RSI
Rapid Sequence Induction and Intubation

Cline Companion Handbook: Chapter 1

Ma, Cline, *Emergency Medicine Manual* chapter (Keadey) : Respiratory Distress

Brady (or standard paramedic text) : Sedation and RSI medications

Objectives

Upon this lecture's completion you will be able to discuss :

- Need for establishing an airway in non-fasting, complex medical or traumatic emergencies .
- The advantages of Rapid Sequence Induction of Endotracheal Intubation (or RSI).
- A protocol for RSI and Intubation
- Medications for RSI and Intubation
  - Sedation
  - Paralysis
  - Adjunctive agents.
    - Reflex bradycardia
    - Analgesia / increased intracranial pressure

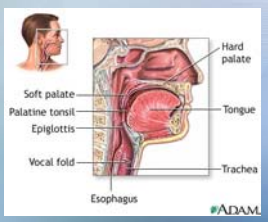
Objectives, continued

- Compare and contrast various paralytics and sedatives
- List the factors determining the selection of a sedative.
- Awareness of the contraindications of RSI.
- Recognize complications of RSI and how to avoid these.

Upper Respiratory Anatomy

Upper Airway

- Mouth and Nose
- Pharynx
- Epiglottis
- Larynx
- Epiglottis
  - Pyriform fossa



Upper Airway Anatomy

Anatomically and mechanically : two "units"

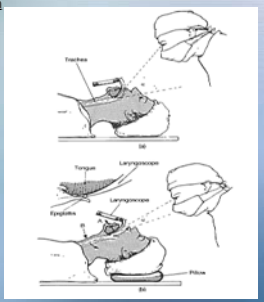
- ***Jaw*** - tongue-hyoid-epiglottis unit
- ***Laryngeal*** unit

- Jaw-tongue attachment
  - Jaw thrust moves tongue out of airway
- Jaw - hyoid - epiglottis attachment
  - Jaw thrust pulls on the hyoid which in turn moves the ***epiglottis*** out of airway

Optimizing Laryngeal Visualization

Optimized Visualization for ET intubation:

- Positioning:
  - alignment of (3) oral -pharyngeal -laryngeal axes
- External pressure: *by the operator*



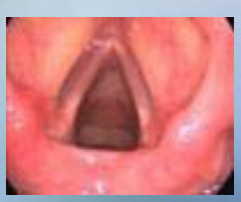
Cricoid Cartilage Pressure

"BURP," or Sellick-Cricoid pressure:

- Moves the whole cricoid - ***cords*** - thyroid unit into alignment

Vocal Cords

- "A" shaped cords wide open
- Epiglottis is pinned (out of view) , anteriorly
- Esophagus
  - Obscured by the posterior pharynx-hypopharyngeal tissue



RSI

- Technique couples sedation with muscular paralysis in patients in extreme need of:
  - Airway control
  - Ventilation and oxygenation
- "Induction" refers to the inducing of unconsciousness
- Paralysis should not precede airway control, which is to say: paralysis should not precede cricoid pressure (Sellick) to prevent aspiration

Case : Upper Body Burn Patient

- Rural Co. FD called to patient's house fire 0.3 miles north of West Elementary School. Your EMS is dispatched to the house of the patient's neighbor (who called 911).
- Dispatch reports to you that the patient is a 67 YOM who awoke in his burning house. He has suffered "a lot" of burns while escaping from his house; he has walked to his neighbor's house (approx. 0.1 mile). He is reportedly in a great deal of pain.
- Upon your across-the-yard assessment, the patient is crying out in pain, and he has obvious blistering and charring of the face, neck, and upper body.
- Is this patient a RSI candidate? Why?

Is This Burn Patient a Candidate for RSI ? Why?

- Yes, he is [and was].
- Because not only is he at risk for impending airway obstruction but also an for impending inability to ventilate a patient also at risk for hypovolemic shock.
  - impending respiratory failure or airway obstruction
- Now, how do you intend to do an awake intubation in this patient who is in severe pain? In this patient who may be uncooperative, anxious, screaming? In this patient who may have altered, swollen upper airway anatomy ??

How to Do an "Awake-Intubation" in this Burn Patient

- Pain medication sedation and paralysis will [were] all be helpful or even essential for :
  - gaining cooperation
  - laryngoscopic visualization and intubation
- This patient was taken from the front yard immediately into the ambulance. NRB placed and IVs started.
  - Morphine 10 mg IV, while RSI preps were being made.
  - Midazolam 10 mg IV
  - Vecuronium1 mg IV . Then Suc. 100mg IV.
  - ET tube then passed through a sooty, charred upper airway and then through swollen black cords
  - Vecuronium 9 mg IV. Then transport [ETA 4 min.]

RSI Patients

- Facilitating intubation in patients who require urgent or emergent intubation but who show evidence of incomplete relaxation:
  - head trauma / multiple injury
    - altered mental status and uncontrolled airway
  - pulmonary edema [this indication may be greatly modified by CPAP]
  - inhalation burns
- Sedation with paralysis for intubation in a patient with:
  - a complex airway or respiratory emergency
    - hypoventilation or ineffective ventilation;
    - impending respiratory failure or airway obstruction
    - risk of regurgitation and aspiration
  - risk of increased intracranial pressure
  - combativeness or seizures in a seriously injured or ill patient who cannot be otherwise managed without serious risk of injury to patient or crew.

Advantages of RSI

- Facilitates intubation by improving visualization during laryngoscopy
- Avoids pain, anxiety, and noncooperation of an "awake" intubation
- Reduces harmful effects of intubation (e.g., bradycardia, pain, intracranial pressure increase, hypertension)
- Minimizes risk of pulmonary aspiration during intubation

RSI Alternatives

- Awake intubation – not advantageous
- Nasotracheal intubation
  - not advantageous
  - does NOT reduce C-spine movement
- Orotracheal intubation using ONLY a sedative
  - shown to be more prone to complications than RSI
- Surgical airway methods
  - lack of experience
  - hemorrhage
- Airway alternatives
  - LMA
  - Combitube
  - BVM

Basic RSI Procedure

- Airway assessment
- Preoxygenation
- Optional adjunctive agents (atropine, lidocaine)
- Sellick maneuver (cricoid pressure)
- Sedative agent
- Paralyzing agent
- Intubation and confirmation

Airway Assessment

- Assess your ability to perform bag-mask ventilation (BMV)
- BMV will be necessary as a rescue procedure if intubation is not achieved during RSI.
- ***If*** you anticipate ***BMV*** is ***not possible***
  - do not proceed with RSI until more help is available. [With the exception of ….]

Sequence for RSI

- ***Prior*** to RSI, appropriate preparation :
  - the medications
  - the equipment
  - and the team needed
- And then as quickly as possible:
  - intubation of the patient

Preparation of Equipment, Laryngoscope, etc

- Select laryngoscope blade type and size.
- Tracheal tube sizes ready
- Optional stylet in tube
- Monitor oxygen saturation.
- Prepare to maintain Sellick maneuver.
- Prepare to suction – assistant should be able to pass this to you upon request.

(There are several mnemonics and time lines for how to proceed)

One Mnemonic for RSI

- SOAP ME PPPE VS PPPE P :
  - **S** uction - Suction tubing and catheters,
  - **O2** - O2 reservoir, BVM, and ventilator attachments are arranged,
  - **A**irways, - airways, laryngoscope and blades, ET tubes and stylet are arranged,
  - **P** [pharmacologicals]- all drugs to be used are drawn-up, labeled, and positioned near the IV,
  - **M** [monitors] - cardiac monitor, O2 sat., and automatic BP monitors are established
  - **E**quipment - Equipment, team members, and drugs are made ready; then proceed

PPPE: SOAP ME *PPPE* VS PPPE P

- **P** re Oxygenate the patient with 100% O2
- **P** re medicate the patient with: - Lidocaine (1.5 mg/kg) IV
  (2 min before sedatives / paralytics)
  (in head trauma pts to prevent ICP)

  - Atropine (0.02 mg/kg) IV
  (this step is optional in adults)
  (to decrease vagal tone)
- **P** ause a few more seconds for the Lidocaine to take effect
- **E** ffective cricord pressure (Sellick's) - assignments now. **E** veryone ready?

SOAP ME PPPE *VS PPPE P*

- **V** entlating with cricord pressure in place
- **S** edative such as: - Midazolam (0.1 - 0.2 mg/kg) IV
  or
  - Etomidate (0.3 mg/kg) IV
- **P** rotecting the airway - cricoid pressure
- **P** aralyze - When enough sedation achieved, give *paralytic agent* of choice and intubation is performed.
- **P**ass the tube
- **E** vidence of correct placement
- **P** ost-intubation management (ET DOPE mnemonic)

P PPE

SOAP ME *P* PPE VS PPPE P

Preoxygenation

- Maximum oxygenation provides patient with oxygen reserve during intubation process.
- Ideally, patient's oxygen saturation should be 100% before starting RSI.
- If patient is spontaneously breathing
  - avoid positive pressure unless hypoxia is present despite supplemental oxygen.

Preoxygenation

- Spontaneously breathing patient:
  - Use a nonrebreather oxygen mask.
  - If a self-inflating BVM is given as "blow by" to a spontaneously breathing patient, this is the equivalent to having the patient breathe room air, and the patient will not preoxygenate.
  - Avoid PPV so as to minimize risk of aspiration
- Hypoventilating or apneic patient:
  - Use a self-inflating bag with maximum oxygen flow
  - Positive pressure BVM - assist will be necessary
  - Consider Sellick maneuver (cricoid pressure) +/or gastric tube placement (NG or OG tube).

Adjunctive Agents

SOAP ME PPPE

Pre medicate and **P**ause

- Lidocaine
- Atropine

- Lidocaine
- Dose: 1.5 mg/kg
- MOA: may lower intracranial pressure
  - may be beneficial in head trauma cases or when ICP elevation is suspected
  - should be administered at least 2 min. prior to intubating
  - it is unclear if lidocaine provides additional ICP reduction that is beneficial when given in conjunction with etomidate

Atropine

SOAP ME PPPE

- Probably useful in <u>all</u> children
- Anticholinergic
  - Prevents bradycardia during intubation
  - Reduces oral secretions (e.g., ketamine)
- Dose: 0.02 mg/kg

Sedative Agents

(SOAP ME PPPE V/S PPPE P)

- While **V**entilating with cricoid pressure in place and **P**rotecting the airway, administer the ***S*** edative
- No perfect sedative
- Most sedatives can cause cardiovascular compromise.
- Selection is dependent upon clinical conditions.
- Many now consider <u>etomidate</u> to be sedative of choice
- Others:
  - Midazolam
  - Ketamine

Etomidate

- Mechanism:
  - onset: less than 1 min
  - duration: short-acting
- Use: sedation
- Dosage:
  - 0.2- 0.3 mg/kg dose
- Benefits:
  - Lowers ICP ; cerebroprotective
  - ***Less*** hypotension
  - Ideal choice for unstable patient with head trauma
- Adverse effects:
  - Myoclonic jerks (resemble seizures)

Midazolam (Versed)

- Mechanism: <u>not</u> a neuromuscular blocker ; i.e., no paralysis. Reversible, amnestic, anticonvulsant
  - onset: 1-2 min
  - duration: 20-30 min; 2-4 hr
- Use: relaxation, sedation, amnesia
- Dose: 0.1 -0.2 mg/kg (same as valium : 0.1 mg/k)
  - Variable dose to achieve unconsciousness(disadvantage)
    - titration not appropriate for RSI.
  - Post ET drip: [1mg / 1cc NS] conc.; starting at 5mg / hr, and titrate up rapidly. Titration is inappropriate for RSI
- Adverse effects:
  - negative inotrope ; ***hypotension***
  - respiratory depression

Ketamine

- Onset: 1 min
- Duration: 30 min
- Dose: 1- to 2-mg/kg IV
- Benefits:
  - *Bronchodilator*
  - sympathomimetic, less likely to cause myocardial depression
  - does not produce true unconscious state because reflexes, including spontaneous respirations, may be preserved.
- Cautions:
  - Increases oral secretions (use atropine as an adjunctive agent) increases ICP
  - Disturbing dreams and emergence reactions [<u>not</u> an RSI issue]

Sedative Selection

- Hypotension: Etomidate
- Status asthmaticus: Ketamine
- Head injury without hypotension:
  - thiopental or
  - etomidate
- Etomidate : becoming agent of choice in patients with hypotension, whether it is caused by trauma, sepsis, or other

Neuromuscular Blocking Agents or Paralytic Agents

(SOAP ME PPPE VS PPPE P)

- **P** rotecting the airway
- ***P*** aralyze
- **P** ass the tube

- Paralytic Agents
  - Succinylcholine (Anectine)
  - Vecuronium (Norcuron)
  - Rocuronium

Succinylcholine

- Mechanism: depolarizing agent
  - onset: rapid (30-60 sec.)
    (onset 1 min; full effect: 4-6 min)
  - duration: brief (10 min.)
- Use: classical rapid intubation "drug of choice"
- Dosage: 1 mg/kg (1.5 mg/kg; rec. doses may vary)
  (Children often require larger doses, i.e., 2 mg/kg)

Adverse Effects of Succinylcholine

- Severe hyperkalemia *1
- Arrhythmias *2
- Fasciculation *1
- Increased intracranial pressure *3
- Aspiration *4
- Malignant fever
- Familial prolonged paralysis (1:1500 pts.)

– *1 May be prevented by pretreatment with minidose (1/10 usual dose)
  – minidose followed by reduced dose (0.5mg/kg : controversial)
– *2 May be prevented by Atropine +/- Lidocaine
– *3 May be prevented by Lidocaine 1 mg/kg
– *4 May be prevented by Sellick's maneuver (cricoid pressure),

More Succinylcholine Adverse Effects

- Post recovery pain
- Increased gastric pressure
- CV instability *3
- Rhabdomyolysis
  – Myoglobinuria *1

– *1 May be prevented by pretreatment with minidose (1/10 usual dose)
– *3 May be prevented by Lidocaine 1 mg/kg

Vecuronium (Norcuron)

(**veh**-kyour-**ROH**-nee-um)

- Mechanism: **non**-depolarizing agent
  - onset: onset: 2-4 min (not 30-60 sec.)
  - duration: 30 min. (not 10 min.)
- Use:
  - for prolonged paralysis
  - when succinylcholine is not indicated
- Dosage:
  - 0.1 mg/kg [same as Valium; 1/10 suc.]

- Succinylcholine : For excellent intubation conditions: suc is superior to rocuronium. Using less stringent conditions, the two agents were not statistically different. Citation: *The Cochrane Database of Systematic Reviews* 2003

Rocuronium

(ro-kyour-ROH-nee-um)

- Mechanism: ***non***-depolarizing agent
  - onset: 1-3 min (vs. 30-60 sec.)
  - duration: 30-45 (not 10 min.)
- Use: for prolonged paralysis
- Adv / Disadvantage
  - Longer duration; less potential for adverse effects than succinylcholine
- Dosage of Rocuronium :
  - 0.6 mg/kg [roughly 1/2 the suc dose]
  - 0.01-0.02 mg/kg/min drip infusion

Depolarizing Agent

- Applies only to succinylcholine
- Causes muscle fasciculations
  - more common in muscular adults
- Fasciculations result in :
  - muscle pain
  - increase the risk of rhabdomyolysis
    - increase the risk of hyperkalemia
    - myoglobinuria
- Fasciculations might transiently increase
  - muscle tone and
  - increase ICP

Mini-dose Defasciculation

- Mini-dose defasciculation
  - prevents fasciculations associated with succinylcholine.
- Administer ***one-tenth dose*** of either
  - Succinylcholine , or
  - nondepolarizing agent (rocuronium, vecuronium) 2 min prior to succinylcholine.
- Defasciculation has <u>not</u> been shown to reduce rate of adverse effects of succinylcholine during RSI.
  - Some [Herbert,…] say that this defasciculating step may used less and less in ED and prehospital protocols

RSI without Defasciculation vs RSI with Defasciculation

<u>RSI with no defasciculation:</u>

- 0 sec: Administer succinylcholine
- 30 sec: Adm. sedative
- ***60 sec: Intubate***

<u>RSI with defasciculation:</u>

- 0 sec: Adm. 1/10th defasciculating dose of rocuronium
- 90 sec: Adm. sedative
- 120 sec: Administer succinylcholine
- ***180 sec: Intubate***

Defasciculation Risk / Benefit

- Benefit: Prevent fasciculations and potential consequences
  - Vomiting / loss of airway
  - Muscle destruction (hyperkalemia, arrhythmias)
- Risk:
  - Prolongs time to intubation by 2-3 min
- Some recommend defasciculation; others don't.

Priming

- Does not have same goal as mini-dose defasciculation
- Is directed at ***non*** depolarizing [ND] paralytics such as rocuronium and vecuronium.
- Shortens onset time of ND paralytics.
- Priming often confused with defasciculation
  - requires one-tenth usual ND paralytic dose
    - similar to defasciculation (which accounts for the confusion)

Priming of Non Depolarizing Agents

- Onset of rocuronium : about 90 sec.
- "Priming," shortens the onset time to 60 sec.
- Administer :
  - one-tenth the usual dose of rocuronium
  - then 5 min later, administer full dose.
- Shortens onset time of rocuronium, but may prolong the time to intubation by a full 5 min

Priming is for Anesthesiologists

- Priming [with a 5 min wait] may have some advantages for anesthesiologists
  - managing stable patients for elective surgery
- Priming is ***not*** indicated for emergent intubation
  - adding 5 min to RSI is an unacceptable hazard
    - prehospital emergent intubation
    - unstable ED patient needing emergent intubation

Sellick Maneuver
(SOAP ME PPPE VS *P*PPE P)

- Gentle posterior pressure on cricoid to occlude esophagus to ***P*** rotect the airway
- Reduces risk of passive regurgitation of stomach contents.
  - Does not prevent vomiting (active regurgitation).
  - Reduces risk of aspiration
- Use with caution if C-spine immobilization is required.
- Initiate as soon as (or before) paralyzing agent is given.
- Do NOT release until tracheal intubation is confirmed.
- Might be beneficial even before RSI if positive pressure BMV is required.
- Beware: sometimes, the Sellick itself can cause gagging or retching

Intubation
(SOA P ME PPPE VS P***P P***E P)

- Maintain Sellick maneuver.
- Airway equipment previously determined:
  - Laryngoscope blade size
  - Tracheal tube size
  - Tracheal tube depth
- P aralyze
- P ass the tube
  - Advance ET through vocal cords under direct visualization as possible.

Confirmation of Intubation
(SOA P ME PPPE VS PP P***E*** P)

Confirmatory ***E*** vidence

- Confirm that trachea is intubated:
  - Rising O2 sat
  - Colorimetric CO_2 detector
  - $ETCO_2$ monitor
  - Esophageal detection bulb or syringe
  - Auscultation

Clinical Indicators of Tracheal Intubation

All of the following are potentially inaccurate.

- Observe for bilateral rise and fall of chest.
- Auscultate:
  - Bilateral lung air exchange
  - Absence of gastric bubbling/gurgling with ventilation
- Vapor condensation in ET
  - Improvement or maintenance of good O2 sat and cardiopulmonary signs
- Confirm ET depth at lip.

End-Tidal CO_2 Measurement

- "Best single means to confirm tracheal intubation"
- False readings possible:
  - CPR (poor pulmonary perfusion)
  - severe DKA (with marked hypocarbia):
  - severe asthma (poor gas movement):
    - PCO_2 may be low even though ET is in trachea.
  - Esophageal/gastric CO_2 production (false tracheal confirmation): Not likely, but possible.

Colorimetric CO_2 Detector

- A change from purple to yellow and vice versa with inhalation/exhalation confirms tracheal intubation.

Colorimetric CO_2 Detector

- Purple to **Y**ellow: **Y**ea ! Secure ET.
- Tan. Think about it.
  - Ventilate patient 6 more times and reassess clinically.
  - Consider alternative method of confirmation.
  - Attempt to correct cause of low perfusion or hypocarbia.

Colorimetric CO_2 Detector

Purple only:

- **P** urple = **P** roblem
- Patients WITH pulse:
  - Problem exists.
  - Tube is NOT correctly placed. Extubate and initiate BMV
- Patients WITHOUT pulse:
  - ET is NOT correctly placed,
  - or lungs not exhaling CO_2
  - Confirm tracheal intubation with alternative method such as direct laryngoscopy.

Pitfalls of CO_2 Detectors

- Use correct size:
  - Adult CO_2 colorimetric detectors can be used in infants as small as 2 kg
    - but must be removed because of the large dead space.
- Use correct duration:
  - If detector is in use for more than 15 min, vapor can cause detector to become wet and nonfunctional.
  - Not useful for long transports, unless detectors periodically replaced during transport.

Clinical Judgment

- NAEMSP position paper on Prehospital RSI http://www.naemsp.org/PositionPapers/prehospitalintubation.pdf
- 95.5% prehospital success rate (Wayne + Friedland; 1657 patients)
  - 2500 hr of formal paramedic education
  - 20 OR intubations
  - 4-12 intubations / year [paramedic JW : est. 20-24 / yr]
    - At least 1 of which is under anesthesiologist's supervision

Contraindications to Field RSI

- Absolute contraindications
  - Pin-in / entrapped patient with inadequate access to patient and airway;
  - unstable or dangerous environment
  - absence of qualified personnel or appropriate equipment
- Relative contraindications
  - patients with relative contraindications to the pharmacologic agents necessary to perform RSI
  - patients with evidence of difficult airway anatomy where RSI may not be appropriate, for example
    - stridor, severe facial trauma, small mouth, short neck, or morbid obesity ["BONES"]

Placement of Endotracheal Tube

- By direct orotracheal laryngoscopic visualization
- Nasotracheal approaches should not be used in RSI
- In general, each intubation attempt should cease after
  - ***45*** seconds or
  - if oxygen saturation drops below ***90%.***
- Efforts at RSI should cease and alternate airway methods pursued if
  - ET tube is not placed by the ***third*** attempt.

Summary

We have discussed :

- A review of the details of the RSI procedure
- RSI indications, contra indications, complications
- Alternative drugs for sedation and paralysis
  - The advantages and disadvantages of these agents
- The importance of basic Sellick and BVM techniques

FYI Addendum

- Esophageal Detector Bulb Method
- Permissive Hypercapnia
- Additional sedatives
  - Diazepam
  - Thiopental
  - Propofol
  - Fentanyl
- Peak CO2 ("end tidal") square wave

Esophageal Detector Bulb Method

- First , squeeze it flat.
- Attach it to ET, then release:
  - Rapid refill = Trachea
  - Slow refill = Esophagus
- Pitfalls:
  - Rapid refill can also occur if ET is too high (ie., in larynx).

Permissive Hypercapnia

- Often it is not possible or even desirable to achieve perfect ventilation in some patients with with respiratory failure.
  - asthmatics
- Aggressive attempt to ventilate may result in decreased venous retuirn and in pneumothorax (and tension pnthx).
- Permissive hypercapnia technique focuses primarily on oxygenation.
  - High PCO_2 levels can be tolerated, but hypoxia is not well tolerated
  - Maintaining oxygenation above 90% is focus.

Diazepam (Valium)

- Mechanism:
  - relaxation and sedation , only; i.e., no paralysis
  - onset: 1-3 min.
  - duration: short; lingering effect 4-6 hr
- Use:
  - for relaxation and sedation
- Dosage:
  - 2.5-15 mg IV (0.1 mg/kg)
- Adverse effects:
  - hypotension
  - respiratory depression

Thiopental

- Onset: 30 to 45 sec for loss of consciousness
- Duration: 10 to 30 min
- Dose: 3-5 mg/kg
- Benefits: Lowers ICP, lowers cerebral metabolism and oxygen demand, anticonvulsant
- Cautions:
  - ***Myocardial depression*** (slow adm. reduces this adverse effect.)
  - Avoid in hypotensive patient in
  - May cause laryngospasm and bronchospasm

Propofol

- Mechanism:
  - hypnotic agent
  - onset: less than 1min
  - duration: 10-20 min
- Use: sedation
- Benefits:
  - lowers ICP
  - consider in hypertensive crisis
- Dosage: 2-3 mg/kg
- Adverse effects:
  - poor choice in the patient with ***hypotension***

Fentanyl

- Mechanism:
  - opioid
  - onset: rapid onset of action
  - duration: 30-40 min*
- Use: sedation and pain-relief
- Dosage: 10 mic/kg
- Adverse effects:
  - chest wall rigidity (paralytic agents may correct problem)
  - increased ICP, and rare seizures
  - rebound (narcotic OD, hrs later)

$ETCO_2$ Monitor

- $ETCO_2$ monitor shows a square wave form.
- Peak PCO_2 occurs during end of exhalation cycle ("end tidal").

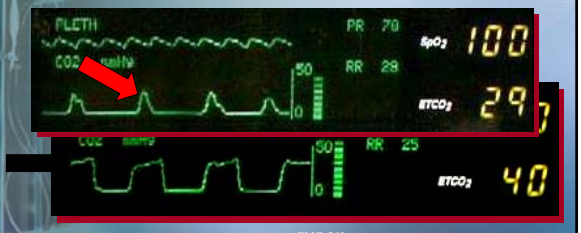
Normal (square) wave form confirms tracheal intubation.

$ETCO_2$ Monitor

- Square wave pattern = ET in trachea
- No square wave, two possibilities:
  - ET not in trachea: Extubate, BMV
    or
  - Lungs not exhaling CO_2
    - Severe air trapping (status asthmaticus)
    - Poor pulmonary perfusion (CPR)
  - Consider alternative means of confirming intubation, or extubate and initiate BMV if tracheal intubation cannot be confirmed.

$ETCO_2$ Monitor

- Top tracing shows abnormal $ETCO_2$ wave form (red arrow). : Esophageal intubation
- Compare this to normal $ETCO_2$ wave form below (yellow arrow), which confirms tracheal intubation.



Bye for now