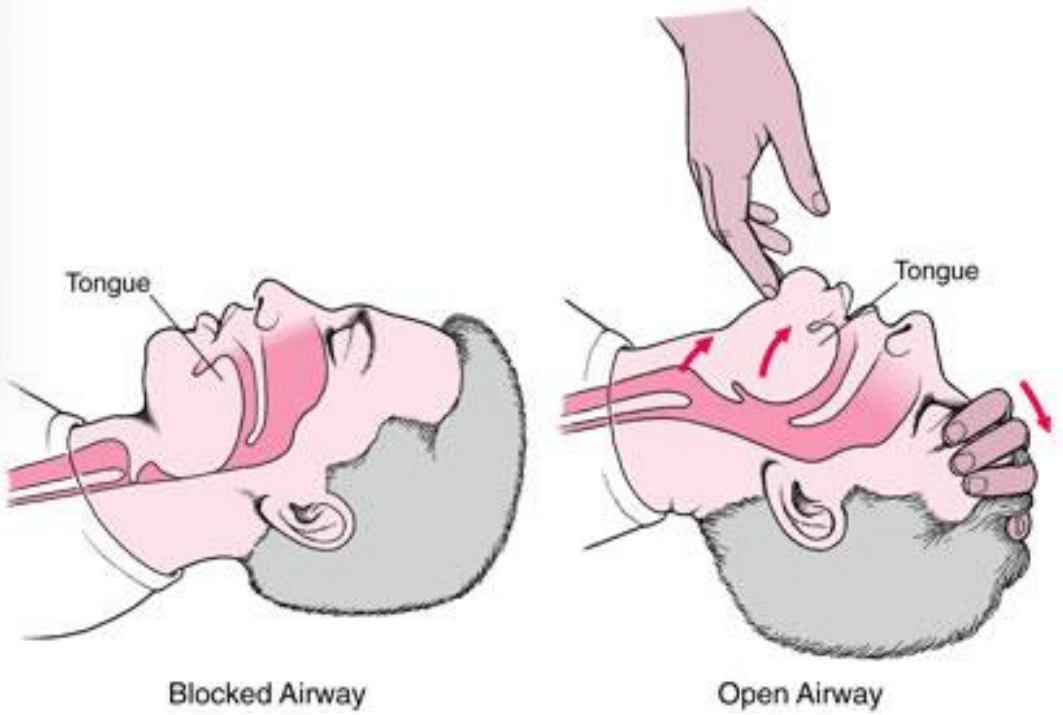
- Watch for the effect of…
  - Head extension
  - Chin lift
  - Jaw thrust

Manual Airway Positioning

- Manual airway manoeuvers are to assist in opening up and protecting a patient's airway
- Manual airway manoeuvers are:
  - Head tilt chin lift
  - Jaw thrust
  - Modified jaw thrust
  - Jaw lift
  - Cross finger technique
  - Recovery position

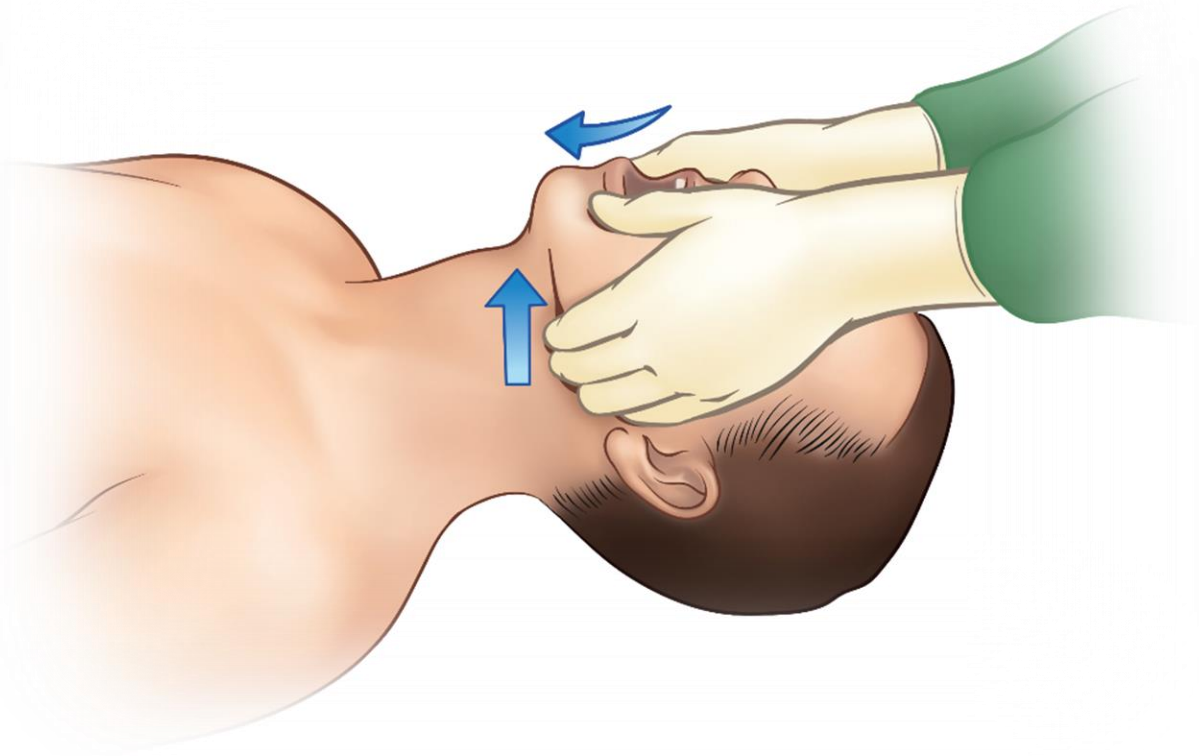
MEDAVIE HealthEd ÉduSanté

Head Tilt/Chin Lift



MEDAVIE HealthEd ÉduSanté

Jaw Thrust Maneuver



MEDAVIE HealthEd ÉduSanté

Modified Jaw Thrust in Trauma

MEDAVIE HealthEd ÉduSanté

Jaw Lift Maneuver

MEDAVIE HealthEd ÉduSanté

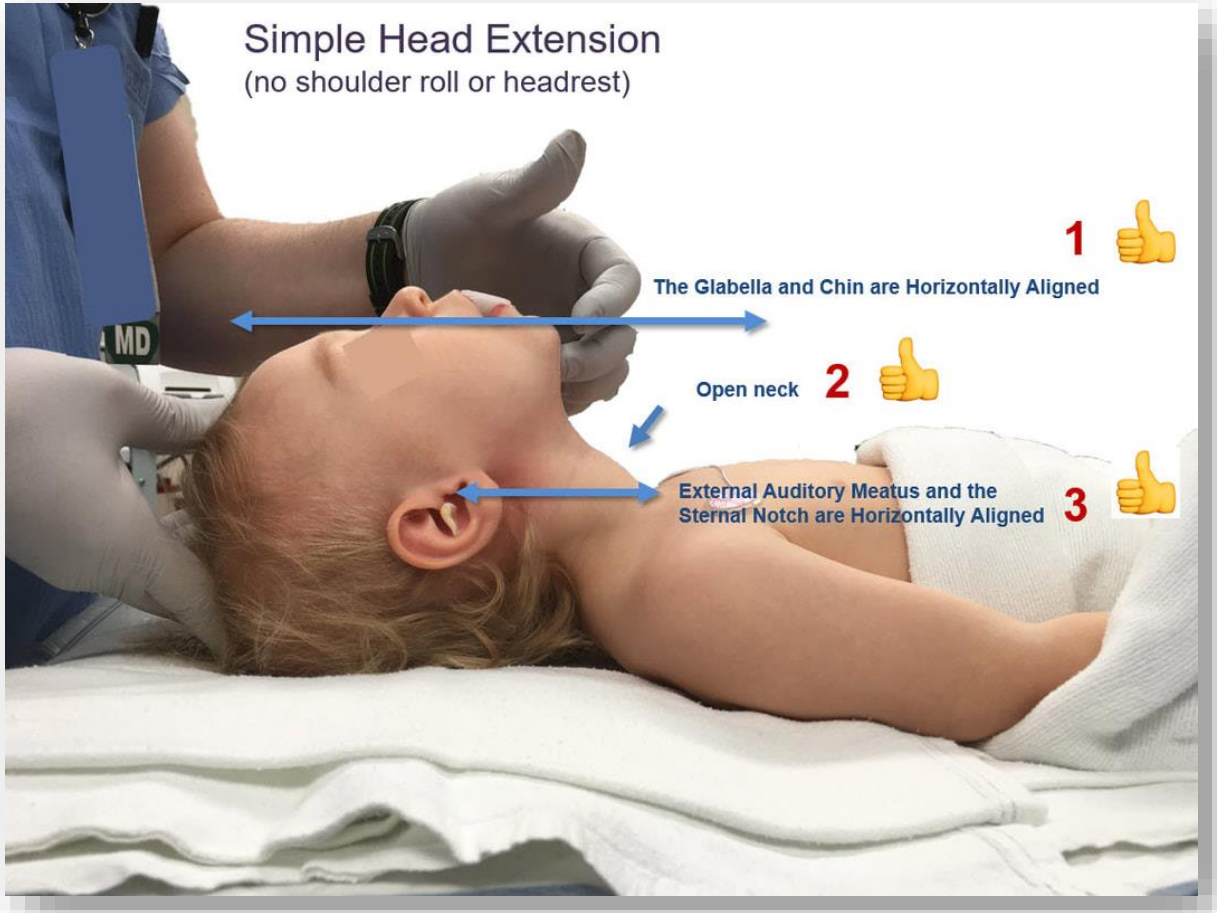
Cross Finger Technique

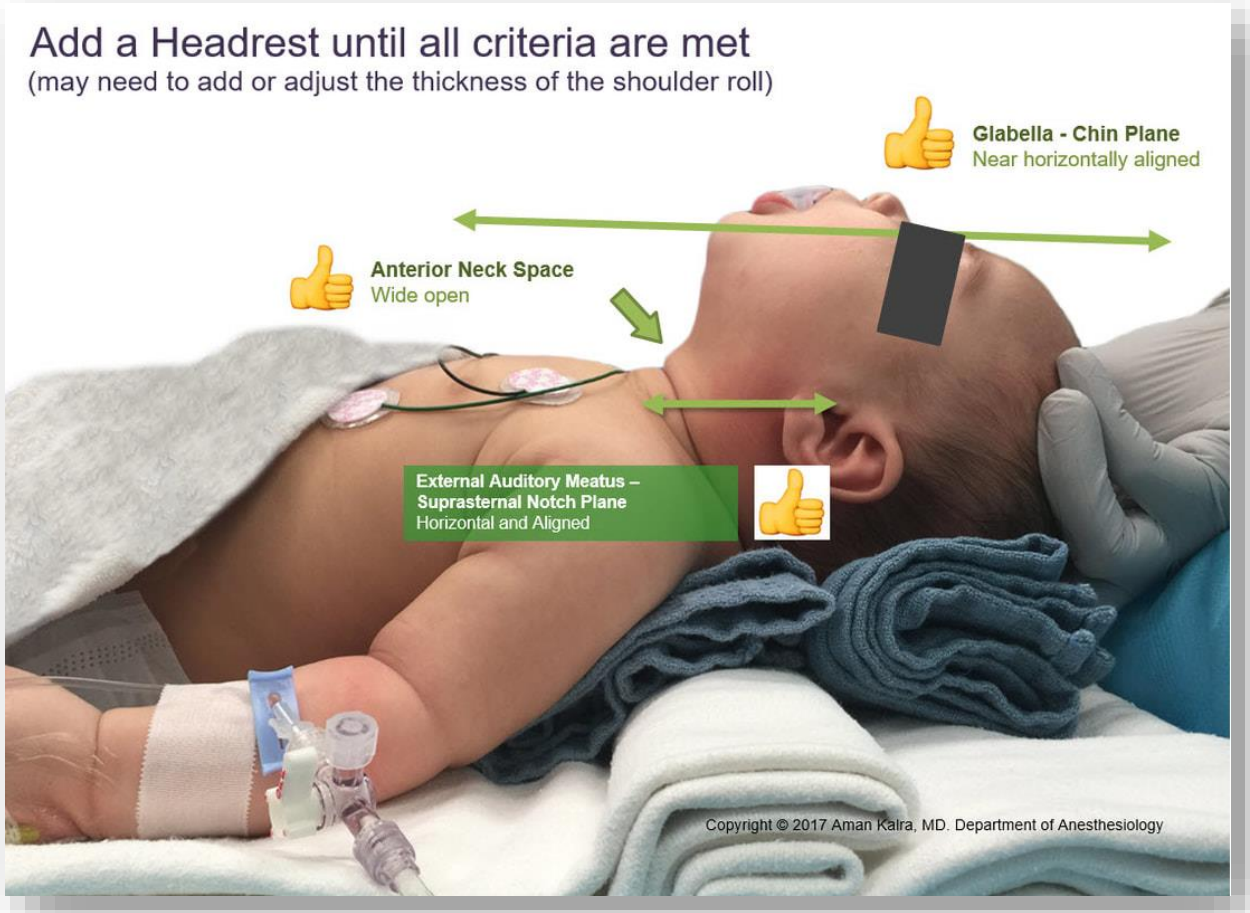
Pediatric Airway

In supine position, the relatively large size of an infant's head results in natural neck flexion compressing the soft upper airway passages. Under conditions of low airway tone like during general anesthesia, the relatively large tongue falls back against the posterior pharyngeal wall and contributes to airway turbulence and upper airway obstruction

MEDAVIE HealthEd ÉduSanté

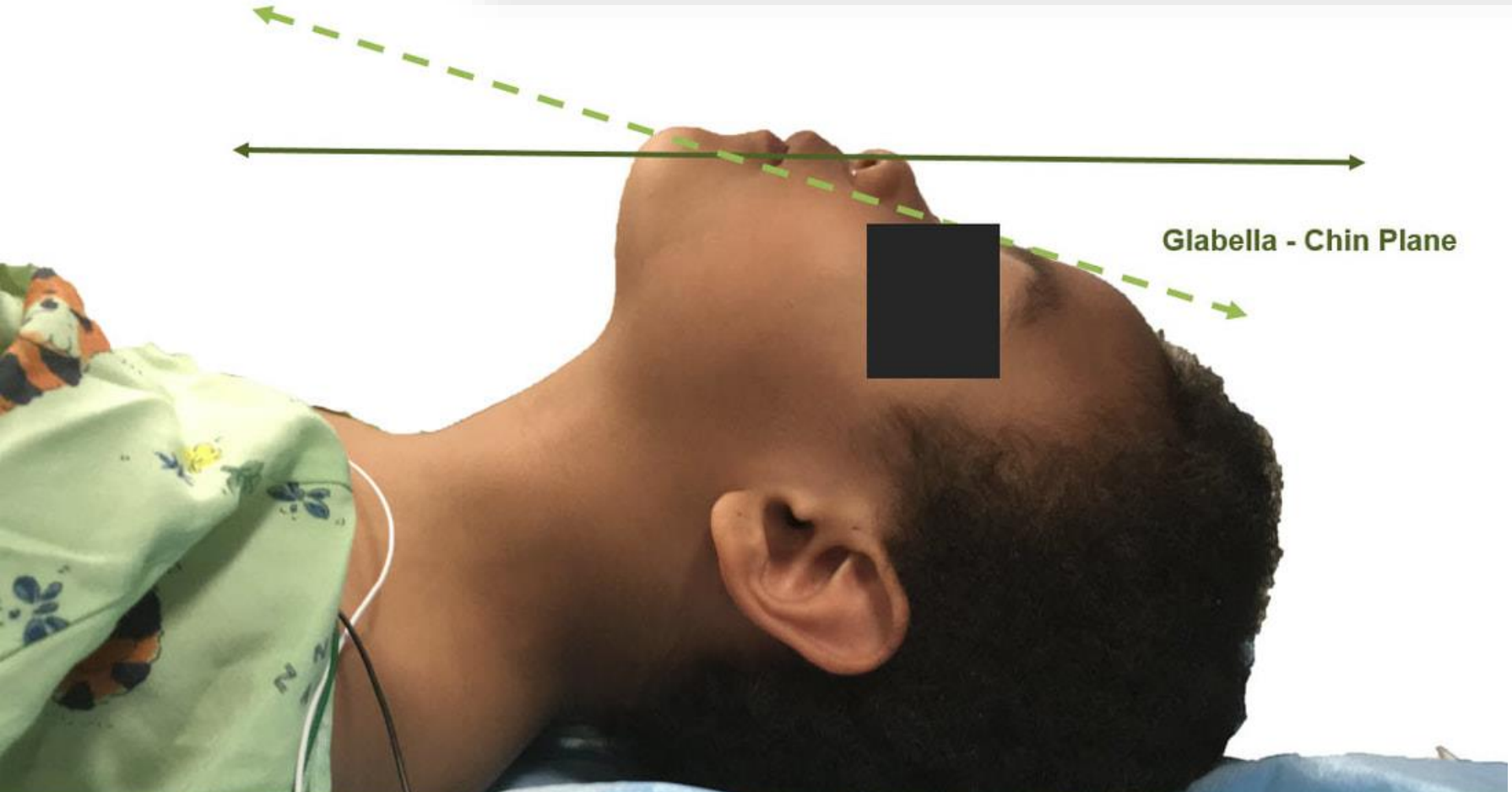
Pediatric Airway



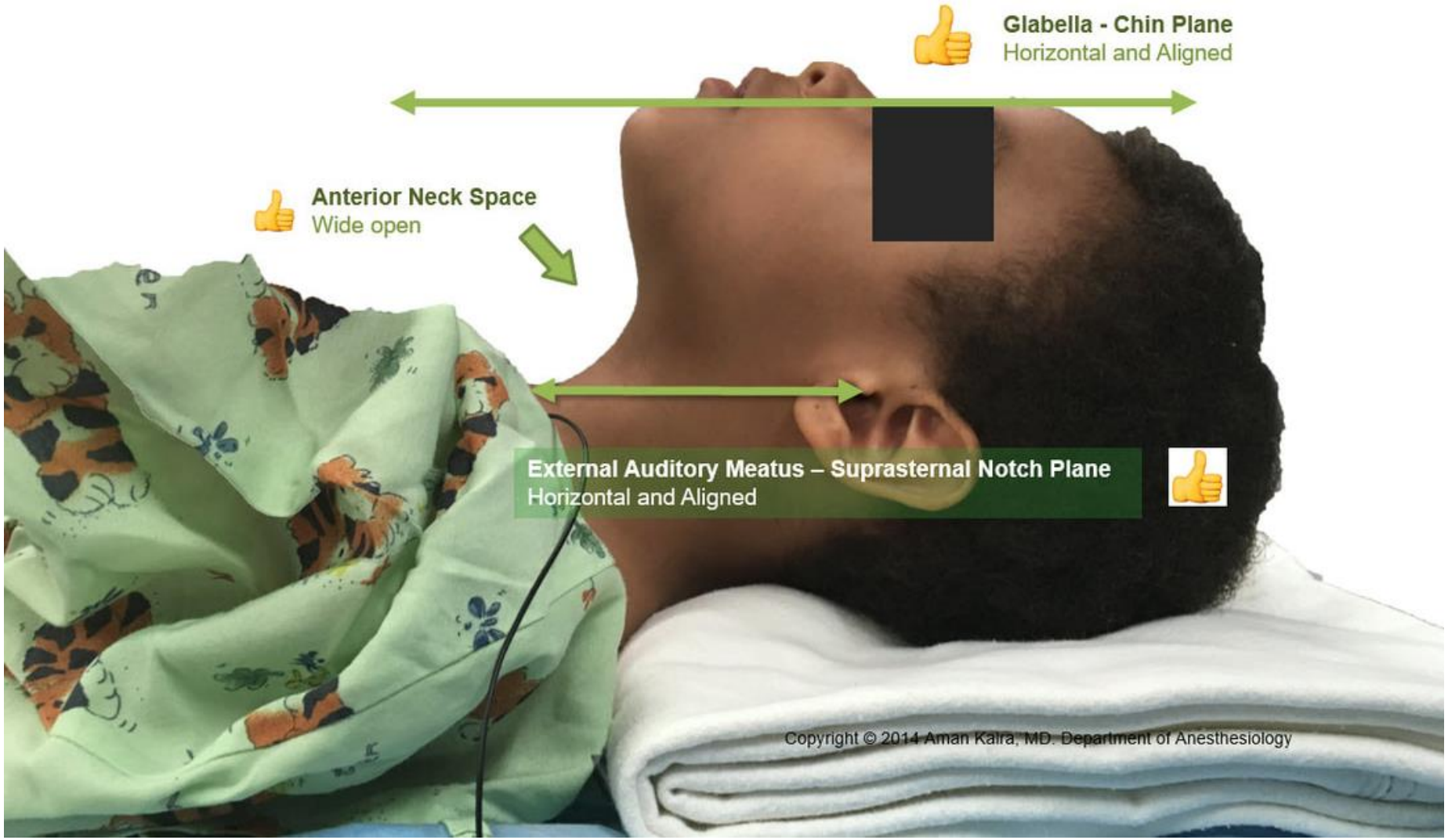


Pediatric Airway

This 6 yo child is NOT optimally positioned. His neck is over-extended as indicated by the tilted Glabella-Chin Plane in the image above. A headrest pillow will help bring the laryngeal, tracheal, and pharyngeal axis in alignment and improve intubating conditions

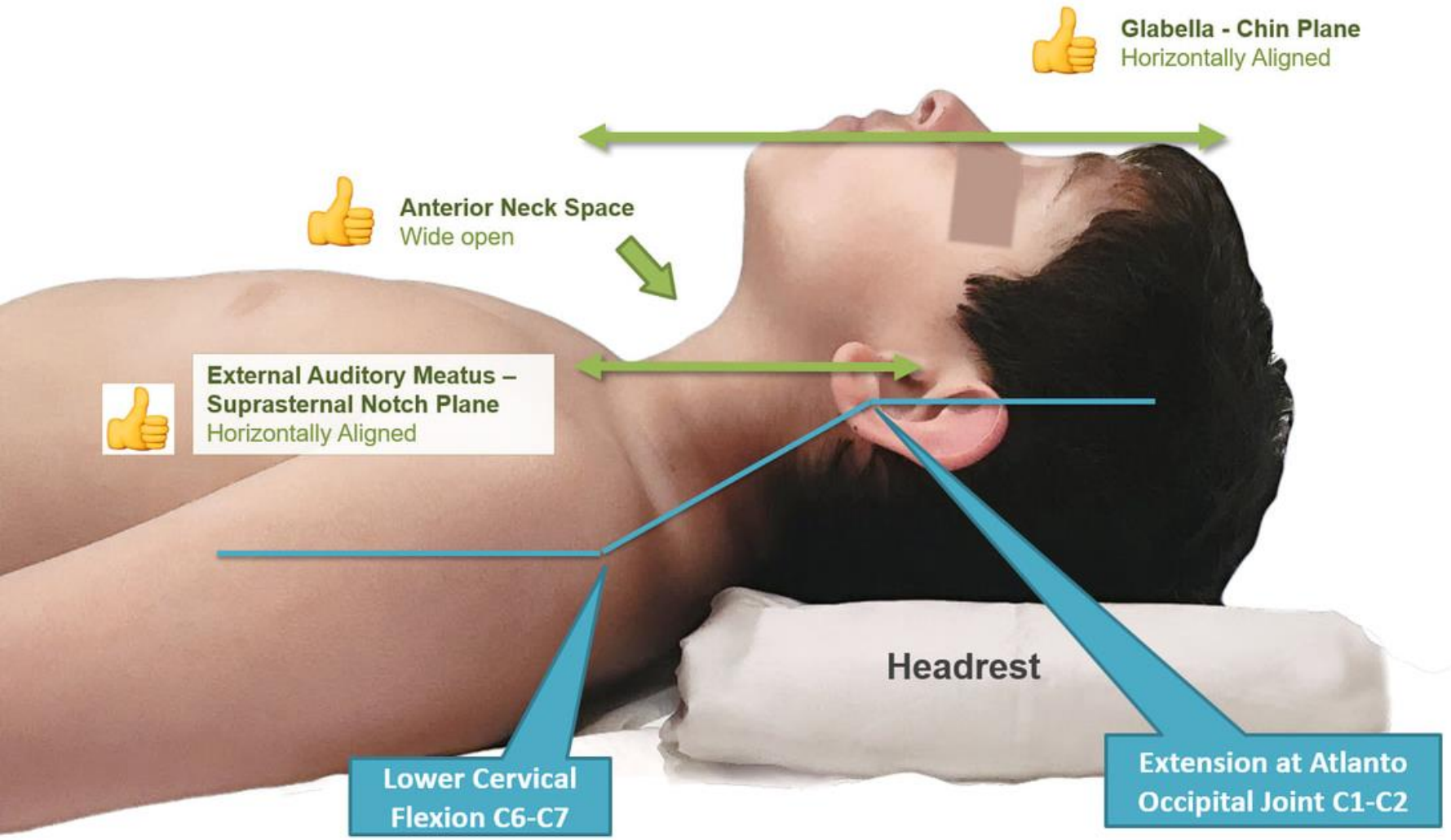


Pediatric Airway



Pediatric Airway

8 y/o in sniffing position



Maintaining Open Airway and Oxygenation?

- Head tilt, jaw thrust, chin lift.
- Apply oxygen (options?)
- Is the airway clear?
- Did she vomit?

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

SUCTIONING

Suctioning

- The physical removal of secretions and material through the use of negative pressure to maintain a patient's airway ensuring adequate ventilation
  - Upper airway
  - Lower airway
  - Tracheostomy

Suctioning

- Indications:
  - To remove secretions, blood or vomitus from a patient's airway
  - For standby use in preparation for endotracheal intubation
- Contraindications:
  - Nil
- Complications:
  - Airway trauma
  - Stimulate coughing or gagging
  - Hypoxia from delays in ventilation with tracheal tube suctioning
  - Vagal stimulation can result in bradycardia and hypotension

Equipment

- Suction Units
  - V-Vac
  - Wall mount
  - Portable battery operated
- Suction Tips
  - Yankauer tip (tonsil tickler)
  - Suction catheter

Upper Airway

- Procedure:
  - Only suction as far as you can see
  - Suction for 10-15 seconds only
  - Oropharyngeal suctioning (v-vac or yankauer)
    - Under direct vision, insert the catheter into the oropharynx along the cheek wall
    - Yankauer: occlude side port to commence suctioning while retracting device
    - V-vac: begin squeezing handle while retracting device
  - Oropharyngeal suctioning (suction catheter)
    - Under direct vision, gently insert the catheter into the nasopharynx/oropharynx
    - Occlude side port to commence suctioning while gently withdrawing catheter

Pediatric Suctioning

- Decrease suction pressure to less than 100 mm/Hg in infants.
- Avoid excessive suctioning time
  - Less than 15 seconds per attempt.
- Avoid stimulation of the vagus nerve.
- Check the pulse frequently.

Pediatric-size Suction Catheters

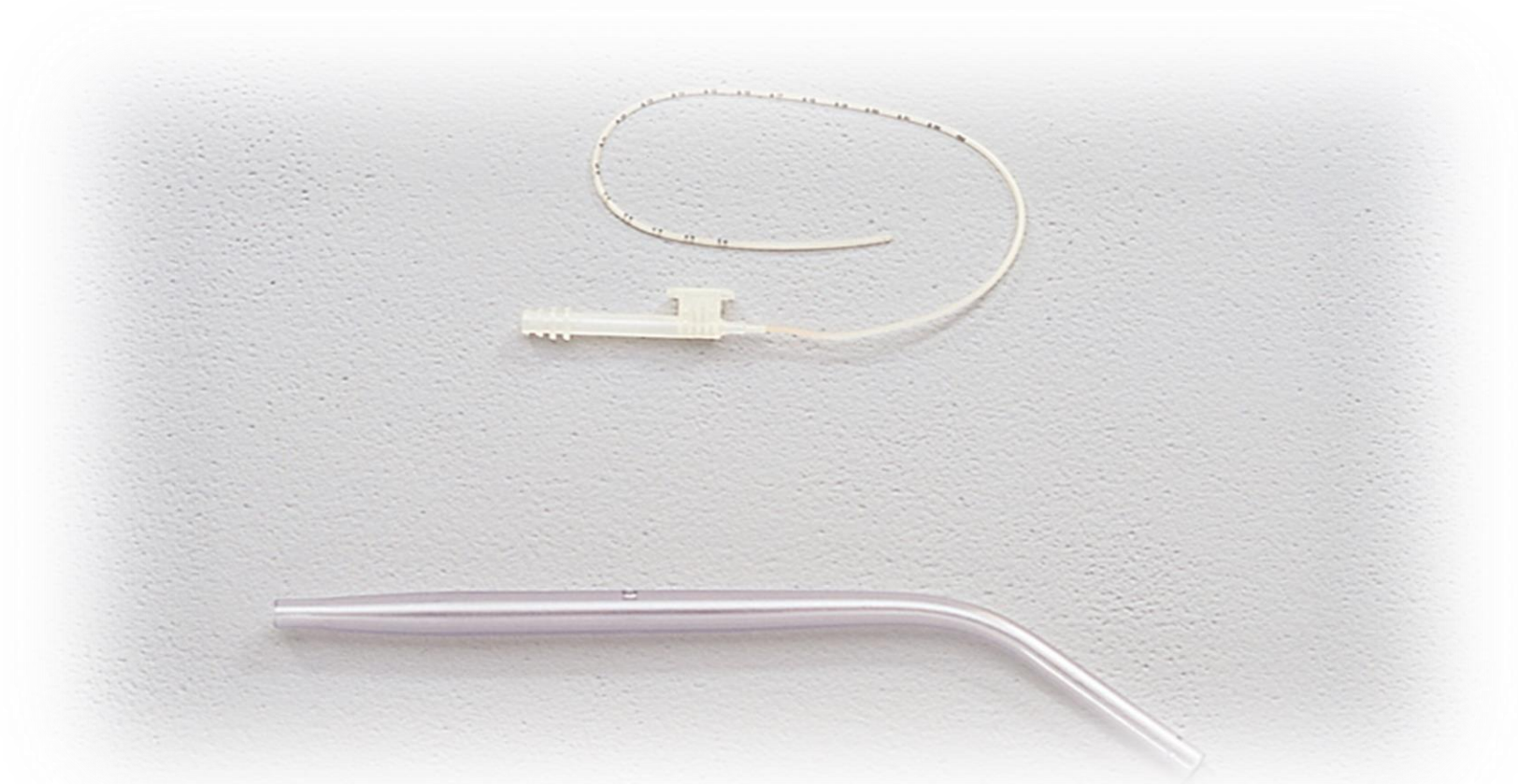


Table 42-6 Suction Catheter Sizes for Infants and Children

Age	Suction Catheter Size (French)
Up to 1 Year	8
2 to 6 Years	10
7 to 15 Years	12
16 Years	12 to 14

Pediatric Oxygenation

- Adequate oxygenation is the hallmark of pediatric patient care
- Ranges from blow-by to high concentration mask
- Patient may be reluctant
  - Demonstrate on yourself
  - Enlist parent or caregiver
  - Resort to blow-by

Pediatric Oxygenation

- Try various techniques to overcome the child's fear

Table 42-7 Equipment Guidelines According to Age and Weight

Equipment	Age (50th Percentile Weight)					
	Premie (1–2.5 kg)	Neonate (2.5–4.0 kg)	6 Months (7.0 kg)	1–2 Years (10–12 kg)	5 Years (16–18 kg)	5–10 Years (24–30 kg)
Airway						
Oral	infant (00)	infant (small) (0)	small (1)	small (2)	medium (3)	medium large (4.5)
Breathing						
Self-inflating bag	infant	infant	child	child	child	child/adult
0_2 ventilation mask	premature	newborn	infant/child	child	child	small adult
Endotracheal tube	2.5–3.0 (uncuffed)	3.0–3.5 (uncuffed)	3.5–4.0 (uncuffed)	4.0–4.5 (uncuffed)	5.0–5.5 (uncuffed)	5.5–6.5 (uncuffed)
Laryngoscope blade	0 (straight)	1 (straight)	1 (straight)	1–2 (straight)	2 (straight or curved)	2–3 (straight or curved)
Suction/stylet (F)	6–8/6	8/6	8–10/6	10/6	14/14	14/14
Circulation						
BP cuff	newborn	newborn	infant	child	child	child/adult
Venous access						
Angiocath	22–24	22–24	22–24	20–22	18–20	16–20
Butterfly needle	25	23–25	23–25	23	20–23	18–21
Intracath	—	—	19	19	16	14
Arm board	6″	6″	6″–8″	8″	8″–15″	15″
Orogastric tube (F)	5	5–8	8	10	10–12	14–18
Chest tube (F)	10–14	12–18	14–20	14–24	20–32	28–38

Maintaining Open Airway and Oxygenation?

- Airway is now clear.
- She is still not breathing effectively.
- Are there other adjuncts to assist in maintaining airway opening?

Airway reflexes intact

No airway reflexes

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

AIRWAY ADJUNCTS

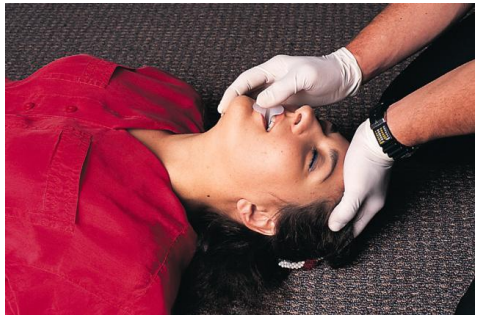
Oropharyngeal Airway (OPA)

- Indications: Unresponsive patients to assist in maintaining patency of the airway by lifting the tongue off of the posterior pharyngeal wall and epiglottis
  - May also be used as a bite block
- Contraindications: gag reflex, FBAO

COMPLICATIONS

- Gagging, vomiting and aspiration
- Soft tissue trauma to the tongue, palate and pharynx
- Biting down on the hard surface can injure the teeth

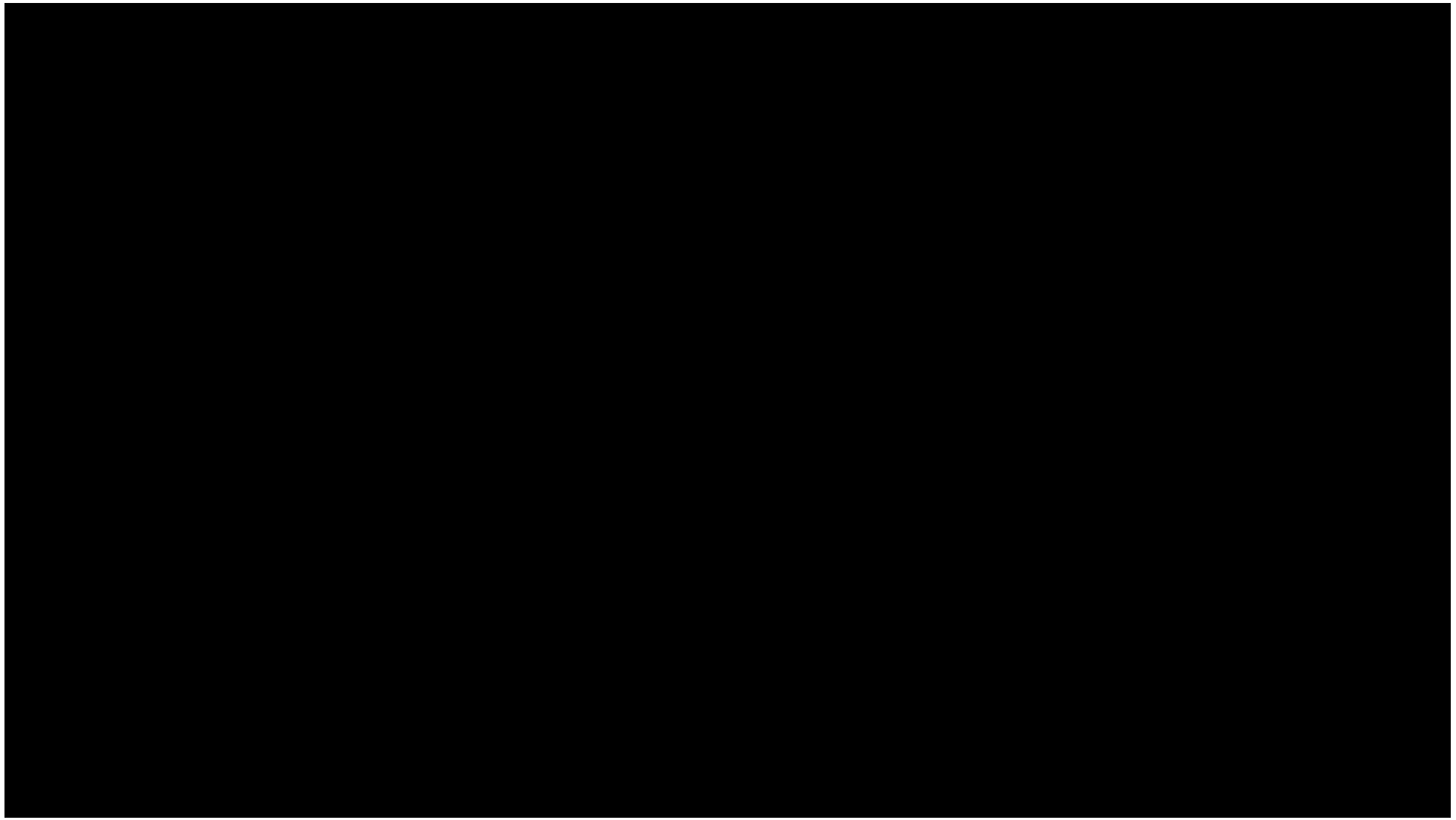
Oropharyngeal Airway (OPA)



- Procedure:
  - Position the patient in the supine position
  - Place in “sniffing” position
  - Measure the OPA
    - Measured from earlobe to corner of mouth
    - May also be measured from the center of mouth to the angle of the jaw
  - Open airway with jaw lift or cross finger techniques
  - Insert the OPA
    - Adult: Inserted upside down and rotated 180° down behind the tongue
    - Ped: Insert directly over the tongue
  - Flange of OPA should sit on patients lips

MEDAVIE HealthEd ÉduSanté

OP Airway: Insertion



Pediatrics

- Inserting an oropharyngeal airway in a child with the use of a tongue blade

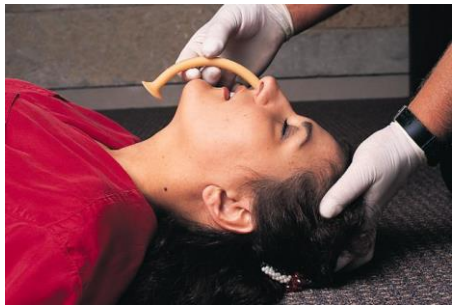
Nasopharyngeal Airway (NPA)

- Indications: conscious or unresponsive patients to assist in maintaining patency of the airway by lifting the tongue off of the posterior pharyngeal wall and epiglottis
- Contraindications: basal skull or nasal fractures

COMPLICATIONS

- Epistaxis and aspiration
- Ulceration
- Insertion through the cribriform plate into the brain

Airway Management



- Procedure:
  - Position the patient in the supine position
  - Place in “sniffing” position
  - Measure the NPA
    - Measuring from patients nostril to the meatus of the ear
  - Lubricate the NPA
  - Insert the NPA with bevel of airway facing the septum of the patient’s nose
    - Right nostril: inserted directly into the airway
    - Left nostril: insert and twist 180° as it enters the airway
    - If resistance is felt remove and attempt other nostril
  - Flange of NPA should sit at patients nostril

Approach to Functional Airway Obstruction

- OPA/NPA, jaw thrust, oxygen, +/- BMV
- Then consider, is there a quick intervention that would make the patient conscious and able to maintain airway?
  - Cardiac rhythm issue? – put on monitor to see if needs electrical intervention with ALS
  - Check for +/- treat low glucose
  - Possible narcotic overdose? (narcan)
- If no readily reversible cause found, extraglottic device (BLS) or intubation (ALS) are then considered as options.

Airway Management and Ventilation

VENTILATION

Bag Valve Mask (BVM)

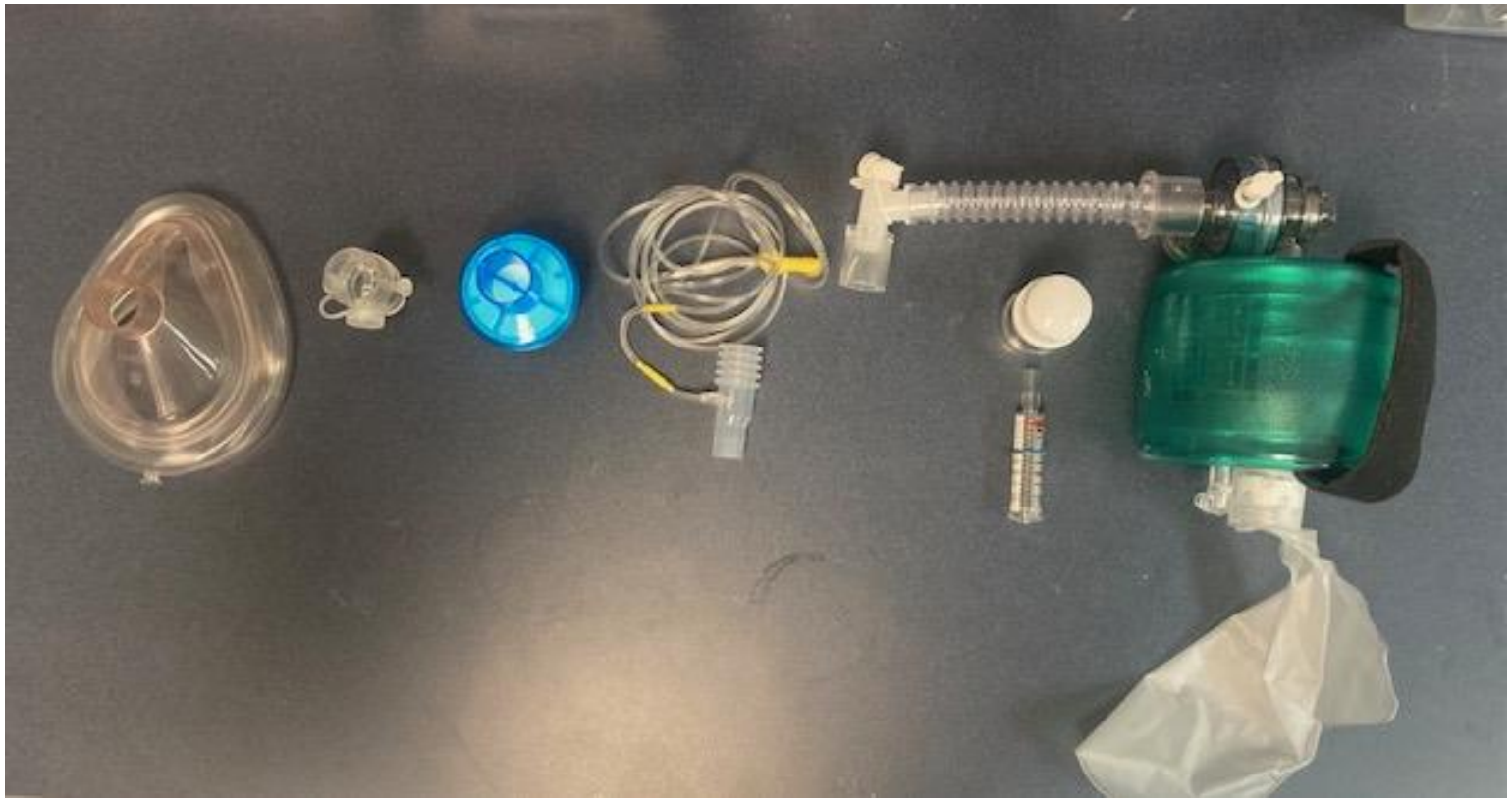
- Bag-valve-mask (BVM) ventilation is an essential emergency skill.
- This technique allows for oxygenation and ventilation of patients until a more definitive airway can be established and in cases where endotracheal intubation or other definitive control of the airway is not possible.
- Requires a good seal and a patent airway.
- Practice with this important skill increases the clinician's ability to provide effective ventilation.
- Adjuncts such as oral and nasal airways can aid with ventilation by relieving physiologic obstruction and by opening up the hypopharynx.

Bag Valve Mask (BVM)

- Masks and bags come in many sizes
- The bag may be equipped with a pressure valve.

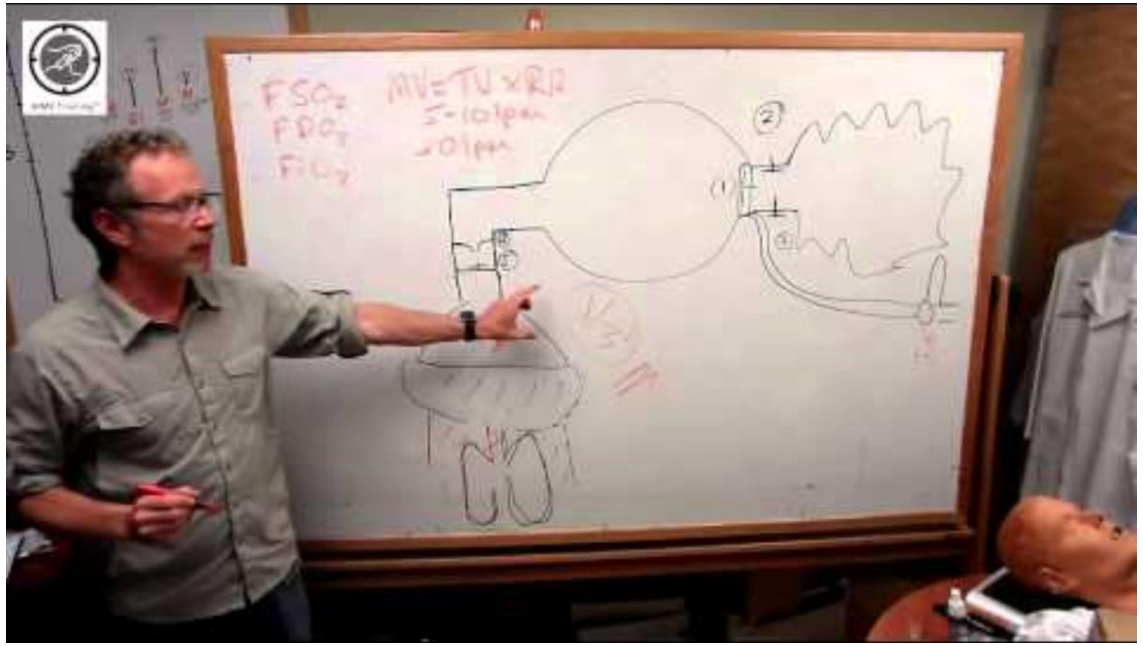
BVM System Components

- BVM device
- PEEP valve
- Manometer
- Flex connector
- EtCO2 device
- Viral filter
- MDI adapter (prn)
- Mask/Igel/ETT



MEDAVIE HealthEd ÉduSanté

Understanding Your Gear



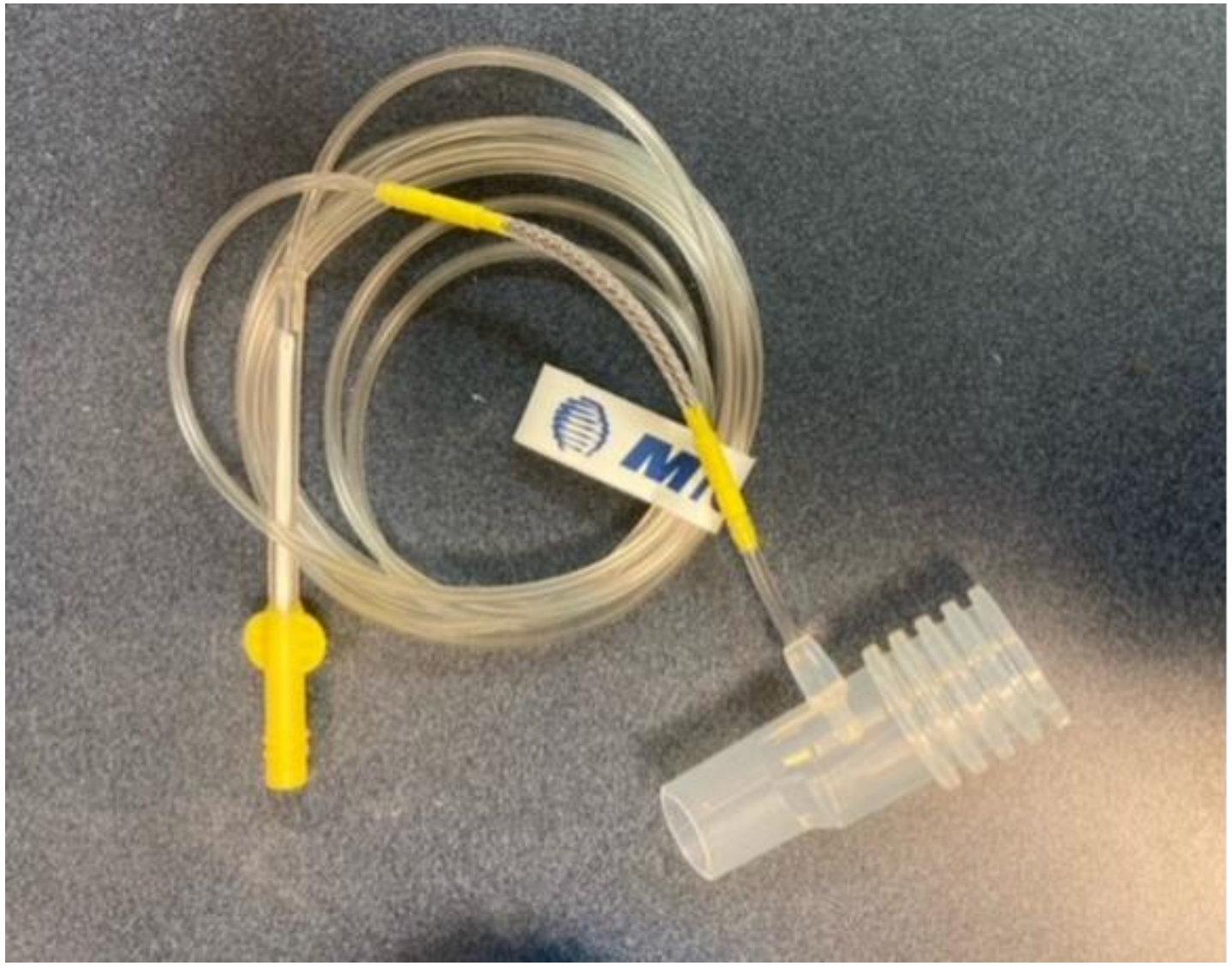
www.aimeairway.ca

BVM System Components

- Flex connector
- Manometer
- PEEP valve

BVM System Components

- $EtCO_2$
  - Between flex connector and viral filter



BVM System Components

- Viral filter
  - Placed between $EtCO_2$ detector and MDI (prn) or mask/ETT/Igel etc.

BVM System Components

- MDI adapter
  - Placed between viral filter and mask/ETT/Igel
- Not required if med admin is not anticipated

BVM System Components

- Remove MDI cannister from plastic holder
- Remove rubber cap from MDI adapter
- Insert cannister tip into MDI port
- Plunge cannister simultaneously with compression of BVM

Bag Valve Mask (BVM)

- Indications:
  - Respiratory failure (failure of ventilation and/or oxygenation)
- Contraindications:
  - FBAO
- Complications:
  - Gastric distention
    - Vomiting secondary to gastric distention hyperinflation or over inflation
  - Barotrauma (pneumothorax, etc.)
  - Air trapping (auto peep)
  - Hypoxia due to inadequate minute volume
  - Equipment failure or empty supplemental oxygen source

Bag Valve Mask (BVM)

- Prepares BVM
- Select appropriate size mask for patient
- Create proper mask to face seal (C-K method)
- Ventilate patient at a rate of 12 – 20 bpm
  - Gentle slow ventilations (over 1 sec)
  - Allow for passive exhalation
- Ensure adequate chest rise (no more than 600 ml)
  - Note the average adult tidal volume is 6 – 7 ml/kg of oxygen)
- Connects oxygen to BVM and adjusts flow rate to 15 lpm
- Continue to ventilate at selected rate

MEDAVIE HealthEd ÉduSanté

BVM Ventilation

Pediatric Ventilation

- Avoid excessive bag pressure and volume
- Obtain chest rise and fall.
- Allow time for exhalation.
- Flow-restricted, oxygen-powered devices are contraindicated.
- Do not use BVMs with pop-off valves.
- Apply cricoid pressure.
- Avoid hyperextension of the neck.

Difficulties

- Contributory factors to improperly performed artificial ventilation
  - Inadequate mask seal
    - Wrong mask size for patient
    - Single rescuer
  - Inadequate minute ventilation
    - Inadequate tidal volume (should be at least 10 ml/kg)
    - Inadequate respiratory rate(hyperventilation is the norm)

Difficulties

- Contributory factors to improperly performed artificial ventilation
  - Inadequate oxygen delivery
    - Failure to ensure patent airway prior to ventilation
    - Failure to deliver enough supplemental oxygen (at least 15 liters/minute)
  - Gastric distention
    - Prevents ability to deliver adequate tidal volume
    - Increases risk of vomiting, which impedes ability to properly ventilate

Predicting Difficult Mask Ventilation

- The goal of the airway assessment is to identify patients who may be difficult to ventilate and/or require alternate approaches to airway management
- Airway assessment and prediction of the difficult ventilation is an inexact science, particularly in the critically ill and in emergency situations

Predicting Difficult Mask Ventilation

- There is no method of prediction that is both highly sensitive and highly specific
- Always be prepared to manage an unanticipated difficult airway
- Airway assessment is valuable as it helps the clinician the mindset of anticipating difficulties and planning appropriately

Predicting a Difficult Mask Ventilation

- **B**eard
- **O**bese
- **O**lder
- **T**eeth
- **S**noring (Sounds)

Adjusting for the Difficult Ventilation

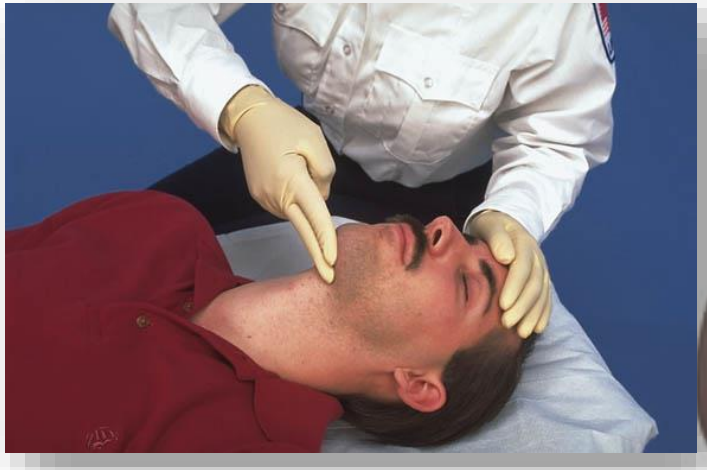
- Beard
  - Use of jelly to improve seal or remove beard
- Obese
  - Use of pillows to “ramp” patient’s head upward so the ears are in line with the sternal notch
- Older
  - Pillows may be used if kyphosis is present or using alternative manual airway maneuvers
- Teeth
  - May require alternative manual airway maneuvers or use of alternative airway adjuncts
- Snoring
  - Alternative airway adjuncts may be used or repositioning of the patient

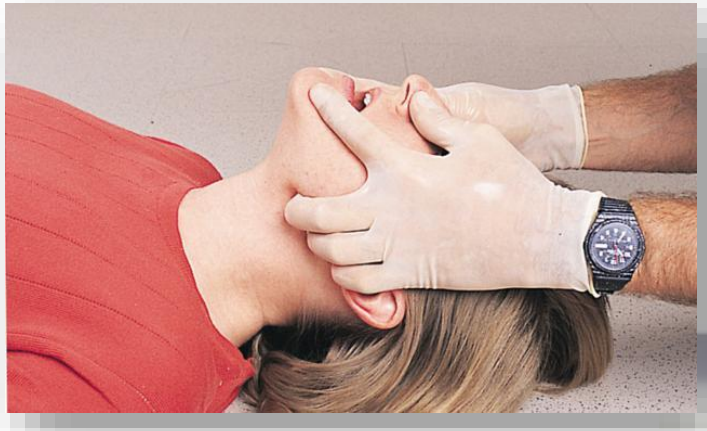
Adjusting for the Difficult Ventilation

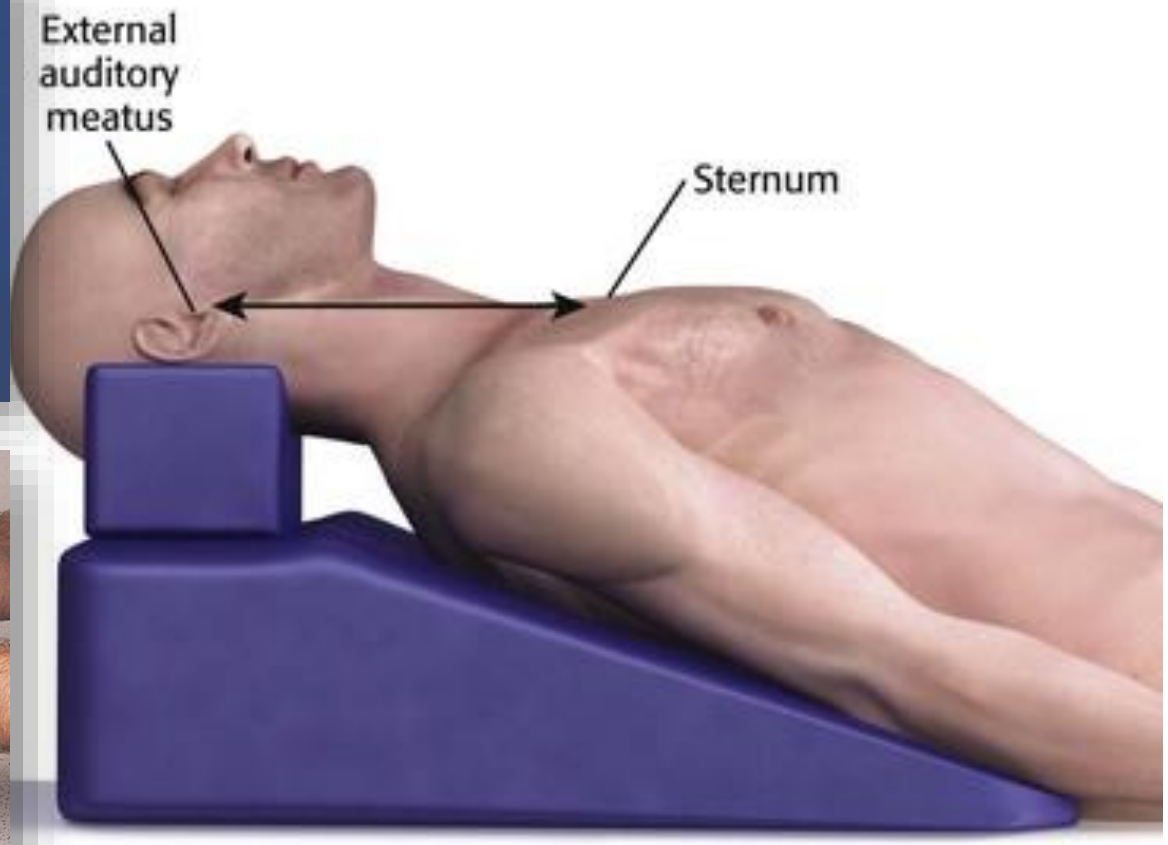
1. Difficult Mask Ventilation Identified
2. Optimise Patient Position and Airway Manoeuvres
3. Airway adjuncts
4. 2 person/4 hand technique (or change operator)
5. Consider obstruction (FBAO, cricoid pressure)
6. Attempt Extraglottic Airway Device insertion

Adjusting for the Difficult Ventilation

- Patient positioning

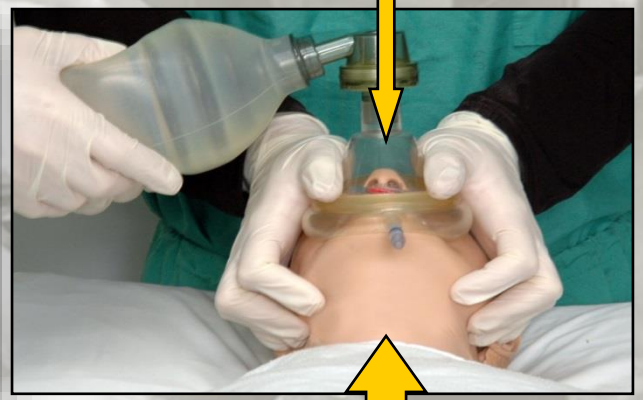






Adjusting for the Difficult Ventilation

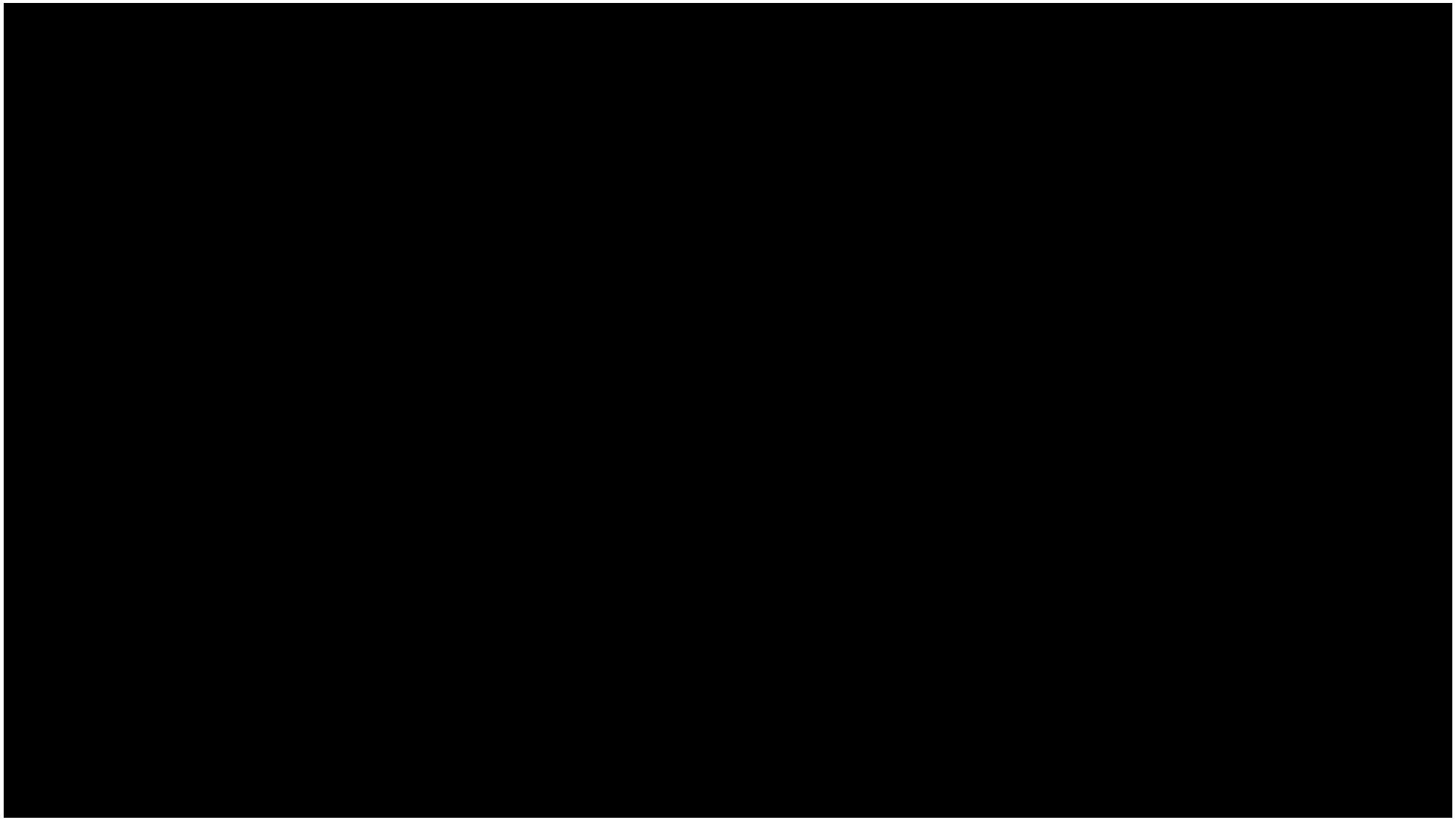
- Two person/four hand technique



Maximizing Oxygenation

- **2** airway adjuncts (OPA+NPA)
- **2** sources of oxygen – dialed up high
- **2** items attached to system:
  - PEEP valve, tight seal – closes the system
  - Manometer – watch airway pressures
- **2** person technique!
- Optimize positioning/airway opening

Difficult BMV



MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

PATIENT POSITIONS

MEDAVIE HealthEd ÉduSanté

Recovery Position

What About C-Collar in Trauma?

- Take the collar off for airway management!!!
- Common error to leave on, it is impossible to do proper jaw thrust and BMV with it on!
- Replace with in line immobilization done by human, as shown, from below, out of the way of the airway manager.

What about lying down/sitting up?

- Common error is to “lie patients down” when they are awake and in severe SOB.
- These patients will ventilate better sitting up, don’t fight them.

Ventilating the Obese Patient

- As discussed already, elevate the head to displace the weight of the abdomen off the chest, allowing easier chest expansion!
- “Ramping” for intubation of obese patients is more specific in terms of bringing pt into sniffing position.

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

EXTRAGLOTTIC DEVICES

Extraglottic Airway Devices (EAD)

- Previously referred to as supraglottic devices.
- Defined as an airway that controls below the level of the oropharynx but does not enter the trachea
- Directly or indirectly oxygenates the trachea
- Requires additional training in usage and skills maintenance

Extraglottic Airway Devices (EAD)

- These “rescue airways” were initially designed for use during “can’t intubate/can’t ventilate” emergencies.
- Placed without direct visualization of the trachea
- Due to the usefulness and success of these airways, they are now considered a backup airway, or have replaced orotracheal intubation in some prehospital areas.

Supraglottic Airway Devices (SAD)

Laryngeal Mask Airways

King LTS-D Airway

i-Gel Airway

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

KING LTS-D

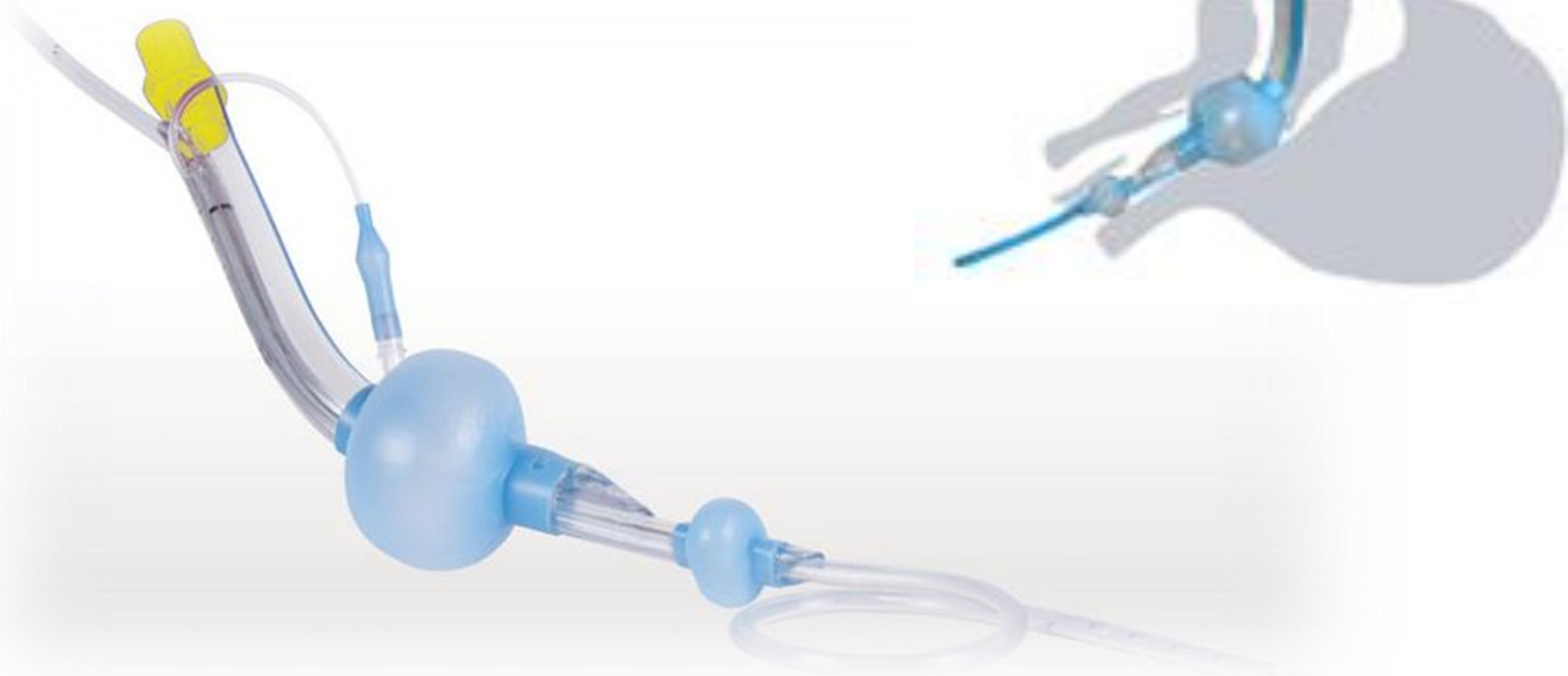
King LT

- Designed for hospital use.
- Can be autoclaved up to fifty times

King LT-D (Disposable)

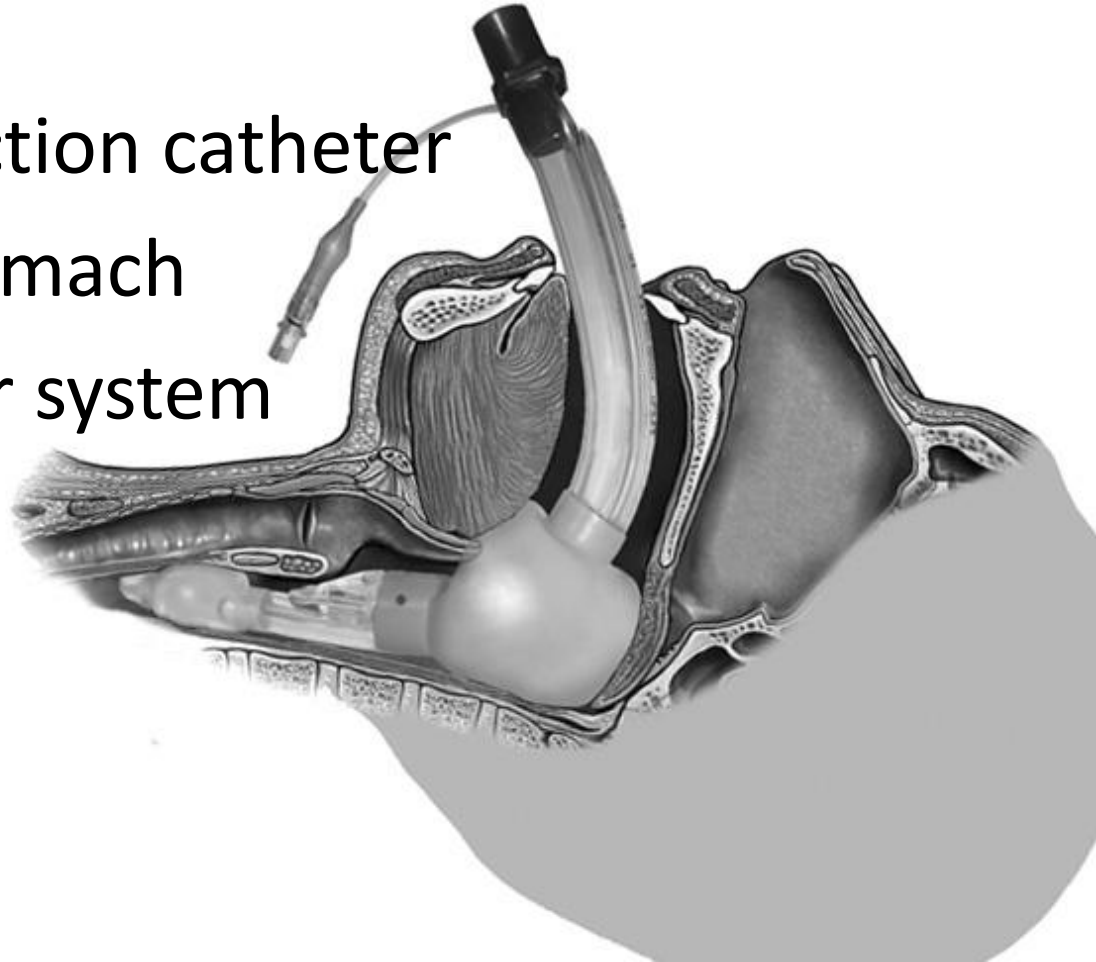
- The disposable version of the King LT Airway
- Single use device
- Partially occludes esophagus to limit gastric distention and aspiration

King LTS-D (Suction-Disposable)



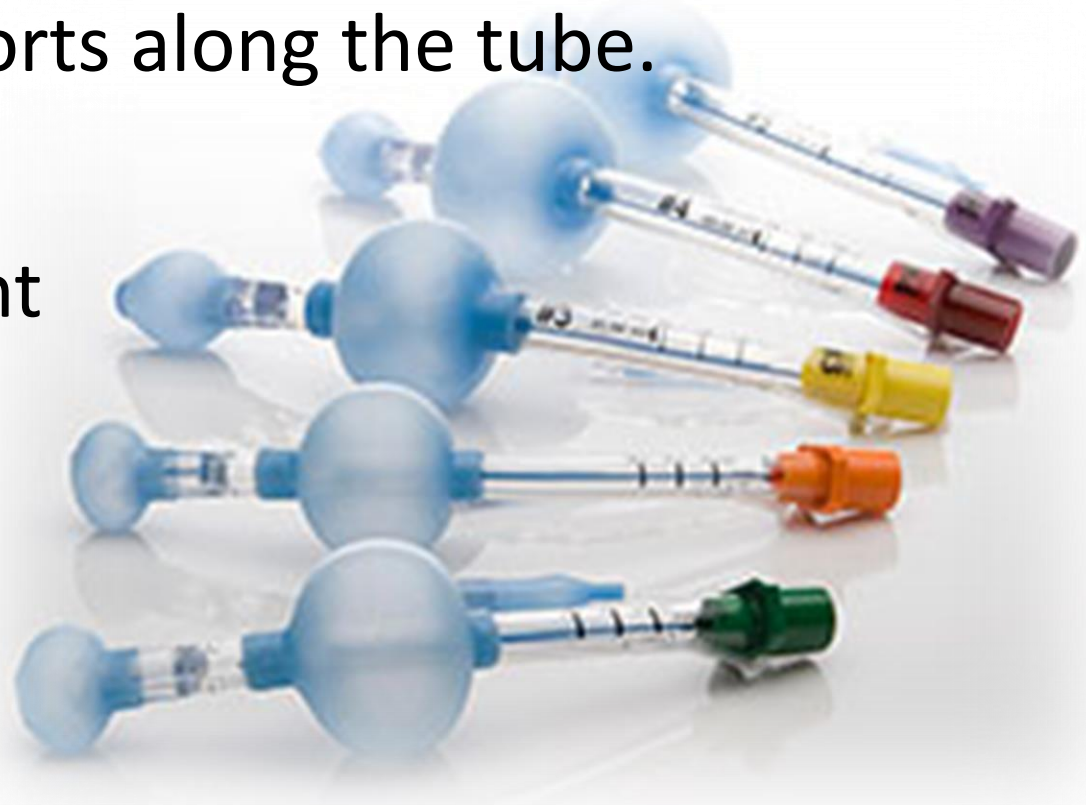
King LTS-D

- Has a second lumen that allows direct passage to the esophagus
- Will accommodate an 18 French suction catheter
- Allows for decompression of the stomach
- Can accommodate a tube exchanger system



King LTS-D

- Available in 5 sizes
- Ventilation occurs between the hypopharyngeal balloon and the esophageal balloon through ports along the tube.
- Latex free
- Designed for esophageal placement



Indications

- Unresponsive breathing or non breathing patient in need of ventilation
- Absence of a gag reflex must be confirmed prior to use
  - Only tolerated in patients who are deeply unconscious or in cardiac arrest

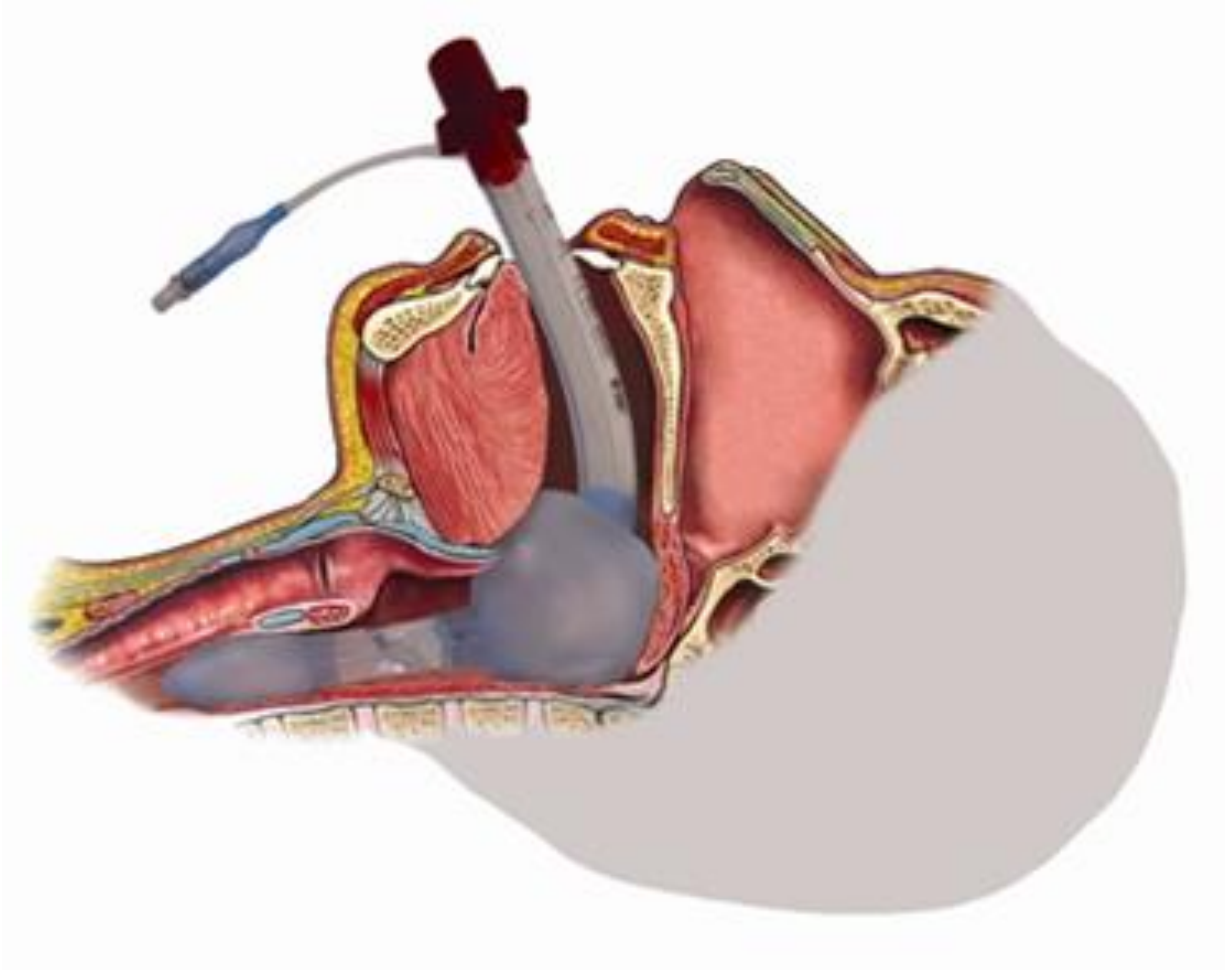
Contraindications

- Intact gag reflex
- Known esophageal disease
- Known caustic substance ingestion

Warnings/Precautions

- Does not protect from aspiration
- Is not tolerated unless deeply unconscious
- Not useful for upper airway pathology (burns, angioedema, epiglottitis)
- Can be accidentally placed in the trachea, must be removed and repositioned in the esophagus
- Must be properly sized to avoid esophageal damage or air leakage

Limitation of the Upper Airway Pathology



- Note where bulbs are sitting in relation to the glottic opening.
- You can see if there is upper airway swelling (burn, epiglottitis, allergic reaction), abscess, mass and foreign body, this adjunct will not be helpful.

Sizing

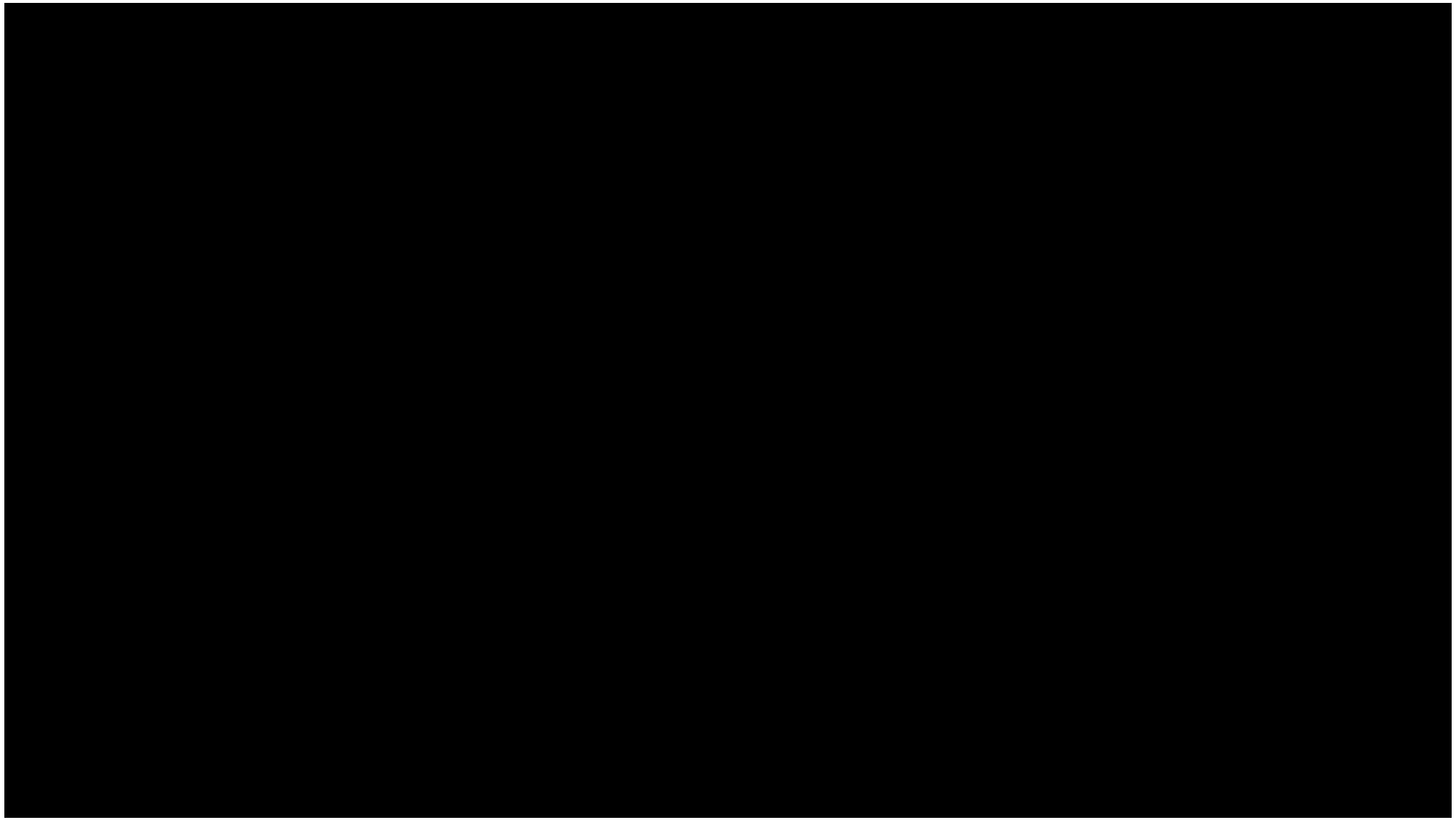
- King LTD #2 (no suction)
  - Green
- King LTD #2.5 (no suction)
  - Orange
- King LTS-D #3
  - Yellow
- King LTS-D #4
  - Red
- King LTS-D #5
  - Purple

- 35 – 45 inches (12 – 25 kg)
  - 25 – 35 ml inflation
- 41 – 51 inches (25 – 35 kg)
  - 30 – 40 ml inflation
- 4-5 Feet Tall
  - 45 – 60 ml inflation
- 5-6 Feet Tall
  - 60 – 80 ml inflation
- Above 6 Feet Tall
  - 70 – 90 ml inflation

Insertion

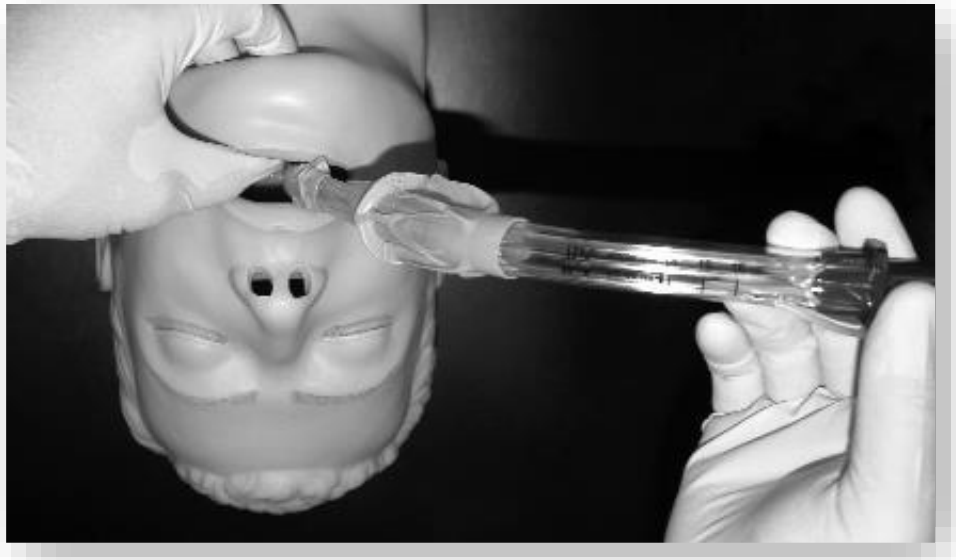
- Pre-oxygenate with BVM to ensure airway is patent
- Correctly size tube based on patient height.
- Test cuffs by inflating with maximum amount of air (remove all air before insertion)
- Apply a water soluble lubricant to the posterior side of the tube (not on cuffs)

Preparing the King LTS-D



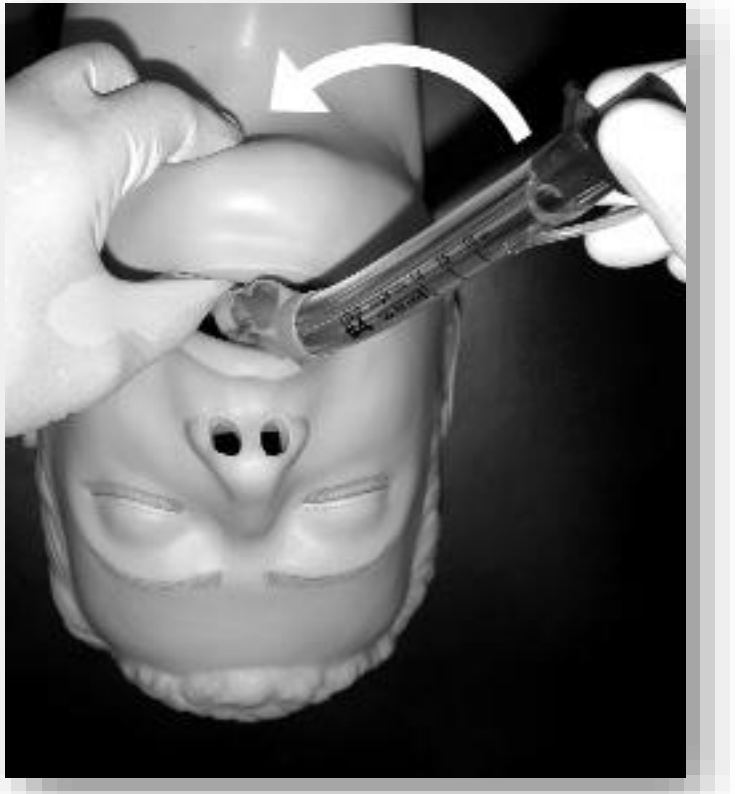
Insertion

- Place patient neutral or in the sniffing position.
- Ensure the absence of a gag reflex
- Open the mouth and lift the chin (or cross finger technique)
- Place the airway to the corner of the right side of the mouth (blue orientation line should be in line with the mouth)



Insertion

- As the tube passes under the tongue, rotate the tube to align the blue guideline with the chin



Insertion

- Without exerting excessive force, advance the airway until the teeth or gums are aligned with the connector

Insertion

- Inflate cuffs to the minimum pressures indicated by the size of the tube
- While ventilating, withdraw the tube until ventilation is easy and unobstructed (maximum chest rise)
- Auscultate for bilateral breath sounds
- If necessary, add additional volume to cuffs to maximize seal of the airway

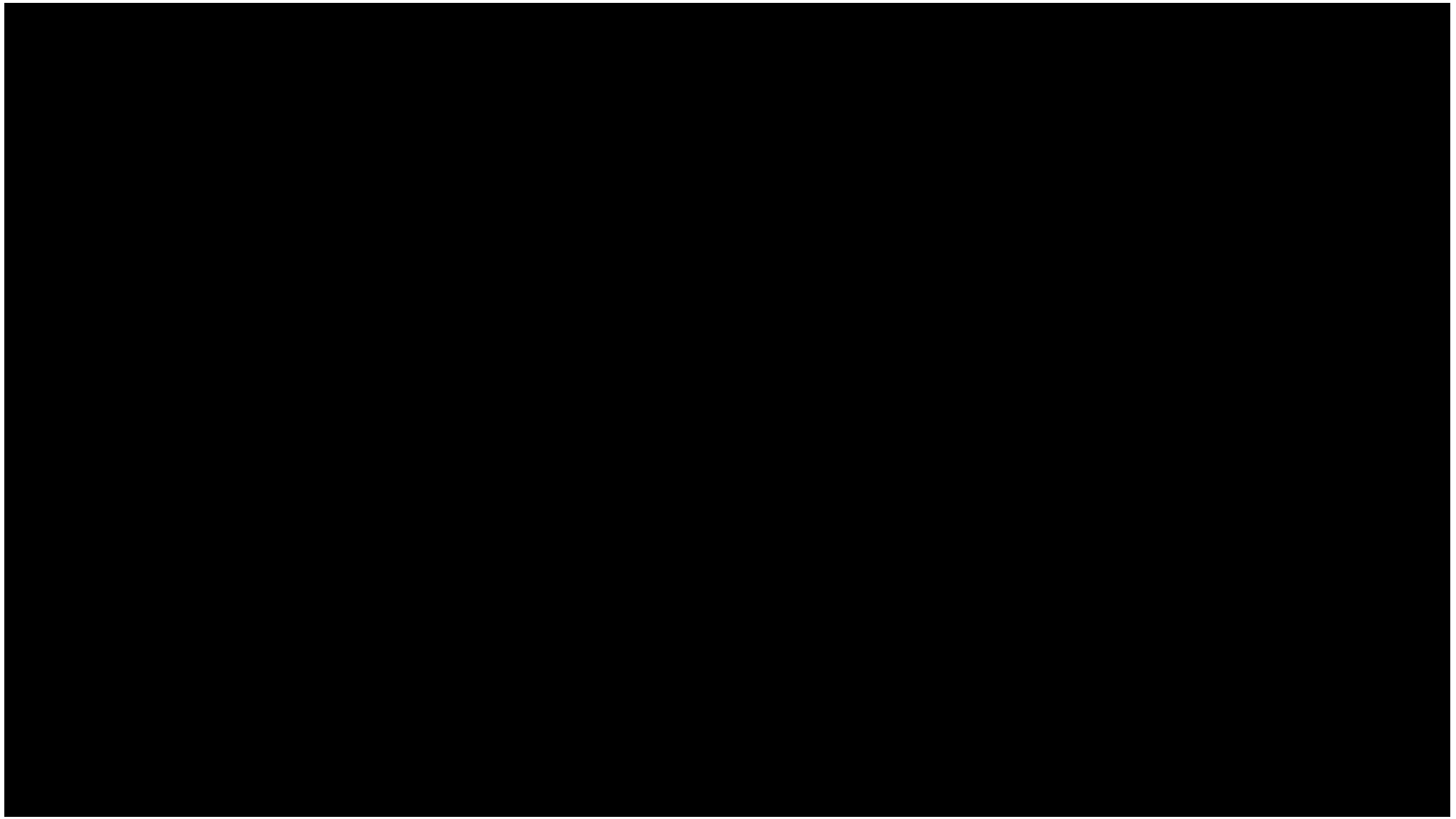
Airway Obstruction

Insertion

- Note the depth of insertion
- Secure the tube to the patient using tape or other acceptable method
- Apply capnography to ensure tube placement and ventilation

MEDAVIE HealthEd ÉduSanté

Insertion the King LTS-D



Removal

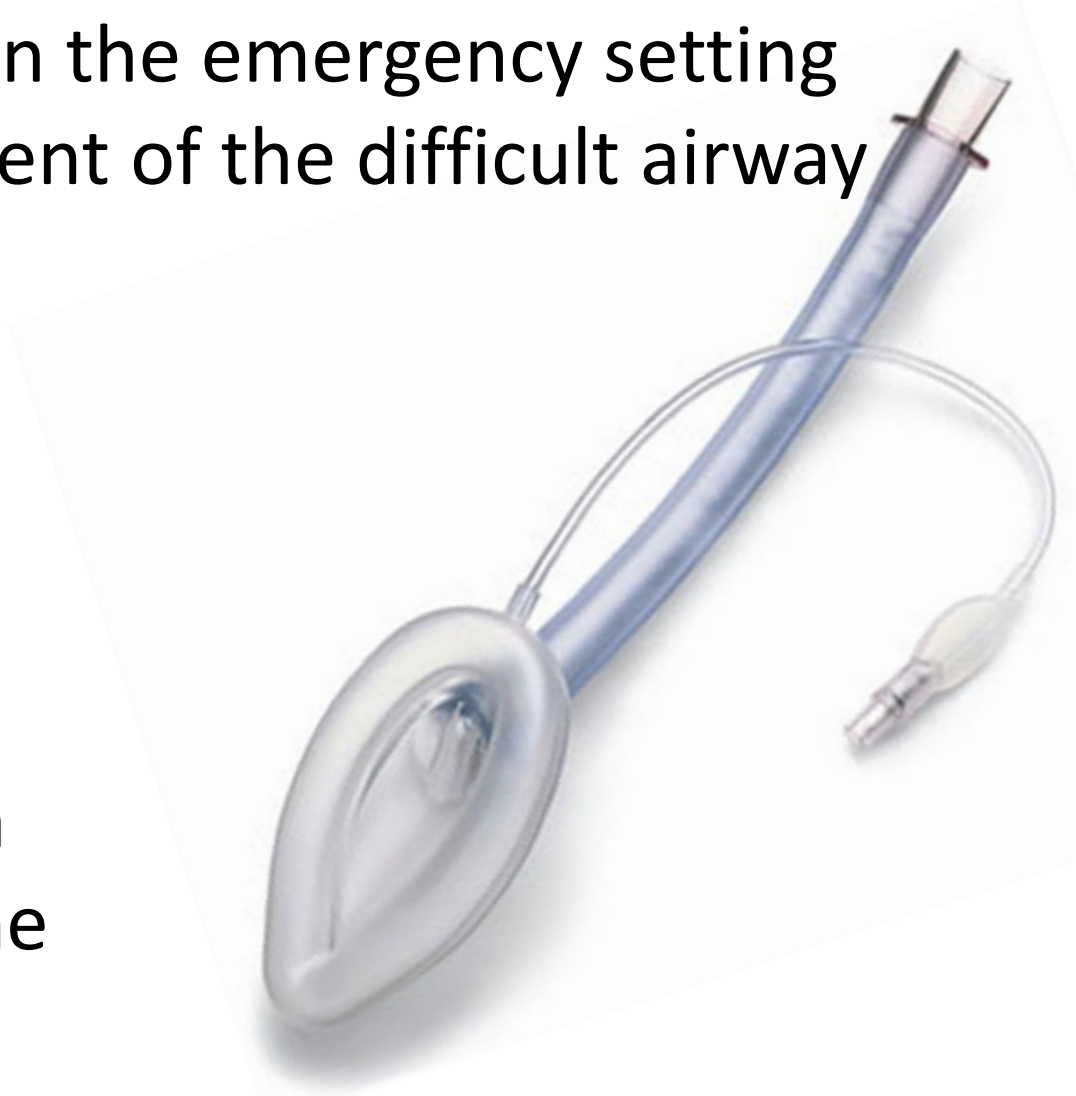
- If there is a return of gag reflex, it may become necessary to remove the device.
- Have suction ready
- Deflate the cuffs fully
- Withdraw the tube
- Suction if required

Airway Management and Ventilation

LMA

Laryngeal Mask Airway (LMA)

- A supraglottic airway device for use in the emergency setting as an accessory device for management of the difficult airway
- Designed to sit in the patient's hypopharynx and cover the supraglottic structures, thereby allowing relative isolation of the trachea
- Results in less gastric distention than with bag-valve-mask ventilation alone

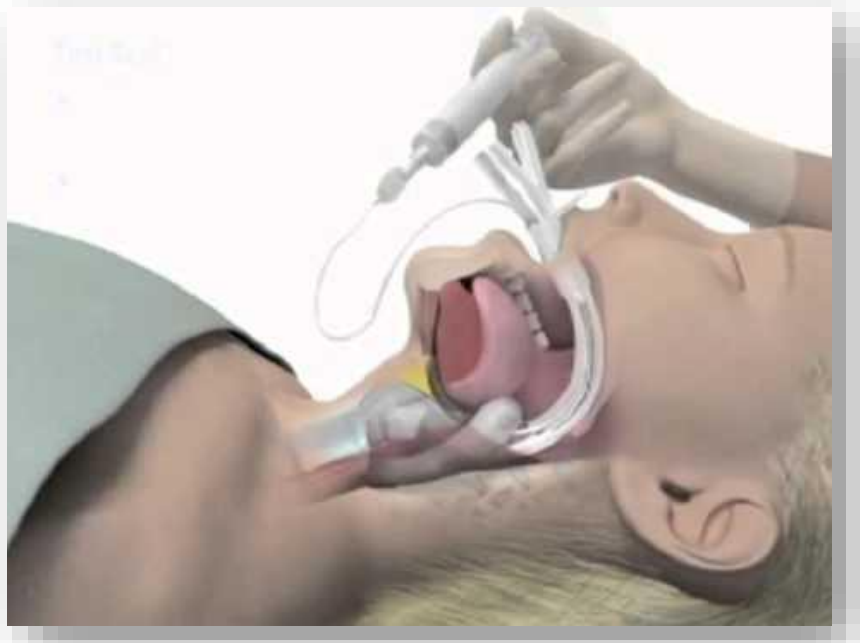


Sizing

LMA Size	Patient Size
1	< 5 kg
1.5	5 – 10 kg
2	10 – 20 kg
2.5	20 – 30 kg
3	30 kg to small adult
4	Adult
5	Large adult (poor seal with size 4)

Indications

- Patients in cardiac arrest.
- Ventilation in normal/abnormal airways
- Failed intubation
- Unconscious patients without a gag reflex, and in need of ventilator support.
  - Patients in irreversible respiratory arrest (i.e. narcotic overdose, hypoglycemia).



Contraindications

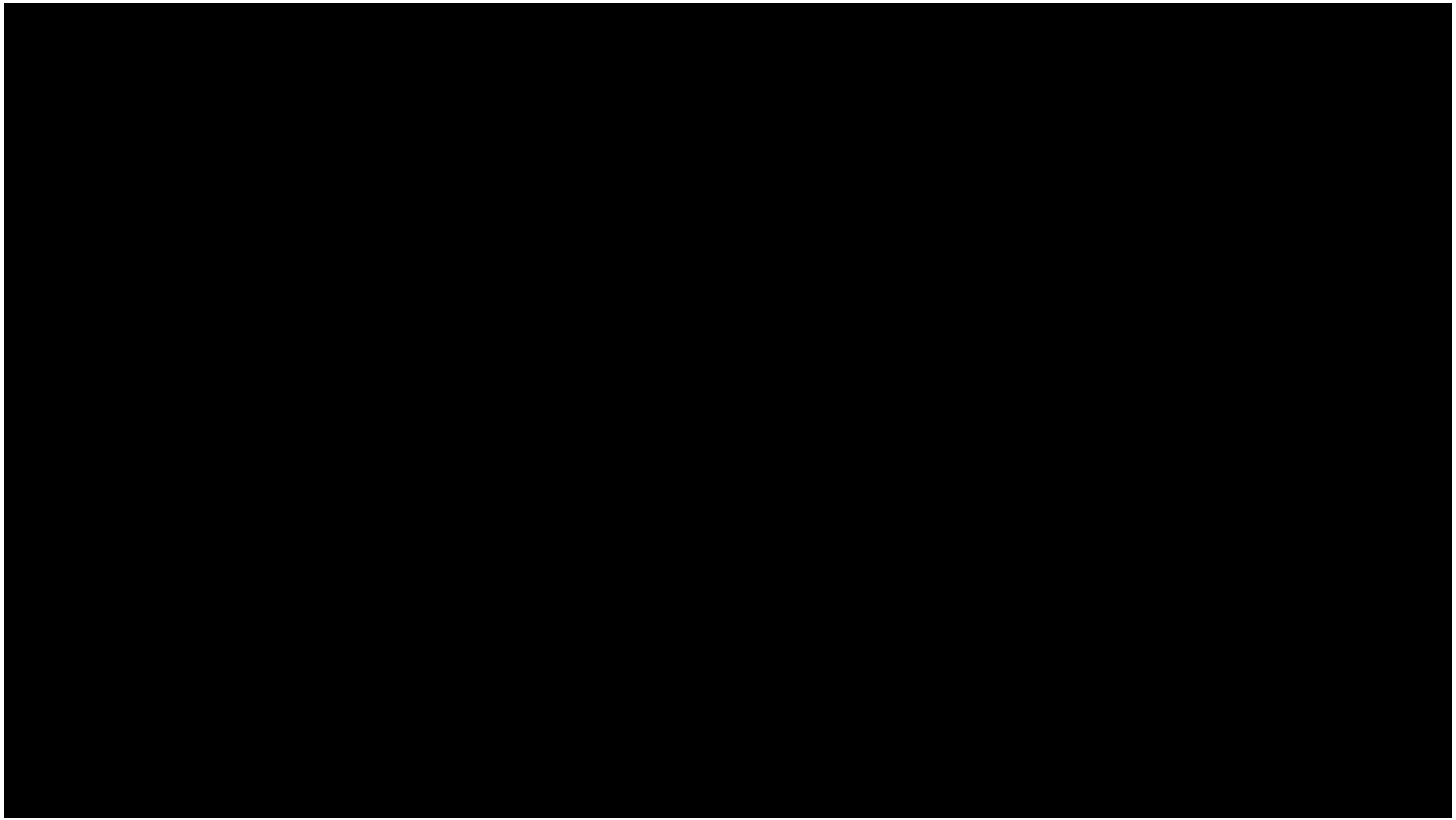
- Intact gag reflex
- Conscious – arouseable patient
- Partial or complete FBAO
- Upper airway pathology (burn, epiglottitis, abscess, angioedema)
  - LMA has same issue as King LT in that it is not a definitive airway secured through the vocal cords.
- Mask sits above the glottis, therefore pathology here may still obstruct ventilation.

Insertion

- Inflate cuff checking for leaks
- Patient in supine position
- Open airway using jaw lift
- Inserted to such a depth that resistance is felt
- Inflate the distal cuff with air
- Ventilate listen for gurgling sounds over the epigastrium or breath sounds over the lungs and watches for chest rise
- Secure airway

MEDAVIE HealthEd ÉduSanté

Insertion



MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

I-GEL

I-Gel

- A extraglottic airway device for use in the emergency setting as an accessory device for management of the difficult airway
- Designed to mirror the shape and contours of the airway
- Non-inflating cuff made of soft gel like material reducing trauma
- Gaining traction as a preferred option in prehospital systems

Sizing

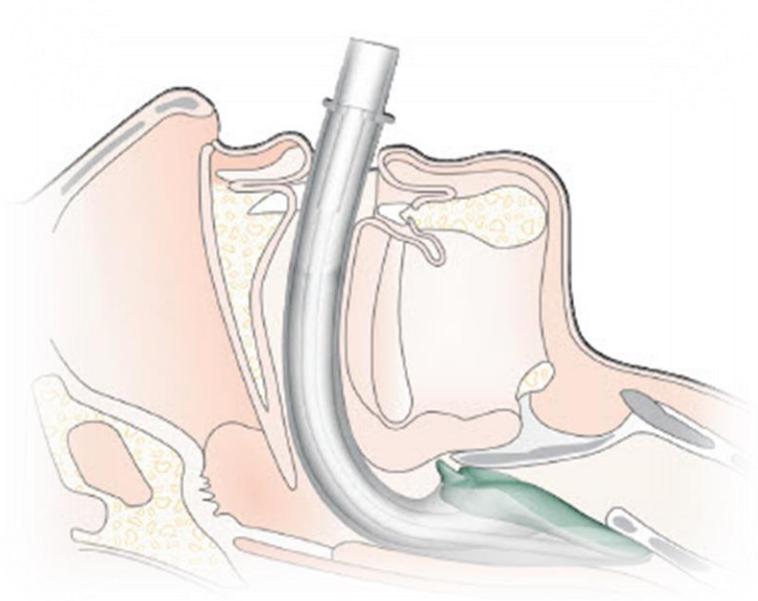
Patient	Weight	i-Gel Size	Colour
Newborn	2 – 5 kg	1	Pink
Infant	5 – 12 kg	1.5	Blue
Small child	10 – 25 kg	2	Grey
Large child	25 – 35 kg	2.5	White
Small adult	30 – 60 kg	3	Yellow
Medium adult	50 – 90 kg	4	Green
Large adult	> 70 kg	5	Orange

Indications

- Patients in respiratory or cardiac arrest.
- Failed intubation
- Unconscious patients without a gag reflex, and in need of ventilator support.
  - Patients in irreversible respiratory arrest (i.e. narcotic overdose, hypoglycemia).

Contraindications

- Intact gag reflex
- Conscious – arouseable patient
- Partial or complete FBAO
- As with any extraglottic device, low utility with upper airway pathology



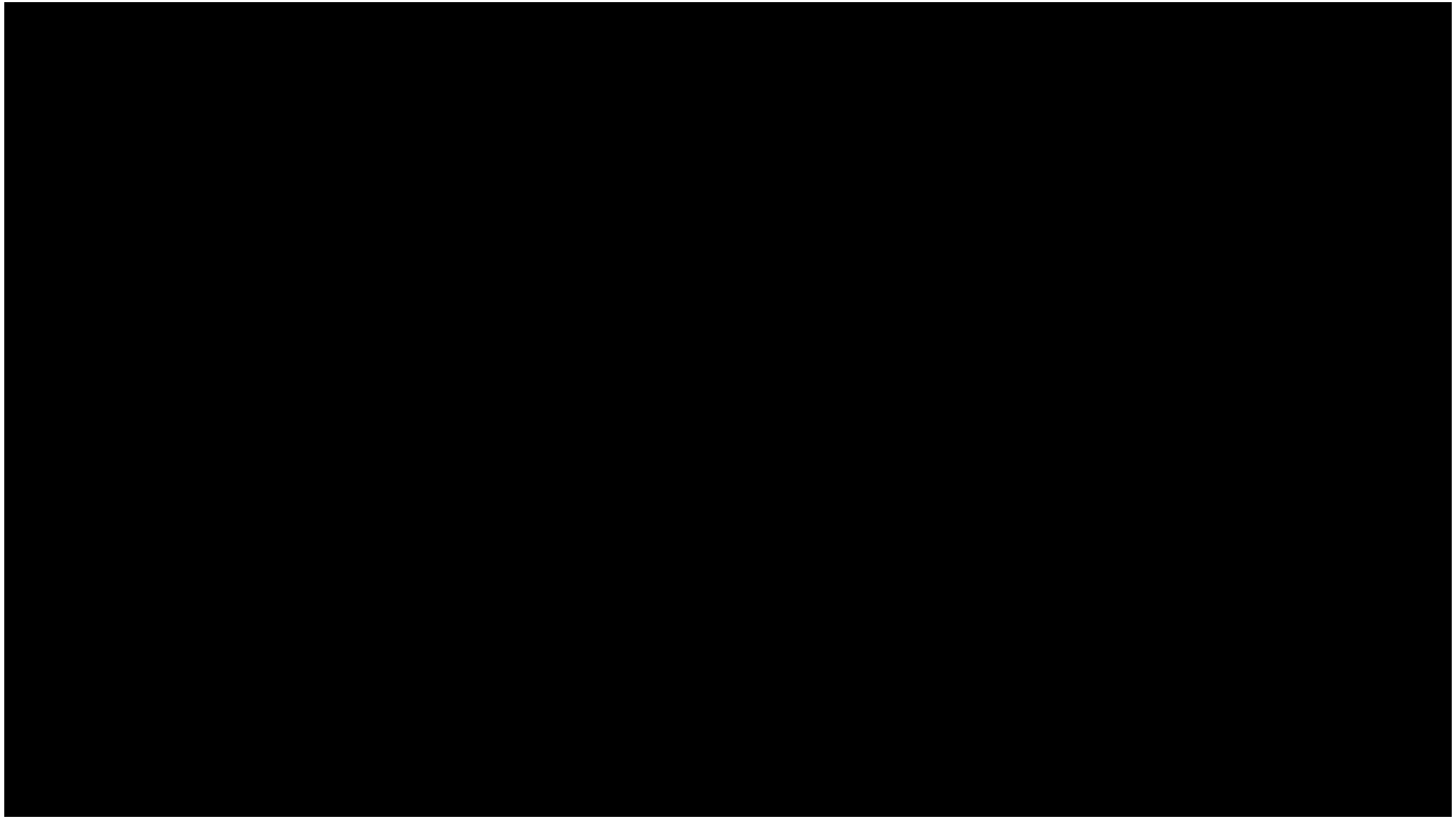
Insertion

- Chooses correct size based on pt weight
- Check the device for integrity
- Assess for gag reflux
- Remove I-Gel from protective cradle and transfer to cover insuring not to touch the cuffed end of the I-Gel
- Place small bolus of lubricant onto the cradle
- Grasp the I-Gel with free hand along the integral bite block and lubricate the back, sides and front of the cuff
- Patient placed in head extended and neck flexed position (sniffing position) unless patient condition does not permit it, in this case a neutral position will work

Insertion

- Open patient mouth by pressing down on the chin
- Introduce the leading soft tip of the I-Gel into the mouth of the patient in a direction towards the hard palate
- Glide the device downward and backwards along the hard palate with a continuous but gentle push until a definitive resistance is felt
- Notes the incisors resting on the integral bite block at about the level of the horizontal black line
- Maintains position of the device by hand until secured with restraint device
- Confirms placement by auscultating over epigastrium and lungs, ETCO2 detector, pulse oximetry
- Confirms chest rise
- Secures device with restraining device

Insertion



MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

CPAP

CPAP

- What is it?
- What does it do?
- How may it help patients?
- Which patients may benefit from it in the emergency setting?
- Has any one seen it or tried it?

Continuous Positive Airway Pressure (CPAP)

- To maintain a continuous level of positive airway pressure in a spontaneous breathing patient
  - Baseline pressure is higher then atmospheric pressure
  - Similar to PEEP though the pressure is during inspiration and expiration versus just during the expiratory phase with PEEP
- Pt still able to inspire/expire normally
- Decreases the work of breathing by expanding the alveoli and increasing compliance
- May cause over distention if too much CPAP is applied decreasing compliance

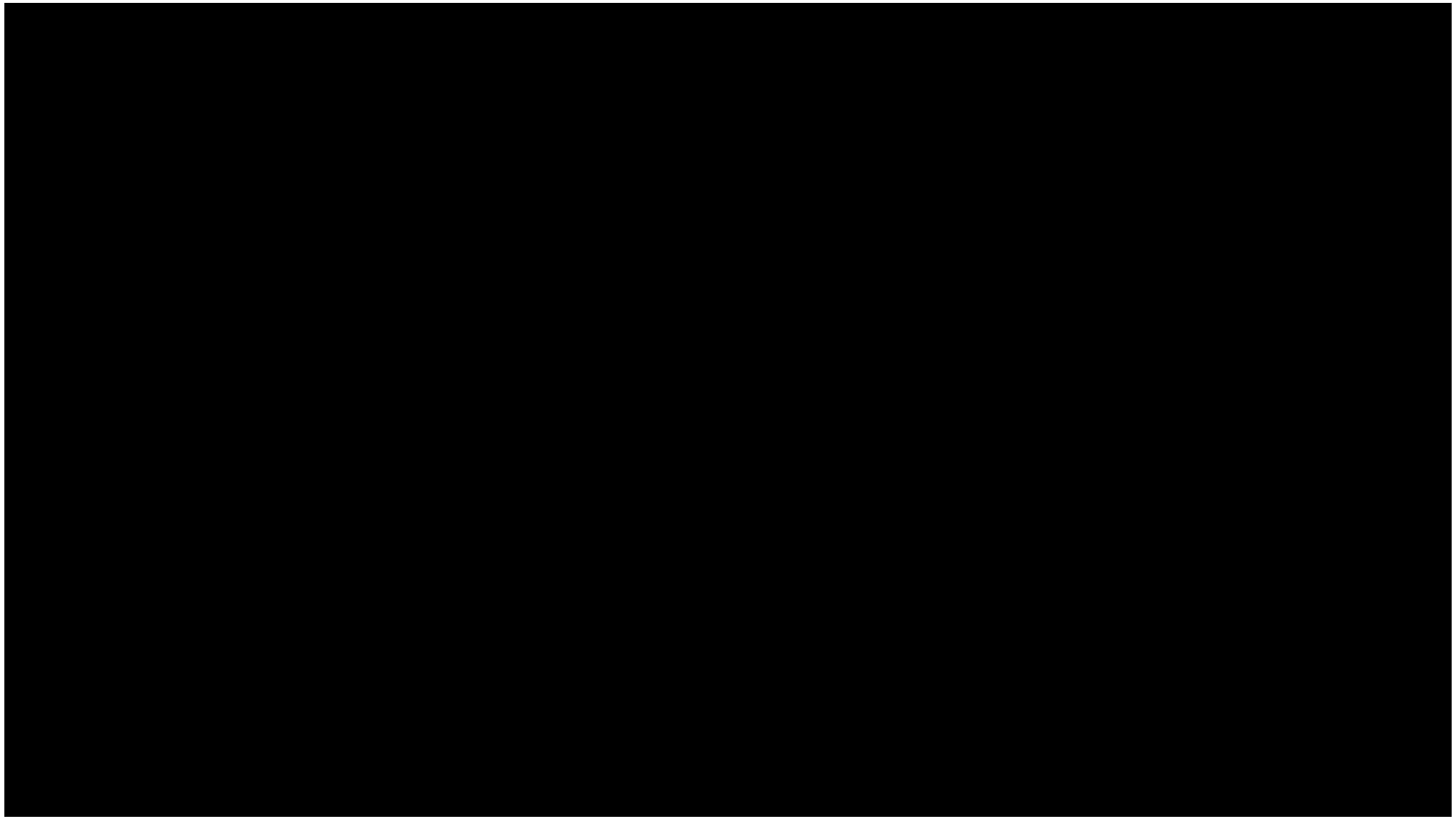
Further Evidence

Out-of-Hospital Continuous Positive Airway Pressure Ventilation Versus Usual Care in Acute Respiratory Failure: A Randomized Controlled Trial

Presented at the International Congress of Emergency Medicine, June 2006, Halifax, Nova Scotia, Canada.

James Thompson, MD, FRCPC, David A. Petrie, MD, FRCPC, Stacy Ackroyd-Stolarz, PhD (C), Darrell J. Bardua, ACP

PEEP



Case

- 72 y/o M SOB
- Worsening for 5 hrs
- PMHx includes COPD, CHF, HTN, DMII, GERD.
- O/E:
  - SBP 160, HR 100, RR 40, Sats 82% on 2 lpm, BGL 11, Temp 38.
  - Alert, protecting airway, gasping respirations, too SOB to talk. Sitting bolt upright.
- Crackles and wheezes diffusely on auscultation.
- Approach?
  - Role for CPAP?
  - Indications?
  - Contraindications?

Continuous Positive Airway Pressure (CPAP)

- Indications:
  - Patent A/W
  - Cooperative patient (not altered)
    - Must be able to follow directions
  - Acute SOB with evidence of CHF, COPD, Asthma, Pneumonia, etc…

- And…
  - Any 2 of the following:
    - RR > 24
    - SpO2 < 90%
    - Skin signs
    - Adventitious sounds

Continuous Positive Airway Pressure (CPAP)

- Contraindications:
  - Unconscious or GCS < 12
  - SBP < 90
  - Hypoventilation
  - Chest trauma
  - Facial trauma/deformity/burns that inhibit proper mask fit
  - High risk aspiration or active vomiting
  - Tracheostomy
  - Pneumothorax

Continuous Positive Airway Pressure (CPAP)

- Application:
  - Explain procedure to pt and obtain consent
  - Place pt in high fowlers position, monitor, SpO2
    - Ensure appropriate amount of oxygen in tank prior to starting
  - Place mask on face and attach straps ensuring a proper seal
  - Initiate CPAP with 15 lpm (3 - 4 cmH_2O)
  - Coach pt on breathing (in through nose out through mouth)
  - Titrate up to max of 25 lpm (8.5 – 10 cmH_2O)
  - Watch for non-tolerance, respiratory failure or change in LOC
  - BP should be assessed q5 mins

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

REVIEW

Providing Supplemental Oxygen

- What are our options for airway management?
- What about a combination?
- How do you choose?
- How much FiO_2 does each deliver?

High Flow Nasal Prong (HFNP)?

- What happens if you combine HFNP with NRB or BMV?
- How many liters can you administer?

Maintaining/Improving Oxygenation

- Optimizing Oxygenation with 2 Sources
- Insert OPA/NPA and apply 2 sources of high flow O_2 (+ maintain jaw thrust)

2 Sources/minimize RA entrainment

Maintaining/Improving Oxygenation

Maintaining Oxygenation

- Insert OPA/NPA AND apply high flow O_2
- Maintain jaw thrust +/- assisted oxygenation/ventilation

THE NEW ENGLAND JOURNAL of MEDICINE

EDITORIAL

Saving Lives with High-Flow Nasal Oxygen

Michael A. Matthay, M.D.

This is the most optimal method of providing oxygen using BLS maneuvers!

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

FOREIGN BODY

Case

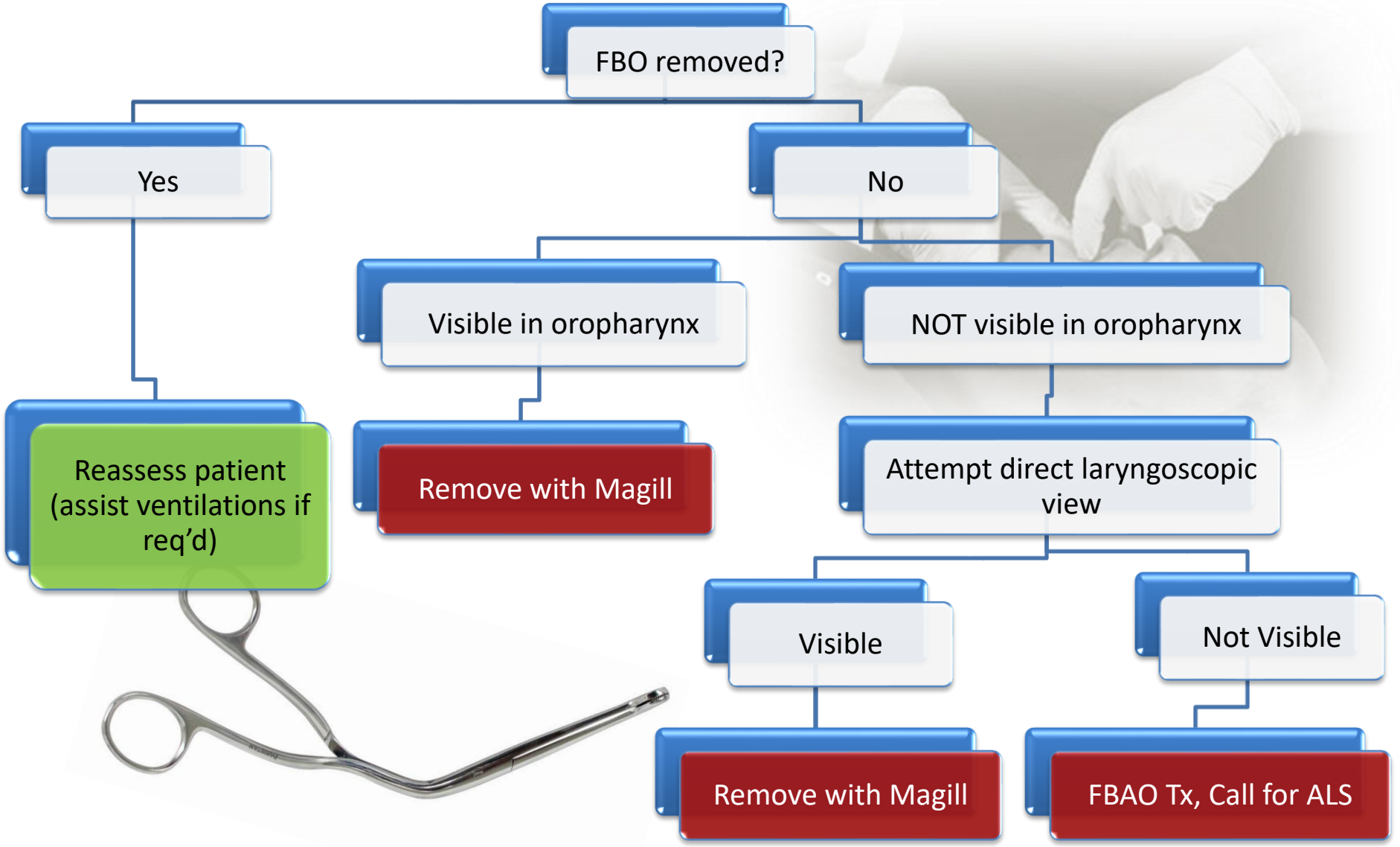
- You are called out for a 55 y/o F who is choking on a piece of steak.
- As you are pulling up to the scene, you review your approach.
- How does it differ if the patient is sitting up coughing?
  - If she is silent/unable to cough?
  - If she is unconscious in the floor?
  - When do you attempt to remove a FB from an airway?

Foreign Body Removal

- Initiate treatment measures for FBO
- Check to see if the obstruction was relieved.
- If obstruction is not relieved consider the following…

MEDAVIE HealthEd ÉduSanté

Foreign Body Removal



MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

NON-INVASIVE MONITORING

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

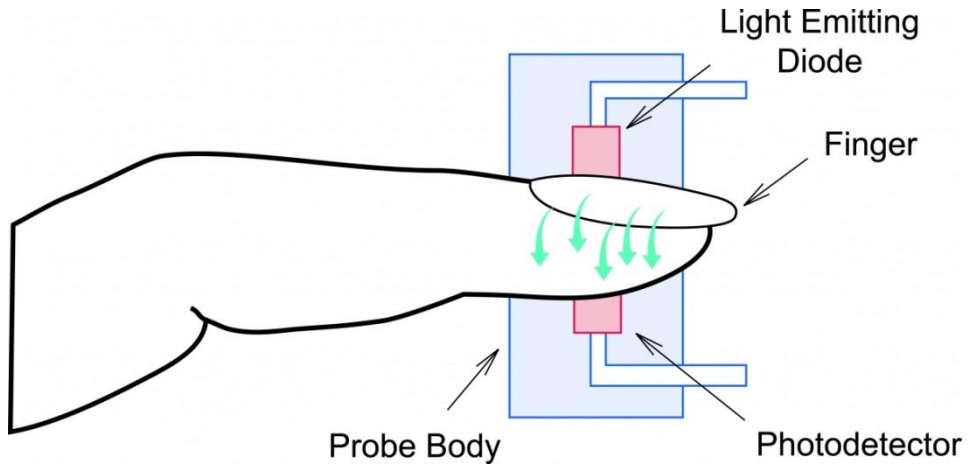
PULSE OXIMETRY

Pulse Oximetry

- Pulse Oximetry is a method to measure hemoglobin saturation in arterial blood

Pulse Oximetry

- Sensor can be placed on finger, toes or earlobes
- Light emitting diode (LED) containing red and infrared wavelengths passed from one side to the other
- Changing absorbance of each of the two wavelengths is measured, allowing determination of the absorbance due to the pulsing arterial blood.
- Ratio of changing absorbance of the red and infrared light given as a percentage.
- Measures the amount of saturated versus unsaturated hemoglobin

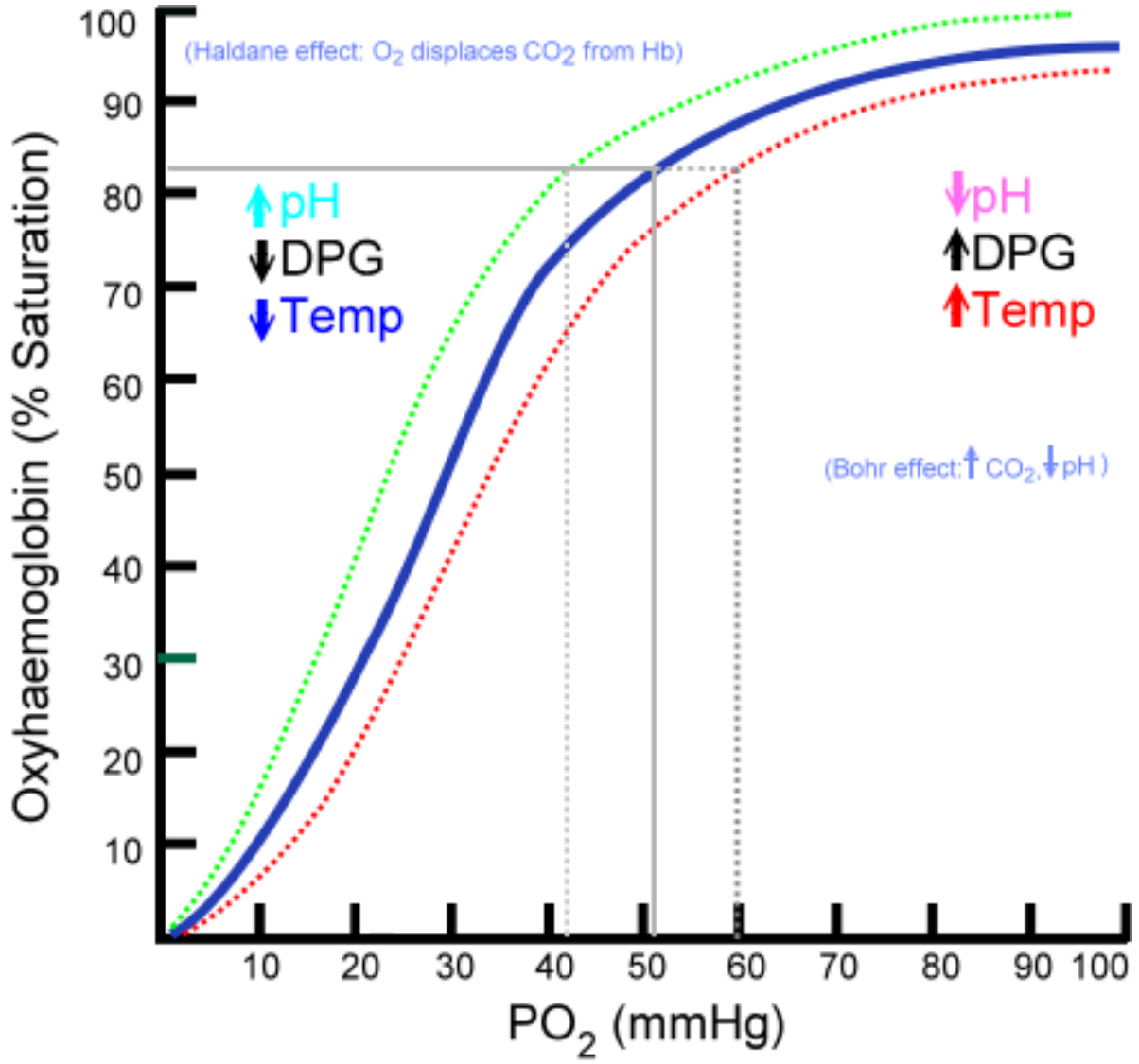


Pulse Oximetry

- What is it saturated with?

Definitions

- What is the difference?
  - Hypoxia
  - Hypoxemia
  - Cyanosis



Pulse Oximetry

- Hypoxemia
  - Lack of oxygen in the blood
  - May be caused by
    - CO_2Poisons
    - Infections (gangrene)
    - $\downarrow O_2$ in atmosphere
    - COPD
    - Hypoperfusion (MI, CHF…)
    - Hypovolemia (anemia, blood loss…)
    - Hypothermia

Pulse Oximetry

- Hypoxia
  - Lack of oxygen to the tissue caused by hypoxemia
- Cyanosis
  - The external sign of hypoxia characterized by the appearance of ‘blue’ tissue

Pulse Oximetry

- Conditions that affect the readings
  - Lack of hemoglobin
  - COPD
  - Hypovolemia
  - Anemia
  - CO, CO_2
  - Hypothermia
  - Bright light
  - Vasoconstriction (↑cap refill)
  - Fingernail polish

Pulse Oximetry

- Use SpO_2 as a guide
- Use clinical judgment/patient presentation as a more accurate guide to need for supplemental oxygen

Treat the patient, Not the monitor!

- SpO_2 and SaO_2 are only accurate when compared to ABG's

Pulse Oximetry

- Is it possible to show 100 % SpO_2 and still be hypoxic?

MEDAVIE HealthEd ÉduSanté

Airway Management and Ventilation

CAPNOGRAPHY

Capnography

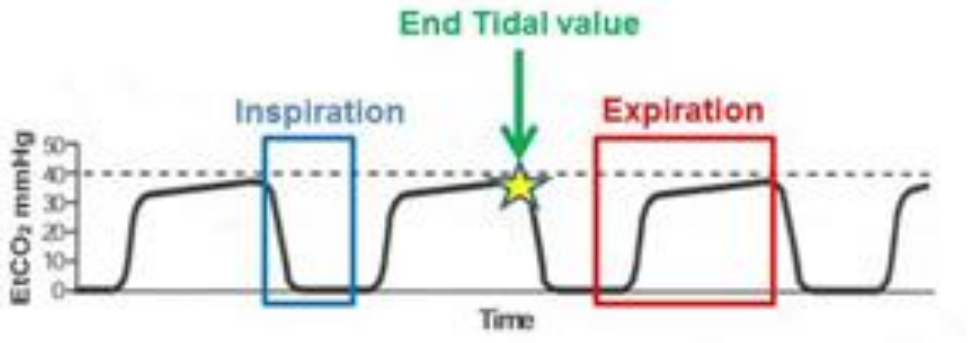
- Capnography is the vital sign of ventilation
- Tracking the CO_2 in a patient's exhaled breath, capnography enables paramedics to objectively evaluate a patient's ventilatory status (and indirectly circulatory and metabolic status)
- A capnograph measures how much carbon dioxide is present in the patients breath

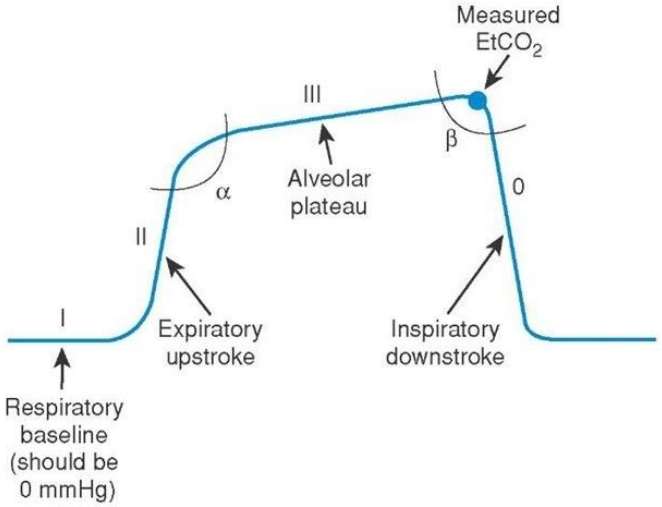
Definitions

- Capnography
  - Measurement of CO_2 in exhaled breath
- Capnometry
  - Measurement of partial pressure of expired CO_2
- Capnometer
  - Numeric measurement of CO_2

Definitions

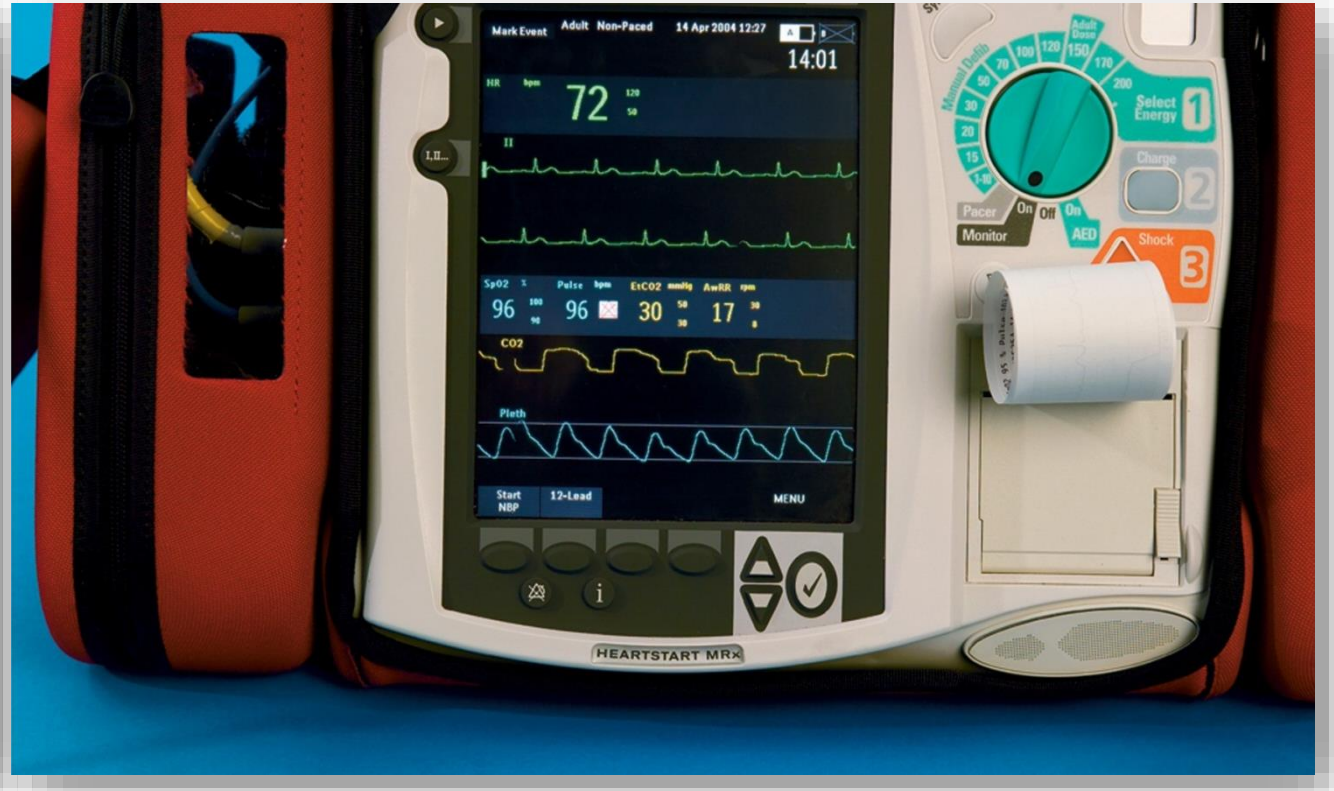
- Capnogram
  - "Real-time" visual waveform of $ETCO_2$





- End Tidal CO_2 ($ETCO_2$ or $PETCO_2$)
  - Level of (partial pressure of) carbon dioxide released at end of expiration
  - Normal value: 35 – 45 mmHg

Capnography



Colorimetric Devices

- Disposable
- Detect exhaled CO_2 with litmus paper
  - H^+ ions in CO_2 cause change in color
  - of paper
    - Color change present between each breath
  - Manufactured in protective plastic housing
  - Placed between vent circuit and endotracheal tube
- Not useful in detecting hyper/hypocarbia

Electronic Devices

- CO_2 absorbs light at specific wavelength
  - Allows for measurement
- Can be qualitative or quantitative
  - Qualitative
    - Detect presence of CO_2
  - Quantitative
    - Determine how much CO_2 is present

MEDAVIE HealthEd ÉduSanté

Mainstream vs Sidestream

MAINSTREAM

SIDESTREAM

Mainstream (Inline)

- Most commonly used for mechanically ventilated patients and intubated patients who require intensive monitoring.
- Can also be used on non-intubated patients (but require a mouthpiece or a mask)
- Sensor is placed directly in the breathing circuit in between the ventilator and the intubation tube
  - CO_2 is measured as the exhaled air passes through the sensor
  - Because the sensor is not in direct contact with the patient, it cannot be contaminated by moisture or secretions

Mainstream (Inline)

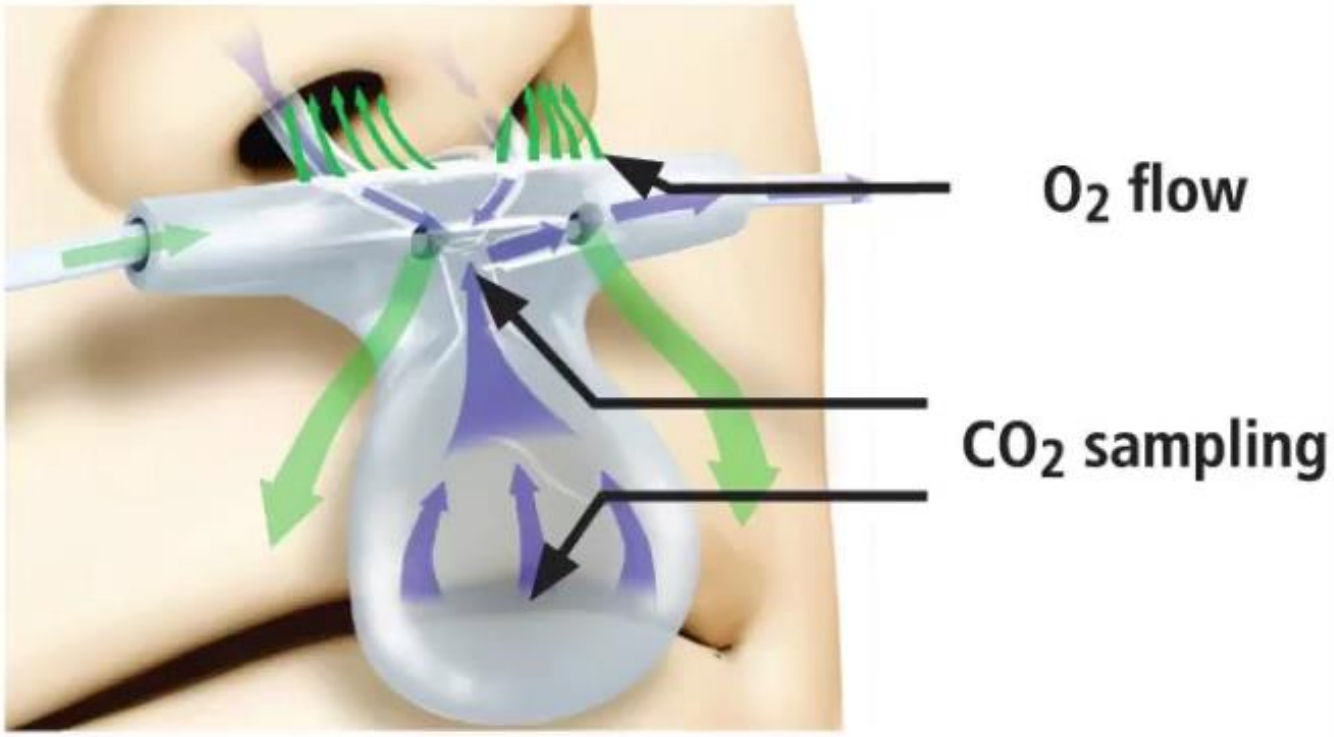
- The inline end-tidal CO_2 device can also be used with extraglottic devices and BVM.
- Considered the standard of care and provides important feedback throughout all stages of airway management
  - Should be used, if possible throughout airway management.
- CO_2 may be present in the stomach from PPV or a previously consumed carbonated beverage.
  - 6 breaths must be administered in order to eliminate the false CO_2 reading prior to relying on the $ETCO_2$ value.

Sidestream

- Sidestream, on the other hand, is non-invasive and diverting.
- This means that the gas sample is transported from the sample site through a plastic tube and analyzed in a sample cell.

Microstream

- Can be used in conjunction with other airway devices (NRB, NC, CPAP)



Sidestream

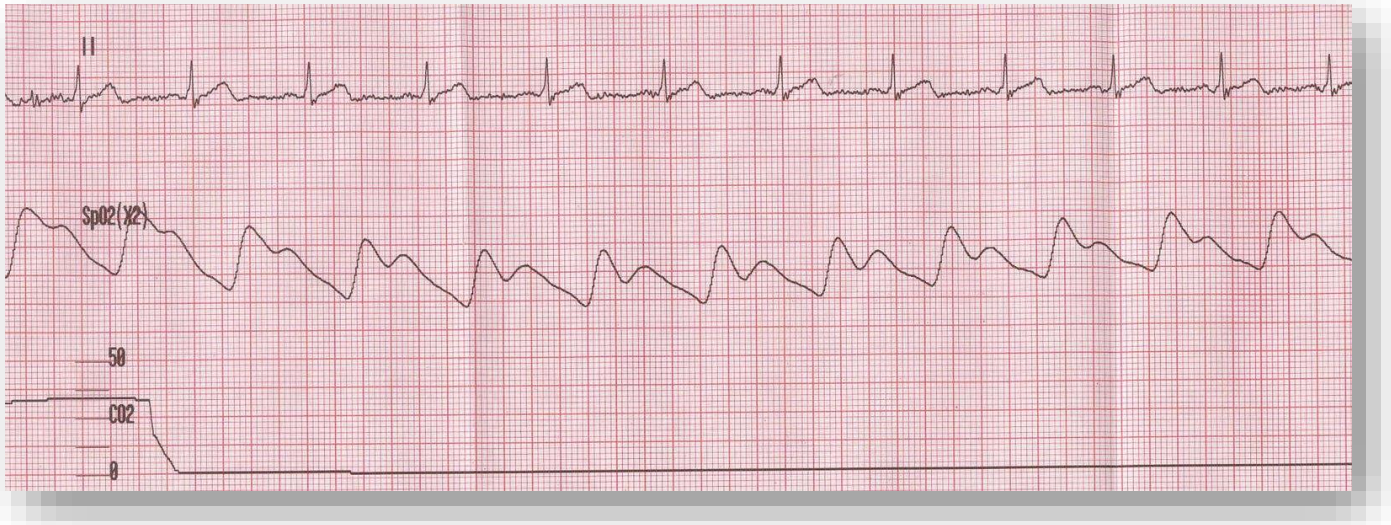
- Be careful of mouth breathers since the expired air to bypass the device
- Does not replace the nasal cannula and should only be considered as a tool to be used during treatment as a means of trending the patients condition.

Oxygenation versus Ventilation

- Oxygenation
  - Oxygen is inhaled into the lungs where gas exchange occurs at the capillary-alveolar membrane
  - Oxygen is transported to the tissues through the blood stream
  - Pulse oximetry measures oxygenation
- Ventilation
  - CO_2 is carried back through the blood and exhaled by the lungs through the alveoli
  - Capnography measures ventilation

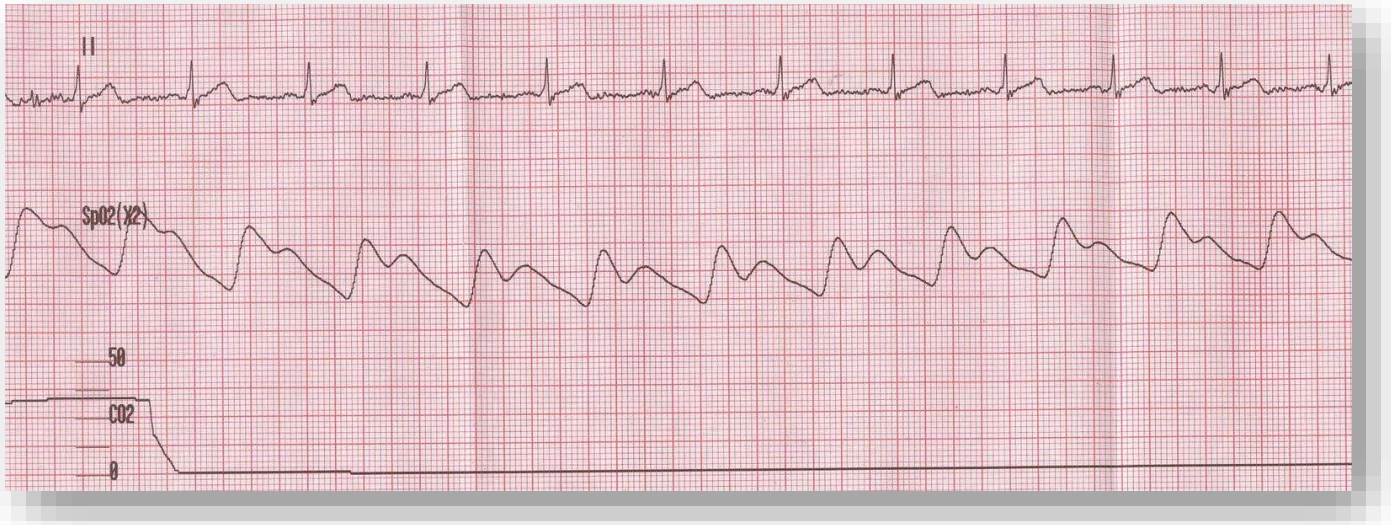
Capnography versus Pulse Oximetry

- Capnography provides an immediate picture of patient condition.
- Capnography will show immediate apnea
- Capnography is not affected by decreased perfusion or dysrhythmias



Capnography versus Pulse Oximetry

- Pulse oximetry is delayed.
- Pulse oximetry will show a high saturation for several minutes.



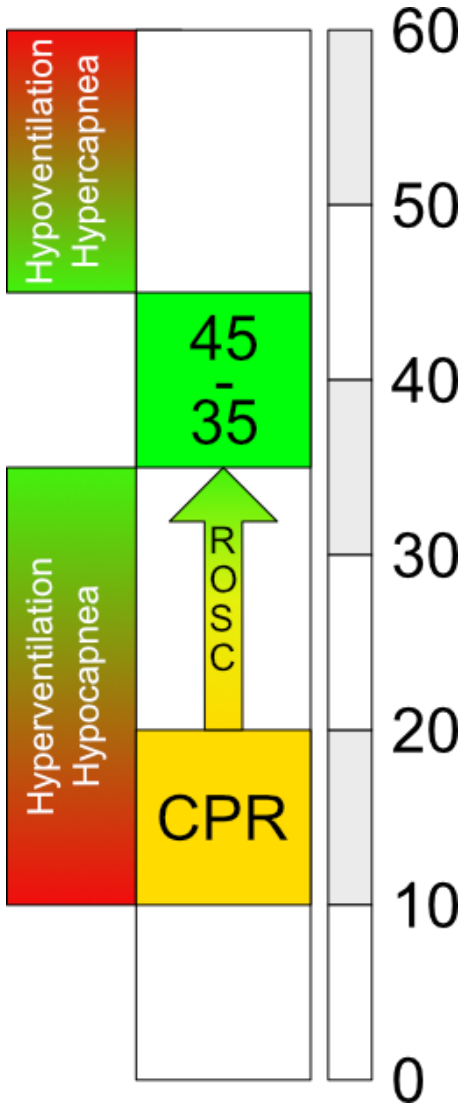
Circulation and Metabolism

- Capnography is a direct measurement of ventilation in the lungs, it also indirectly measures metabolism and circulation
  - Increased metabolism will increase the production of carbon dioxide increasing the $ETCO_2$
  - Decrease in cardiac output will lower the delivery of carbon dioxide to the lungs decreasing the $ETCO_2$
  - $ETCO_2$ reflects changes in cardiac output and pulmonary blood, not ventilation

Values

- Normal
  - $ETCO_2$ 35 – 45 mmHg
  - During CPR 10 – 20 mmHg

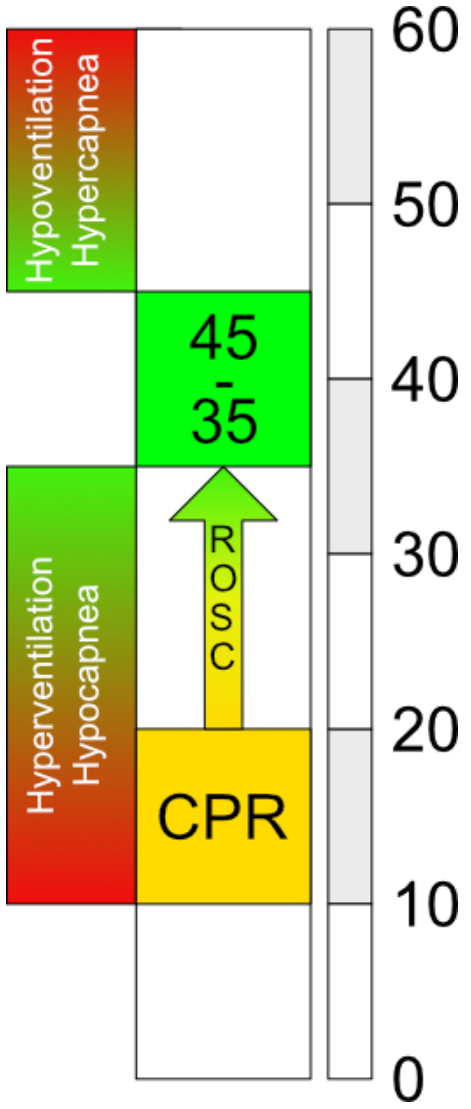
- If ROSC is achieved you should see a sudden increase to normal or above normal



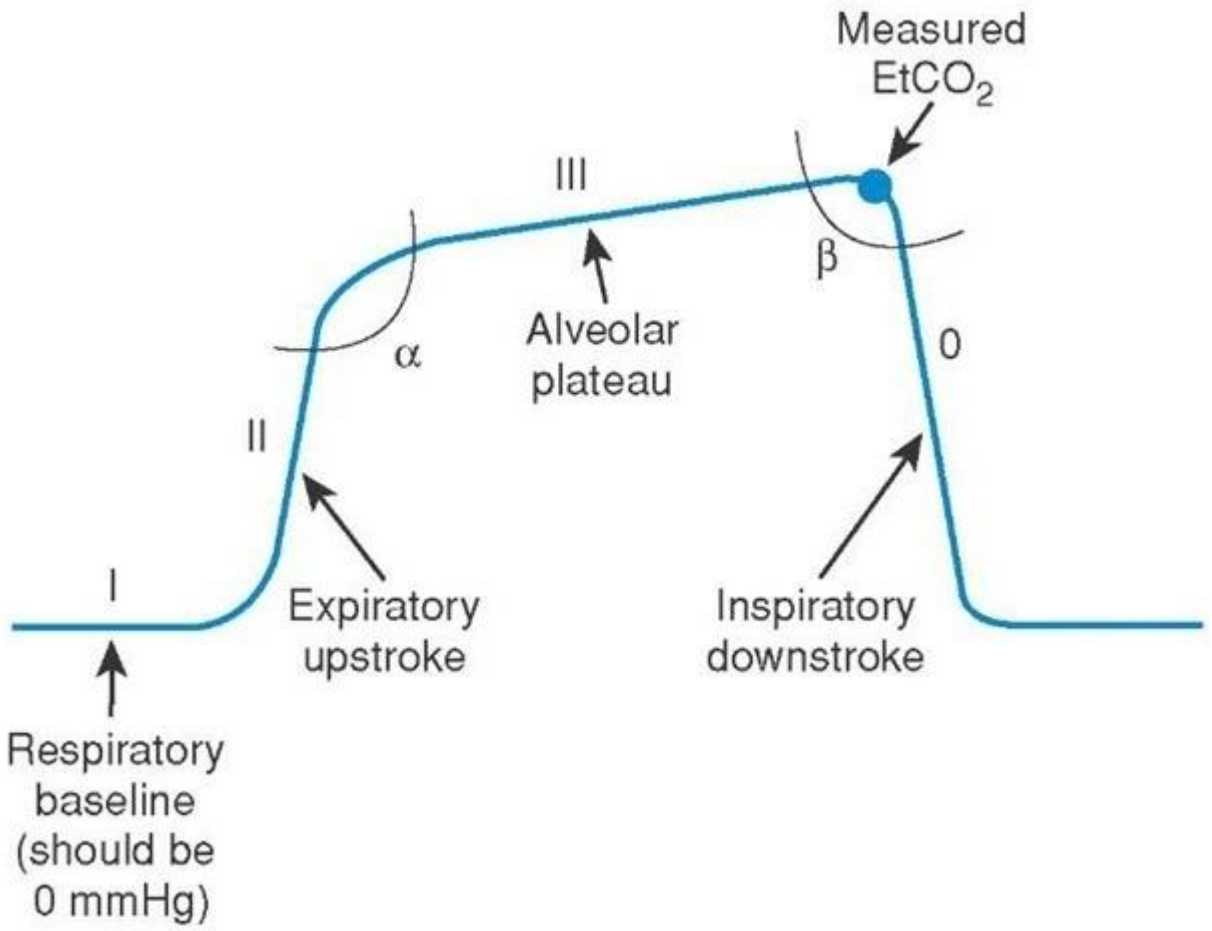
Values

- Abnormal

< 35 mmHg	hyperventilation hypocapnea
> 45 mmHg	hypoventilation hypercapnia



The Wave Form



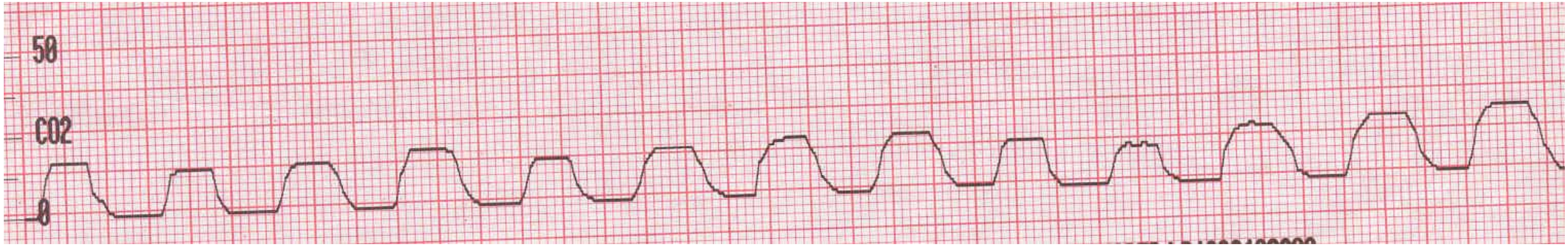
Inspiration	Expiration	Inspiration

Clinical Uses

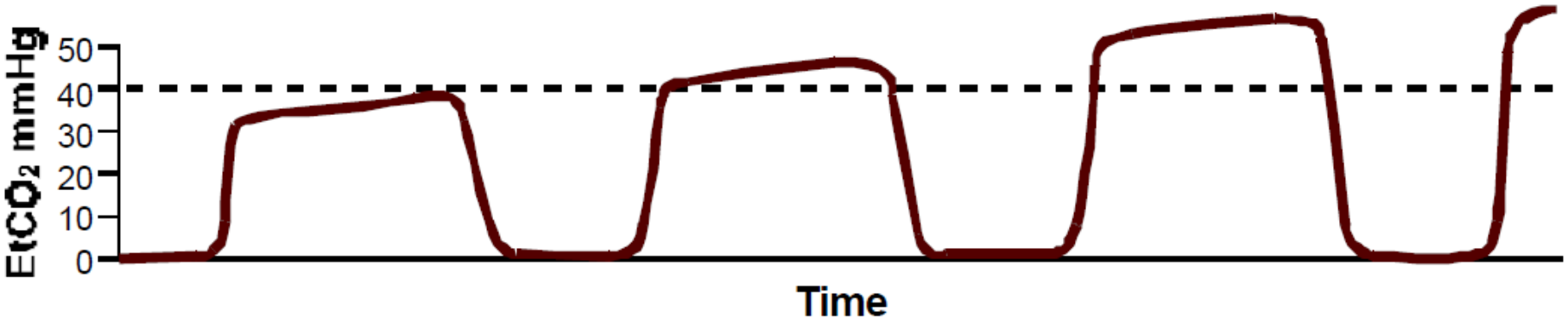
- Monitoring ventilation
- Confirming, maintaining, and assisting intubation
- Measuring cardiac output during CPR
- End-tidal CO_2 as predictor of resuscitation outcome
- $ETCO_2$ in asthma/COPD
- Troubleshooting

Hyperventilation

- Capnography monitors patient ventilation, providing a breath by breath trend of respirations and an early warning system of impending respiratory crisis.

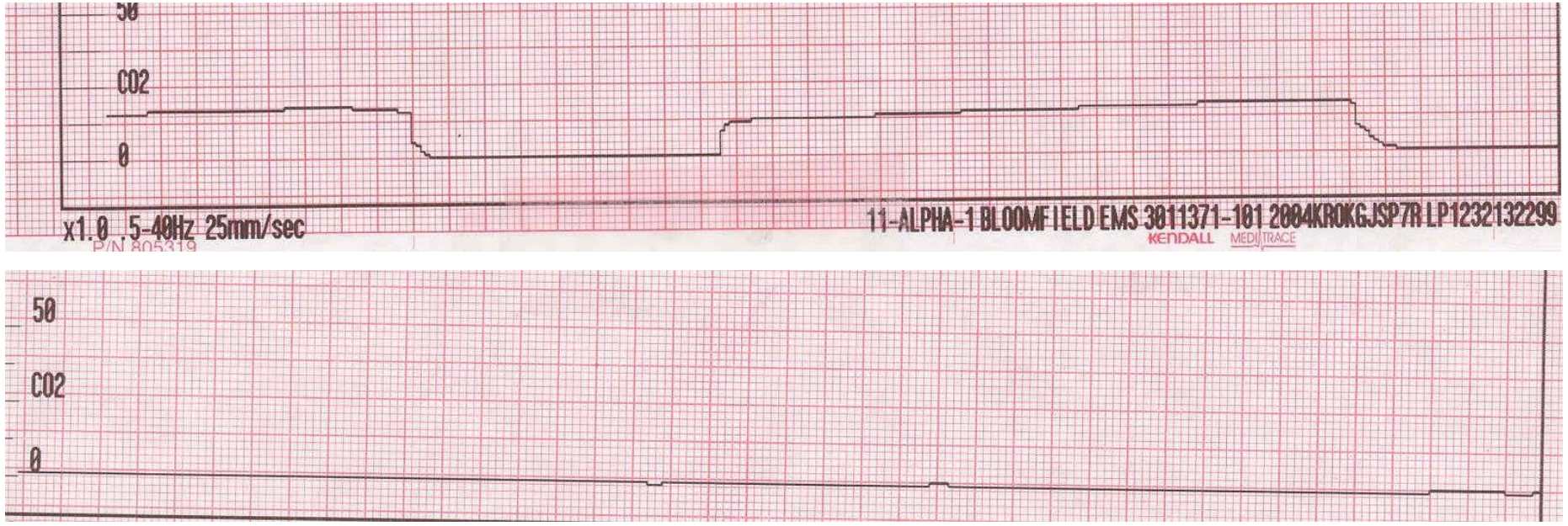


Hypoventilation



ET Confirmation

- Continuous end-tidal CO_2 monitoring can confirm a tracheal intubation.
- A good wave form indicating the presence of CO_2 ensures the ET tube is in the trachea.



During CPR

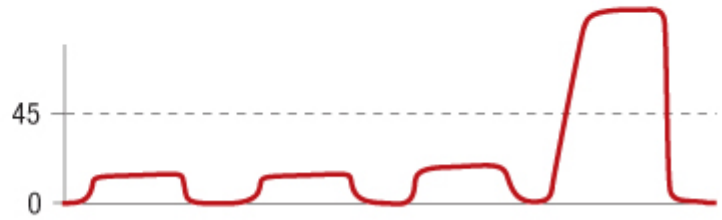
- The capnograph of an intubated cardiac arrest patient is a direct correlation to cardiac
- Increase in CO_2 during CPR can be an early indicator of ROSC output.

Return of Spontaneous Circulation (ROSC)

- $ETCO_2$ can be the first sign of return of spontaneous circulation (ROSC).
- Don’t stop compressions until you have completed the current cycle of CPR to assess for a pulse

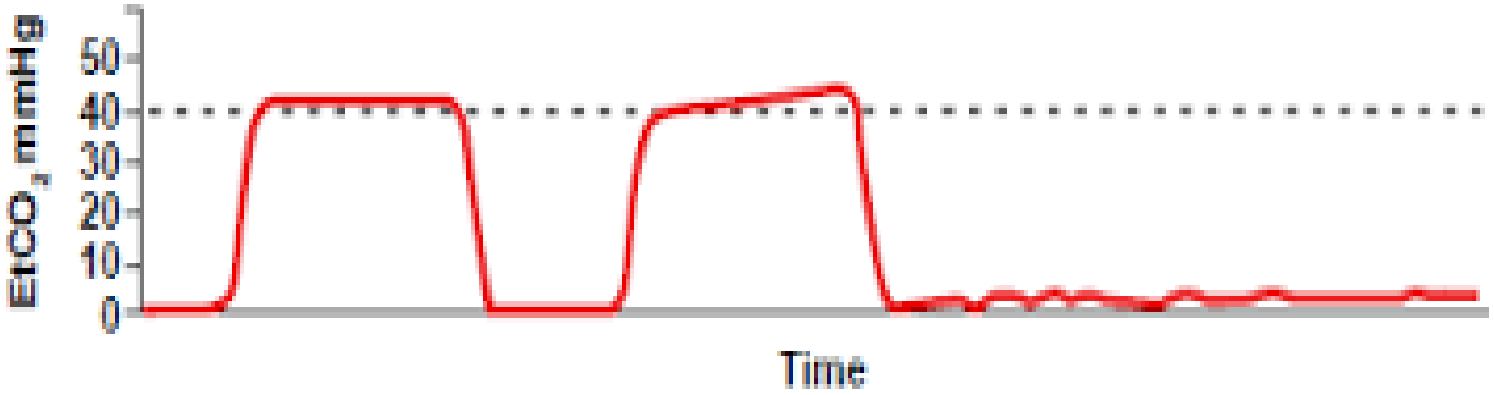
Sudden increase in $EtCO_2$

- Return of spontaneous circulation (ROSC)



Apnea

- A sudden drop in $ETCO_2$ may indicate
  - Displaced ET
  - Respiratory arrest
  - Cardiac arrest
  - Equipment malfunction



Predictor of Resuscitation Outcome

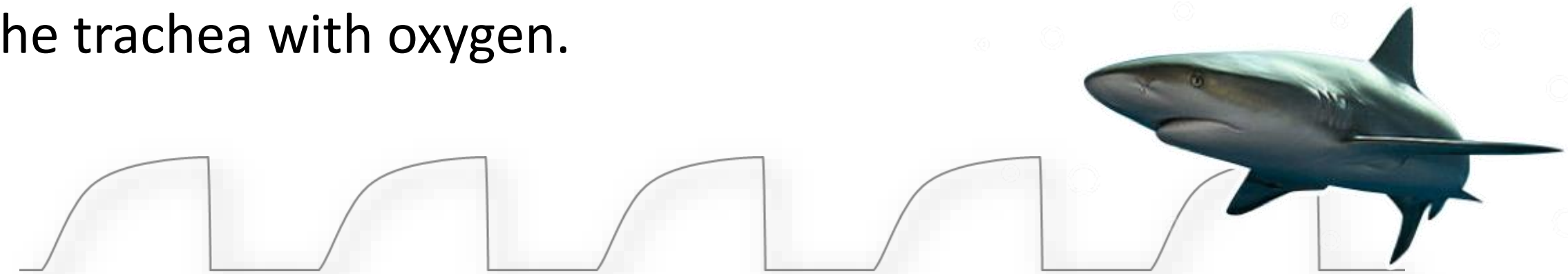
- $ETCO_2$ measurements during a resuscitation give you an accurate indicator of survivability for patients.
  - Survivors >30 mmHg
  - Non-survivors <10 mmHg

Capnography

WAVE FORM SHAPES

Bronchospasm

- Bronchospasm will produce a characteristic “shark fin” wave form as the patient has to struggle to exhale
- Caused by uneven alveolar emptying
- Down stroke remains the same as the patient begins inspiration and fills the unrestricted anatomical dead space of the trachea with oxygen.



Inadequate Seal

- As air escapes around the cuff during ventilation the waveform will distort

Obstruction

- An obstruction in the ETT may cause an irregular wave form

Elevated Baseline

- A capnogram that does not touch the baseline is indicative of a patient who is rebreathing CO_2 through insufficient inspiratory or expiratory flow.

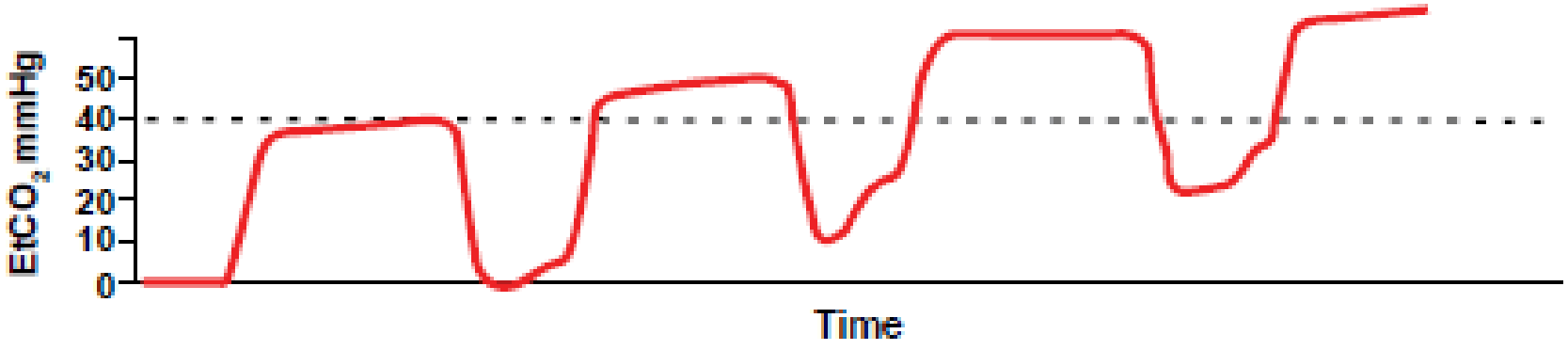


Figure 13: Capnogram illustrating incomplete inhalation and/or exhalation.

Good Videos to View

Lesson 2 (https://youtu.be/rsd5C7FLXXo)

Lesson 3 (https://youtu.be/GUV7BTlGLeM)