

# **Tricks of the Trade: Airway and Ventilator Management**

**Brett M. Fadgen MSN, CRNA, CFRN, NRP**

University of Pittsburgh Physicians  
Center for Emergency Medicine-STAT MedEvac  
[bmfadgen@gmail.com](mailto:bmfadgen@gmail.com)  
linkedin

# Objectives

- Recognize airway anatomy
- Identify appropriate airway adjuncts
- Describe steps to optimize ventilation and intubation
- Discuss cricothyrotomy
- Explain modes of ventilation
- Visualize pathophysiology and correction of tension pneumothorax

# Airway Assessment

- Is Pre-Hospital Airway Management easy??
  - Quite challenging
  - Unpredictable
  - Time sensitive
  - Obstacles...



# Airway and Ventilation Challenges

- Traumatic distortion
- Beards
  - Difficult BVM ventilation
- Recessed chin
  - Tongue insertion more posterior.. Anterior view
- Small mouth
- Teeth
- LARGE tongue
  - Difficult to ventilate?

# Airway and Ventilation Challenges

- Morbidly obese
  - Positioning
  - Thick neck, no neck
- Pathologic and physiologic diseases
- Trauma
  - LeForte III fractures/Facial trauma
    - Bleeding
    - Swelling-angioedema
    - Vomiting
    - Burns

# Airway Assessment

- General appearances and structures
- Atlanto-Occipital extension/cervical range of motion
  - Chin to ceiling
  - Sniffing position
    - In-line cervical stabilization...Trauma
- Mandibular/Thyromental distance
  - Cricothyroid/thyroid cartilage to chin
    - 6cm or 3 finger breaths

# Airway Assessment

- Mouth opening/width
  - 6 cm or 3 finger breaths
  - Edentulous...dentures in or out?
- Mallampati
  - Can it be assessed in the field?
  - Ma-am, I know your unconscious, but open your mouth and stick out your tongue...

# L.E.M.O.N.

- **Look externally.** If a patient may require intubation, look for characteristics that generally predict a potentially difficult airway.
- **Evaluate,** using the 3-3-2 rule. The patient should be able to fit three fingers into the mouth, three fingers from the angle of the jaw to the chin, and two fingers between the Adam's apple and the bottom of the jaw.
- **Mallampati score.** Perform a Mallampati evaluation by opening the patient's mouth. The more of the uvula that can be seen, the easier the airway.
- **Obstruction.** Look for anything that might obstruct the oropharynx, including soft tissue swelling or foreign bodies in the airway.
- **Neck mobility.** Be aware that patients with limited neck mobility may not be able to be moved into the optimal position for intubation.



# Airway Adjuncts

- OXYGEN
- **OP and NP airways**
  - NP- Lubricate
    - Fem-28-30mm
    - Male 30-32mm
- Pulse oximetry
- Capnography
- Laryngoscopes
- Esophageal Detector
- Rapid Sequence Induction (RSI)
- Needle/surgical airway
- **SUCTION**
- Video scopes?
- **BOUGIE**
- Supra-glottic Airways
- Endotracheal tube securing device
- **POSITIONING**

# Endotracheal Tubes

- 7.0 Adult Females
- 8.0 Adult Males
- 10cc syringe
- Stylet on all patients
  - Murphy's eye
  - KY jelly
- Peds Age/4+4= ETT
  - ALWAYS have 1 size smaller ready
  - ALWAYS refer to Broslow tape

# King LT

- 5 sizes, all color coated
- Pediatrics >12kg
  - 2
  - 2.5
- Adult
  - 3
  - 4
  - 5

# Positioning

- Is the patient on the floor or stretcher?
  - Floor
    - Optimize positioning
      - Firm pillow/bath blankets under shoulders and head
      - sniffing position

Can you move them first?

# Positioning

- Stretcher
  - Elevate head of stretcher ~30 degrees

WHY? Gravity

# Positioning

- Stretcher continued..
- Aligns Oral, Pharyngeal, and Laryngeal Axis
- Displaces abdomen to allow easier lung expansion
- Decreases passive gastric contents entering airway
  - Can be done while on a backboard

# Positioning

- Stretcher continued..
  - Increases diaphragmatic excursion with PPV
    - Improved Functional Residual Capacity
  - Easier BVM compliance
    - decreases chance to overcome lower esophageal sphincter

# Airway management

- The patient's positioned, we need to ventilate them, now what....
- OP or NP placement
  - Caution with patients you suspect are on blood thinners. NP will cause epistaxis!
- SUCTION before ventilation...
- WHY?



# Airway management

If we suction first, less chance gastric contents enter the lungs!



# Recap and Procedure

- Position the patient
  - Suspected cervical injury?
- Oxygenate 100% FiO<sub>2</sub>
- Oral/nasal airway placed
- Suction before ventilation
- Keep Suction at the patient's head

# Recap Adding ALS and RSI

- Ventilate (assist or controlled) with capnography
- Apply nasal cannula >10 lpm (apneic oxygenation)\*\*\*
- Stylet in ETT and syringe (+back up syringe)
- Verbalize checklist with partner to confirm everything is present

\*\*\* Indicates use with medication assisted intubation/RSI

# Recap Adding ALS and RSI

- Have Plan B and C ready
  - Supra Glottic airway
  - Cricothyrotomy
- RSI\*\*\*
- Open front of C-Collar for cricoid pressure\*\*\* / External Laryngeal Manipulation
- **Suction again before laryngoscopy especially if using videoscope**
- Intubate WHAT do you see...

# What did you see? Cormack grade?

- Grade I
  - Glottis fully visualized
- Grade II
  - Landmarks identifiable, laryngeal aperture partially obscured
- Grade III
  - Laryngeal aperture **MOSTLY** obscured, arytenoids partially visible
- Grade IV
  - Unable to visualize laryngeal aperture

# How do we improve our view?

- External laryngeal manipulation
  - Intubator moves larynx to improve view of glottic opening.
- Sellick's maneuver/cricoid pressure
  - 30-40 Newton's of pressure....huh..
  - Evidence suggests too much causes lower esophageal sphincter to open
- B.U.R.P.

# Recap Adding ALS and RSI

- Confirmation of placement
- Secure ETT
- More sedation/non-depolarizing paralytic\*\*\*
- Ventilator/BVETT



# Confirmation of Proper Placement

- Waveform ETCO<sub>2</sub> and figure
  - Gold standard
- Bilateral breath sounds equal
- Absent Epigastic sounds
  - not reliable
- Esophageal Detection Device (EDD)

# Capnography / End-Tidal CO<sub>2</sub>

- Normal; 35-45mmhg
- Hypercapnic; >45mmhg
  - Ventilate Faster
- Hypocapnic; <30mmhg
  - <25mmhg
    - Perfusion low
    - Cardiac arrest
    - ***Esophageal intubation***
    - Cracked detector



# Surgical Cricothyroidotomy

- Unable to establish airway
  - Unsuccessful endotracheal intubation  
OR
  - Inability to maintain oxygenation and ventilation with a rescue airway
    - King LT-D
    - LMA

# Surgical Cricothyroidotomy

- Recognizing injury or disease that would make orotracheal intubation impossible
  - Massive facial trauma
  - Compound mandibular fracture
  - Le Forte III facial fracture
  - Airway burns or edema
  - Laryngeal fracture

# Surgical Cricothyroidotomy

# Equipment

- Scalpel
- Curved hemostat *WHY.....?.*
- 5.0-6.0 mm cuffed endotracheal tube
- 10cc syringe
- Gauze/ABD pads
- Alcohol wipes/betadine
- Suction
- BOUGIE....huh

# Surgical Cricothyroidotomy

- Palpate cricothyroid membrane
- Clean site
- Make a *vertical* incision through skin and expose membrane
  - May be several mm's- Partner pulling tissue laterally
  - Suction bleeding
- Make a *horizontal* incision through membrane with scalpel-
- Place Hemostats, OPEN wide, remove scalpel!



# Surgical Cricothyroidotomy

- Place BOUGIE with gloved pinky, remove hemostats
- Insert ETT over the bougie ensuring Caudal direction..
- Inflate cuff
- Ventilate with BVM
- Confirm with waveform ETCO<sub>2</sub>
- Don't let go of the ETT!!!

# Needle Cricothyrotomy

- Large bore needle/catheter enters the trachea via cricothyroid membrane
- 10ml syringe with 5ml sterile H<sub>2</sub>O or NSS attached
- Needle/Catheter held at 90 degrees to cricothyroid membrane
- Pull back plunger during entry into the trachea until bubbles are noted
- Change angle to 45 degrees caudally

# Needle Cricothyrotomy

- Once air bubbles visualized, advance catheter off the needle to hub
- Remove needle and syringe
- Re-Attach syringe to catheter, withdraw plunger with ease confirm placement by presence of bubbles
- Attach TransTracheal Jet Ventilator.
  - 1 second on, 2-4 seconds off
- *Can use BVM with some commercial needle cricothyroidotomy sets*

# Cricothyroidotomy Concerns

- Visualize and palpate landmarks
- Bleeding
  - Cricothyroid membrane is **Avascular**
  - Neck **is very** vascular—Capillary
    - Gauze, **Suction** and ABD's
- Don't lose the hole, make sure it is big enough
- Watch for creating false passage
  - Lung sounds, Sub Q air
- ETT kinking
  - Guide ETT caudally

# Cricothyrotomy

Regardless of method

Don't let go of the airway device!!!!



N307ME

STAT MedEvac

STAT MedEvac

# RSI / Pharmacology

- Propofol
- Etomidate
- Ketamine
- Fentanyl
- Midazolam
- Succinylcholine
- Rocuronium
- Vecuronium

# RSI/Pharmacology

- Propofol
  - Dose; 1-5-2.5mg/kg
  - Provides sedation and amnesia
- CV Effects
  - Hypotension and Bradycardia
    - Decreases CO
    - Severe bradycardia with Precedex/  
Dexmedetomidine
- Neuro
  - Decreases ICP
    - May be bad choice with TBI pts due to  
decreased CPP



# RSI / Pharmacology

- Etomidate
  - 0.2-0.3mg/kg
  - Sedation/hypnosis
- Cardiac stable
  - < 10% MAP reduction
- Neuro
  - May activate **seizure foci in epileptics**
  - **Myoclonus-tremors** in 1/3 of pts.
- Endocrine
  - ***Supresses cortisol release***
  - Cxn is the septic ICU pt. Steriods....

# RSI/Pharmacology

- Ketamine
  - 1-2mg/kg 200mg Max for induction
  - Dissociative agent
  - Kappa analgesia receptors
- Great for **Asthmatic** and **septic** patients.
  - Bronchodilates, decreased resp. depression
- Contraindications
  - Globe injuries, Known Cardiac, Increased ICP, many more.

# RSI/Pharmacology

- Midazolam
  - 0.1mg/kg - 4mg, IV, IN, or IM
    - Onset 30 seconds-1 minute
    - Sedation, anticonvulsant
    - Short duration
    - More potent than Diazepam
    - Cardiovascular
      - Modest reduction in BP

# RSI / Pharmacology

- Fentanyl
  - 1mcg/kg
    - Onset 1 minute
    - Short term analgesia
    - Mu1 and Mu2
    - Cardiac stable
    - Can cause Bradycardia
    - Chest muscle rigidity with multiple doses

# RSI/Pharmacology

- Succinylcholine
  - 1-2mg/kg
  - Onset 30 seconds
  - Duration 3-5 minutes
  - Depolarizing Muscle relaxant
  - Sustained depolarization of neuromuscular junction.
    - That's why we see fasciculations
- Will raise K<sup>+</sup> 0.5meq/L in pts with normal renal fxn
- Causes Bradycardia- Pronounced in Peds
  - Atropine 0.01mg/kg

# RSI/Pharmacology

- Succinylcholine Contraindications
  - Hyperkalemia/Renal failure
    - Will increase  $K^+$   $>0.5\text{meq/L}$
  - Sub-acute Burns  $>8\text{hrs}$  old
  - Increased intra-ocular pressure
  - Open globe injuries
  - Malignant Hyperthermia
  - Muscle wasting diseases ( $K^+$ )

# RSI / Pharmacology

- Rocuronium
  - 0.6-1.2mg/kg **1mg/kg**
    - Maintenance dose 0.3-0.6mg/kg
  - Onset 60-90 seconds
  - Duration 30 minutes
  - Non depolarizer
- Caution with liver failure patients

# RSI/Pharmacology

- Vecuronium
  - 0.1-0.4mg/kg **0.1mg/kg**
  - Onset 90 seconds-3 minutes
  - Duration 37 minutes to 2 hrs(0.4mg/kg)
- Caution in liver failure patients
  - Prolonged paralysis





MEDIC 96

*Caring for the Community. One Patient at a Time*



EMERGENCY

N506LS

LIFELINK

# Positive Pressure Ventilation

- 3 types of positive pressure ventilation
  - 1. Mandatory
    - Ventilation is initiated and ended by the ventilator
    - No patient control
  - 2. Assisted
    - Set rate, but spontaneous breaths can be initiated by patient, controlled volume by ventilator
    - PSV or AC
  - 3. Spontaneous
    - Patient controlled respiration
    - CPAP

# Ventilator modes

- Assist Control (AC or VCV)
- Pressure control (PCV)
- Synchronized Intermittent Mandatory Ventilation (SIMV)
- NiPPV
  - CPAP
  - BiPAP

# Ideal settings

- Assist control
- Rate 10-14
- Tidal volume 6-8ml/kg
- New data suggests 6-8ml/IBW
  - Minute Volume 6-10 lpm lower total volumes, higher rates
  - Decreased Volutrauma and Barotrauma
- 5 PEEP ALWAYS
  - 4-6 PEEP is Normal/physiologic
  - Decreased pre-load with PEEP >8.

# Ideal Body Weight Calculation

- Different for males and females:
- Male:
  - Inches
    - $IBW = 50 + 2.3 * (\text{inches of height} - 60)$
  - Centimeters
    - $IBW = 50 + 0.91(\text{centimeters of height} - 152.4)$
- Female:
  - Inches
    - $IBW = 45.5 + 2.3 * (\text{inches of height} - 60)$
  - Centimeters
    - $IBW = 45.5 + 0.91(\text{centimeters of height} - 152.4)$

Download an App or use a chart!

# Assist Control/Volume Control

- Set rate and volume
- Variable pressure
- Patient may initiate breath above set rate
- Pre-set tidal volume is delivered
- Pressure may be variable due to compliance
  
- Caution
  - Barotrauma, hyperventilation, Auto PEEP, and Volutrauma can occur

# Pressure Controlled Ventilation

- Set Rate
- Set Pressure
- Set inspiratory time- 1.2, 1.4, etc.
- Will have variable Tidal volumes
  - Once the set pressure is reached, expiration phase begins regardless of tidal volume
- Minute Volumes may be decreased or increased.
- May see in ARDS pts.
- Less incidence of Volume and Barotrauma.

# Pressure Regulated Volume Controlled Ventilation

- Set rate and Volume, variable Pressure
  - Pressures are altered to achieve a set tidal volume
- The idea is to deliver tidal volume with minimizing risk of barotrauma
- For transport ventilators;
  - Lower tidal volumes, higher rates.



# Synchronized Intermittent Mandatory Ventilation SIMV

- Volume Controlled mode
- Set rate and tidal Volume like A/C
- Patient initiated breaths do not receive the set tidal volume
- Breathing “synchronized”
  - Decreases bucking the tube

# Pressure Support Ventilation

- Patient triggered assisted mode.
- Preset pressure delivered.
- Patient controls rate, inspiratory time, and volume.
- The higher the pressure is set, the less work for the patient.
- Can be used with SIMV and CPAP for weaning.

# Non Invasive Positive Pressure Ventilation (NPPV)

- CPAP and BiPAP
  - Could be done through ETT, Mask, or Nasal mask
  - ETT is difference b/t invasive VS. non-invasive
- Patients breath spontaneously
- Increases Alveolar ventilation
- Decreases work of breathing
  - Improved gas exchange
  - Decreased muscle use
- COPD and CHF population
- May require small amount of sedation

# NPPV

- Contraindications
  - Patients with decreased mentation
    - aspiration
  - Hemodynamic instability
  - Morbidly obese that need to lay flat.....
  - Facial trauma
- Cautions
  - Beards
  - Improperly sized mask

# NPPV

- CPAP or BiPAP, settings may differ between ventilators.
- Initial set up is typically:
  - Pressure support (or iPAP) 10
  - PEEP (or ePAP) 5
  - Breath rate Zero

# Troubleshooting Ventilators and Patient Safety

- Peak plateau pressure (Pplat)
  - Transpulmonary pressure
- Peak Inspiratory pressure (PIP)/alarms
  - Highest pressure generated with positive pressure ventilation
- Low airway pressure alarm
- Ventilation/perfusion

# Peak Plateau Pressures (Pplat)

- Pplat is essentially transpulmonary pressure, or “the pressure difference across the lung calculated by subtracting the pleural pressure from the alveolar pressure”
- Press the inspiratory hold button, release, then press and hold for 1 second... It should be less than 30cmH<sub>2</sub>O

# Peak Plateau Pressures (Pplat)

- Pplat is believed to be a better indicator of alveolar distention than the Peak Inspiratory Pressure (PIP) because it is not influenced by upper airway resistance or ventilator equipment.
- Leads to Ventilator-induced lung injury...  
barotrauma and volutrauma



# Alarms and Pressure Settings

- D.O.P.E.= Displaced, Obstructed, Pneumothorax, Equipment
- High pressure alarm Set to 40cm H2O
  - Whats wrong?
    - Decreased compliance... Obstruction sputum/ blood, kink, Pneumo, bronchospasm, Patient waking up?
  - Correction:
    - Suction
    - Sedation
    - Bronchodilator
- Rule out hypoxia, don't just change the settings...

# Alarms and Pressure Settings

- Low pressure alarm Set to 5cm H2O
  - ETT dislodged
  - Circuit crack
  - Disconnect
  - Cuff leak
- Low O2 pressure
  - Wall outlet/main with <50psi
  - Tank empty

# Alarms and Pressure Settings

- Increased PIP without change in Pplat would indicate ***increased airway resistance***
  - Obstruction, bronchospasm, secretions, or kinked ETT
- Increased PIP with increase in Pplat would indicate ***Decreased compliance***
  - Pulmonary edema, Pneumothorax, Pleural effusion, Auto-PEEP, asynchronous breathing-waking up

# Ventilation/Perfusion

- How do we improve SpO<sub>2</sub>?
- How do we increase or decrease EtCO<sub>2</sub>?

# Ventilation/Perfusion

- $SpO_2$ 
  - Add PEEP
  - Increase  $F_iO_2$
- $EtCO_2$ 
  - Increase/decrease Rate
  - Increase/Decrease Tidal Volume
  - Which way?

# Tension Pneumothorax

- Simply the build up of air within the pleural space secondary to an injury to the lung
- Usually a result of penetrating or blunt trauma
- Can occur from alveolar rupture in the COPD patient

# Tension Pneumothorax

- Signs and symptoms
  - Dyspnea
  - High PIP
  - Diminished or absent breath sounds to effected side
  - Tachycardia
  - Hypotension
  - Jugular Vein Distention
  - Tracheal Deviation (late)

# Relief of Tension Pneumothorax

- Decompression
  - 2nd intercostal space mid-clavicular (preferred)
  - 4th intercostal space, Anterior-axillary
- Over the rib technique
- 12g, 14g, or 16g 3 inch angio catheter (adults)
- Create 1 way valve after rush of air



# Tension Pneumothorax

- Cautions
  - 4th intercostal space
    - Liver injury
  - 2nd intercostal space
    - Brachiocephalic and subclavian injury
- Obese patients
- Hemothorax

# Chest Drainage Systems

- Pleur-vac
  - Keep upright to maintain seal
  - Keep suction applied
    - Bubbles in water indicate leak. Think at insertion site..
  - 20cm H<sub>2</sub>O standard, can adjust dial, floating arrow will mimic amount of cm/H<sub>2</sub>O
  - If water seal only, suction not applied, maintain blue water separate
    - Blue water seal will fluctuate with inhalation/exhalation
- If it is full, have referring facility switch out new Pleur-vac

Lets Play!



Questions?

# Special Thank You

- STAT MedEvac and Ross/Westview EMSA for equipment
- Don Holsten for the pig tracheas and lungs!

# References