Advanced Airway Management I: Rapid Sequence Intubation

SU-08

2 Hours

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The technique of rapid sequence intubation makes immediate airway control of the airway possible in often difficult clinical situations. This course will discuss the technique, indications and pitfalls of rapid sequence intubation in various emergency department scenarios. The approach is a practical one, with illustrative cases.

- Identify situations in which emergent intubation is necessary.

- Discuss the use of neuromuscular blocking agents.

- Explain the technique of rapid sequence intubation.
Course Overview

Introduction

Part 1 - Rapid Sequence Intubation - the technique

Definition
Indications
Contraindications

Review of the 7 Steps
1. Planning and Preparation
2. Pre-oxygenation
3. Pre-medication
4. Administration of Anesthesia and Paralysis
5. Laryngoscopy
6. Intubation and Confirmation of endotracheal tube placement
7. Post-procedure sedation and treatment

Part 2 - Abbreviated Pharmacology of RSI

Neuromuscular Blocking Agents (NMB)
- succinylcholine
- atracurium
- mivacurium
- pancuronium
- rocuronium
- vecuronium

Sedatives and Induction Agents
- Barbiturates
- Benzodiazepines
- Etomidate
- Propofol
- Ketamine

Part 3 - Case scenarios

Introduction

Each time we encounter a seriously ill or injured patient in the ED, we must ask the following:
1. Does this patient need airway intervention now?
2. Will this patient need airway intervention in the near future (i.e. while in my department or shortly thereafter) based on expected clinical course?
3. How long do I have to complete the procedure?

When we conclude that the patient does require ventilatory assistance, then we must quickly decide:
- What is my best approach to ventilatory assistance?
- What are my backup modalities if my first approach fails?
- Do I have the means and materials at the bedside for my primary and secondary approaches?

Over the past decade RSI has become both the mainstay and the standard of care in emergency department airway management due to the combination of a high success rate and low complication rate in skilled hands. The technique arose in part to address the problem of airway management for the patient who requires emergency surgery but has a full stomach. As such one of the more beneficial aspects of RSI is that when performed properly it can be used to prevent the aspiration of gastric contents in the critical ill patient.
Part I: Rapid Sequence Intubation - The Technique

**Definition**

The term Rapid Sequence Intubation (RSI) now commonly refers to a technique of orotracheal intubation shortly after the administration of an anesthetic agent and a muscle relaxant without using bag valve-mask (BVM) ventilation. This technique requires sufficient pre-oxygenation to allow several minutes of apnea prior to the development of arterial desaturation. In those instances where the patient’s underlying conditions, such as primary hypoventilation, morbid obesity, or lung disease, do not allow the patient to adequately preoxygenate with spontaneous respiratory efforts, then bag-valve-mask preoxygenation and ventilation is necessary prior to laryngoscopy. Modified RSI is standard RSI with the use of ventilatory support usually using BVM during the pre-oxygenation phase of the procedure. On rare occasion, some patients have such dangerously low levels of oxygenation that they require ventilatory assistance throughout. Though this is not RSI as defined, the principles are the same. In general we will refer to both RSI and modified RSI as one technique.

The RSI technique is divided into 7 discrete steps:

8. Planning and Preparation
9. Pre-oxygenation
10. Pre-medication
11. Administration of Anesthesia and Paralysis
12. Laryngoscopy
13. Intubation and Confirmation of endotracheal tube placement
14. Post-procedure sedation and treatment

**Indications for RSI**

The indications for RSI are the same as those for emergency endotracheal intubation. Indications for endotracheal intubation are generally:

1. Hypoxemia
2. Hypoventilation with respiratory acidosis
3. Protection of airway from aspiration of gastric contents
4. Protection of airway patency
5. Expected clinical course threatens oxygenation, ventilation, airway patency, or aspiration
6. Facilitate emergent special procedures e.g. CT scan

If the patient is not immediately moribund and there is time for a trial of medical intervention, such as bronchodilators in asthma, or noninvasive ventilatory support in COPD, then immediate intubation may be delayed until the clinical course is more evident.

Anticipated deterioration in patient’s clinical condition warrants emergency airway intervention. Endotracheal intubation in a controlled fashion results in significantly fewer complications (such as airway trauma, aspiration of gastric contents, or failed intubation) than the more hurried “crash” intubation.

**Contraindications**

There are no absolute contraindications to RSI.
The primary relative contraindications to routine RSI are:

1. Anticipated difficult airway
2. Anticipated inability to BVM ventilate

In the presence of each of these contraindications, the urgency of the clinical setting may warrant the use of RSI. Paralysis of the spontaneously breathing patient when you do not
expect to be able to ventilate with a BVM is extremely risky without special airway devices such as laryngeal mask airways (LMA), and surgical airway expertise (cricothyrotomy or tracheotomy) immediately available and reliable.
Remember the old axioms “Burn no bridges. Take nothing you cannot return or replace.”

**Step 1 - Planning and Preparation**

The first step in preparation for advanced airway intervention is planning which techniques you will use first, then planning what you will do when the first approach in unsuccessful. Carefully assess the patient for:

1. anatomic features or injuries which contribute to difficult laryngoscopy
2. anatomic features or injuries which may prevent effective BVM ventilation
3. adverse reactions to anesthetic agents
4. history of prior failed intubation attempts

Have the basic equipment available at the bedside with ready access to back-up equipment in the event of an unanticipated difficult intubation. A difficult airway cart at the bedside is ideal.

The patient should be placed on a cardiac monitor, continuous pulse oximetry, and BP monitor. The patient should have secure IV access. If concerned place a second IV catheter before administering any anesthetic agents.

You should always have the assistance of another pair of skilled hands!

**Basic Equipment for RSI**

1. Oxygen source and tubing
2. Self-inflating ventilation bag and valve
3. Non-rebreathing O2 face masks with reservoir for pre-oxygenation
4. Anesthesia masks for BVM ventilation – appropriate sizes at least 2
5. Assorted sizes of nasopharyngeal and oropharyngeal airways
6. Range of sizes of endotracheal tubes
7. Malleable stylet
8. Syringes 10 cc and needles
9. Lubricating jelly, 4 % lidocaine
10. Phentylephrine and 4% lidocaine solution with atomizer
11. Selected intravenous anesthetics and muscle relaxants
12. Suction apparatus with large rigid suction catheter (Yankauer or tonsil) attached
13. Magill forceps
14. All sizes of Miller and Macintosh blades with functioning light sources
15. Two functioning handles
16. Towels, foam pads, or rolled sheets for positioning patient’s head
17. Tape or other device for securing ET tube after intubation
18. Stethoscope
19. End tidal CO2 detector and/or esophageal detection device
20. Pulse oximeter and EKG monitor

**Positioning the patient**

The sniff position is the optimal head position for laryngoscopy. The sniff position requires approximately 35 degrees of neck flexion plus greater than 30 degree of extension of the head on the neck at the atlanto-occipital joint. Appropriate neck flexion is best achieved in the adult by elevating the head a few inches (10 cm.) with towels or other padding under the patient’s occiput prior to extending the head on the neck. Optimal direct visualization of the glottis is seen with marked (approximately 80 degrees) of head extension with the appropriate mild neck flexion.
In some patients, especially those who are extremely obese, towels must be placed under the shoulders, neck and head in order to obtain the appropriate sniff position. Young children, due to their relatively large head circumference, often have appropriate neck flexion without additional padding under their head. Though extremely important to optimize laryngoscopy, the sniff position is only appropriate in the setting of a known stable cervical spine.

Choosing a Laryngoscope blade

Advantages of a curved blade include less trauma to the epiglottis and less reflex airway reactivity which results from lifting the epiglottis directly. The straight blade allows better visualization in the setting of an anterior larynx or a long floppy epiglottis. A straight blade is preferable in infants, young pediatric patients, and patients with an anterior larynx.

Step 2. - Preoxygenation

A fundamental component of RSI is that the patient is apneic and not actively ventilated from the time the anesthetic or muscle relaxant takes effect until the patient is successfully intubated and ventilated through the endotracheal tube. During this period of apnea the patient utilizes the residual air in his lungs to maintain arterial oxygen concentration. The goal of preoxygenation is to maximize the oxygen concentration in the patient’s lungs and body tissues prior to inducing apnea.

A patient spontaneously breathing 100% oxygen by facemask will reach maximal intrapulmonary oxygen concentrations in 1 – 4 minutes. If the patient is breathing rapidly and deeply, i.e. high rate with high tidal volumes, then preoxygenation requires only 30 – 60 seconds. If respirations are slow and/or shallow then preoxygenation may require up to 4 minutes. Note that the non-rebreathing mask usually available in our emergency departments does not provide the same seal as an appropriately tight fitting anesthesia face mask. As a result, our patients do not receive more like 75% rather than 100% FIO2. This results in a shorter safe apneic interval.

In some instances, the patient’s ventilatory effort is inadequate to preoxygenate the patient. In this case, the RSI technique is “modified” to preoxygenate the patient using BVM ventilation with 100% O2. Adequate preoxygenation with positive pressure ventilation in this fashion requires only 4-5 maximal breaths in normal patients. It is important to apply Sellick’s maneuver of cricoid pressure during any BVM ventilation to minimize gastric distention and regurgitation.

The time required for oxygen saturation to decrease to 90% following maximal preoxygenation in normal patients with normal body habitus is approximately 6 minutes. In the obese, this time decreases to 4 minutes. In the morbidly obese, this time is under 3 minutes. The time to arterial O2 desaturation can be nearly doubled by using nasopharyngeal airway to deliver 3 L/min of oxygen to the oropharynx during this apneic interval. Remember that even while maintaining an adequate pO2, the arterial pCO2 continues to rise throughout the apneic period.

Step 3. Premedication

There are several medications that may be used prior to the administration of the induction and paralytic agents in RSI. With the exception of atropine in the pediatric patient, these agents are elective refinements in the RSI technique. The premedications address several different aspects of the physiology of RSI. The antisialogues improve visualization by decreasing oral secretions. Other agents are used to blunt the sympathetic responses to
laryngoscopy and intubation. While “defasciculating doses” of neuromuscular blocking agents were initially explored to reduce postoperative muscular soreness (an issue that we rarely have the luxury to consider), they are now also suggested to blunt potentially harmful spikes in intraocular, intracranial, and intragastric pressures associated with succinylcholine.

The downside of the use of premedications in general is that they add complexity to the procedure and consume valuable time and resources. Particularly important is the time required, usually of the nursing staff, to obtain, prepare and administer the agents. In many circumstances in the ED this time is better spent attending to more essential items.

Depending on the agent, these medications are administered IM or IV during the approximately 2-5 minutes prior to the administration of the anesthetic and paralytic agents. This usually coincides with the preoxygenation period above.

The principal premedications considered in emergency airway management are:

1. Atropine
2. Lidocaine
3. Glycopyrrolate (Robinul) – antisialogue with minimal CNS effects
4. Defasciculating agent – usually a low dose of a non-depolarizing muscle relaxant
5. Opioids – especially fentanyl or sufentanyl
6. Non-narcotic Sedatives – especially benzodiazepines, droperidol, ketamine
7. Vasoconstrictors – especially phenylephrine (Neosynephrine) and oxymetazoline (Afrin)

**Step 4. Administration of Anesthetic and Muscle Relaxant**

As a general rule – *Never be paralyze a patient while they are aware and able to remember.*

As a result a general anesthetic agent should be given to every patient who is given neuromuscular blockade. In most circumstances the induction agent should be give first, with the paralytic shortly afterwards.

The use of neuromuscular blockade (NMB) is central to the technique of RSI. It is the NMB that eliminates the active forceful regurgitation of gastric contents during laryngoscopy. It is also the NMB that relaxes the muscles of mastication. This permits the easy distraction of the mandible and tongue by the laryngoscope thereby better exposing the glottis.

The downsides of NMB, independent of the agent used are:

1. Apnea
2. The tongue, mandible and oropharyngeal soft tissues then collapse into the airway losing the natural anatomic contours and relationship as well as obstructing BVM ventilation.

The anesthetic serves primarily to spare the patient the torture of awake paralysis. The anesthetic agents commonly used vary in considerably in their relative analgesic and amnestic properties as well as in their impact on visceral reflexes, intracranial pressure, and systemic arterial pressure.

**Selection of Agents**

The selection of an anesthetic agent and muscle relaxant can be a complex process. In general, the choice of anesthetic and relaxant agents should be based on the clinical status of the patient and your familiarity with the agents you choose. A more detailed discussion of the more common agents may be found below. Usually simple is better when lives are at stake.

The 5 major clinical parameters that should influence your decision in a particular patient are...
1. hemodynamic stability and the risk of hypotension  
2. respiratory drive and the risk of additional respiratory depression  
3. intracranial pressure and cerebral perfusion  
4. the presence of ischemic heart disease  
5. the rapidity of effect of your agents

The anesthetic agents differ widely in their speed of effect, tendency to produce hypotension and respiratory depression. All agents have the potential to depress central sympathetic outflow and as a result produce hypotension. The induction agents differ in their tendency to induce histamine release, cause direct myocardial depression and produce vasodilation. All of these are factors that produce a hypotensive effect.

Less prominent concerns that influence the choice of induction agents are the amnestic properties, emetic properties, desired duration of effect, ability to titrate to desired effect.

The principle decision in selecting a muscle relaxant rests on the relative risk of depolarizing neuromuscular blockade balanced against the slower onset of effect and longer duration of action of the non-depolarizing neuromuscular blocking agents.

Timing of Administration

This is a surprisingly controversial aspect of the technique. The governing principal is that the general anesthetic you choose should have time to take effect prior to the onset of paralysis.

The optimal timing then depends on the speed of onset of your induction agent as compared to that of your paralytic agent. If your induction agent acts much faster than your NMB then you may reasonably give the paralytic first. For example, if you choose thiopental as your induction agent, it has a very rapid onset of action of essentially one circulation time (i.e. a few seconds). You can push thiopental immediately after your succinylcholine, the most rapid onset of the paralytics, and your patient will almost never know what happened. Most of the other induction agents are slower in effect than succinylcholine and as such should be administered prior to the succinylcholine.

The risk of administration of the induction agent first is that in the event of significant respiratory depression or apnea, you lose a portion of your safe apneic interval for laryngoscopy while you wait for your paralytic to provide take effect. This concern becomes much more significant when you choose to use a slower acting paralytic such vecuronium at 0.1 mg./kg.

Sellick’s Maneuver

Application of cricoid pressure, Sellick’s maneuver, is an essential component of safe RSI technique. Place the index finger over the cricoid while placing the thumb and long finger on either side of the trachea. The thumb and long finger stabilize the cricoid while the index finger provides gentle posterior pressure. Cricoid pressure should be maintained without interruption from the time of anesthetic administration until completion of endotracheal intubation and inflation of the cuff. Do not use excessive force as you may obstruct the airway and prevent passage of the endotracheal tube.

Sellick’s maneuver should also be used any time that the patient requires BVM ventilation during the procedure. If you are using Sellick’s maneuver prior to NMB, remember that should the patient actively regurgitate you should not try to prevent active emesis with cricoid pressure. Release the cricoid pressure and promptly role the patient on his/her side for suctioning before proceding with your procedure.
Depressed Sensorium

Often the patient who requires RSI has a depressed sensorium due to their illness, shock, or medications. The decision to use an induction agent must rest in part on your assessment of whether there is any chance that the patient may be aware, the risks of the agents in that setting, and on consideration of the other effects of the anesthetic agents such as blunting of reflexes.

One option is to reduce the dose of anesthetic agents. This takes advantage of the fact that the factors that depress the sensorium are additive and that it requires less medication to achieve comparable anesthetic effect.

Remember however that the patient who is initially unaware, (such as the patient with status seizures) may recover after control of their presenting problem. They would then awaken to their paralyzed state.

Intubating Conditions

The patient is ready for intubation when the patient is apneic, unresponsive, and the jaw is fully relaxed and easily mobile. When using succinylcholine, this follows the apparent fasciculations and usually requires approximately 45 seconds. Use a stopwatch. Do not attempt to intubate under suboptimal conditions of incomplete muscular relaxation.

Step 5 Laryngoscopy

The laryngoscope is held in the left hand. The right hand is initially used to either open the mouth using a scissor technique between the right molars of the anesthetized patient or to further extend the head by placing the hand on the vertex of the head and providing downward pressure.

The laryngoscope is then gradually advanced under direct visualization beginning on the right side of the mouth pushing the tongue to the left until the epiglottis is identified. A curved blade (e.g. Macintosh blade) is then slipped into the anterior vallecula and lifted forward at a 45 degree angle thereby distracting the mandible and lifting the epiglottis. A straight blade (e.g. Miller blade) is place just below the tip of the epiglottis. The epiglottis is then lifted directly using a similar upward forward motion as with the curved blade exposing the glottis.

Once you have exposed the glottis and can readily identify the arytenoid cartilage and the vocal cords below the elevated epiglottis, you are ready to pass the endotracheal tube.

A Few Pitfalls

Be aware of several pitfalls in technique that may render the intubation more difficult:
1. Avoid pushing the laryngoscope blade too far into the oropharynx as it may engage the vallecula and force the epiglottis downward over the glottis.
2. Avoid getting too close to the patients mouth while performing laryngoscopy. Your eyes should be at least 8 inches from the patients mouth to allow you to use both eyes hence maintaining stereoscopic vision
3. Avoid rocking the laryngoscope backwards to lift the epiglottis. This maneuver risks fracturing the teeth and actually pulls the tongue and mandible toward your line of sight rather than upward, forward and out of your line of sight.
4. Avoid hurrying. Use the safe apneic interval to allow yourself the opportunity to clearly identify the anatomy and to solve the any problem of axis alignment or anatomic distortion.

External Laryngeal Manipulation
External laryngeal manipulation often improves visualization of the glottis. This should be a reflex technique when visualization of the airway is difficult and can convert a Grade 3 view to a Grade 1 view of the glottis. This is performed while elevating the tongue and mandible with the laryngoscope. The laryngoscopist then grips the thyroid cartilage using the thumb and first 2 fingers of the right hand and maneuvers the glottis into the field of view. Though the thyroid cartilage is usually the best place to start, similar technique applied to the cricoid level then the hyoid level may provide better glottic exposure. The BURP (backward upward rightward pressure) maneuver is one approach to external laryngeal manipulation which addresses the most common problem of an anterior glottis.

**Step 6  Intubation and Confirmation**

When the glottis is clearly exposed, use the right hand to guide the styletted endotracheal tube from the right side of the mouth through the cords.

The average adult woman usually tolerates a 7.0 – 8.0 mm. internal diameter endotracheal tube while the average adult man tolerates a 7.5 - 8.5 mm. internal diameter endotracheal tube.

Confirmation of endotracheal tube placement

The two most reliable techniques to confirm successful endotracheal tube placement are:

1. End tidal CO2 (EtCO2) detection
2. Visual fiberoptic identification of tracheal rings through the endotracheal tube

The self-inflating bulb type and the aspiration syringe type of esophageal detector devices have been shown to be highly reliable in the OR setting, however some recent reports have questioned their reliability in less controlled settings.

The absence of detectable end tidal CO2 may occur in the following settings:

1. Esophageal placement of the endotracheal tube
2. Complete circulatory arrest. In the setting of cardiac arrest, approximately 30% of patients may have no detectable EtCO2 using the disposable detector devices with the ET tube correctly placed in the trachea.
3. Severe bronchospasm
4. Complete plugging or kinking of the endotracheal tube

*When in doubt, take it out.*

If there is no detectable EtCO2, then the best clinical course is usually immediate reintubation except in the setting of cardiac arrest or the extremely difficult intubation. In the latter settings, the use of other signs or an esophageal detector device may be helpful to further assess tube position.

Arterial oxygen desaturation measured by pulse oximetry may be delayed up to 10 minutes in the fully preoxygenated patient. It is more desirable to identify inadvertent esophageal placement prior to significant arterial desaturation, allowing time to place the tube correctly.

Other signs used to confirm endotracheal tube placement include symmetric breath sounds, tube misting which appears on exhalation and disappears on inhalation, absence of breath sounds over the stomach, chest rise and fall. These signs are not fully reliable and may be present with esophageal placement.
The use of EtCO2 is becoming the standard of care for confirmation of endotracheal tube placement and should be routinely used and documented.

The last step prior to taping the ET tube into position is to confirm that the tube is above the carina. The endotracheal tube should be inserted to a depth of 21 cm. In adult women and 23 cm. in adult men as measured at the lower teeth. This depth provides an adequately secure ET tube while avoiding intubation of a mainstem bronchus. Symmetric breath sounds with ventilation and chest x-ray are also helpful.

Step 7 Post-Intubation Management and Stabilization

Following intubation the tube should be firmly secured with tape. A bite block or oral airway should be placed between the teeth to prevent the patient from biting the tube. The oropharynx should be suctioned.

The patient should be sedated and probably restrained using soft wrist restraints to avoid self-extubation during emergence from anesthesia. Continuous paralysis is probably undesirable once necessary procedures are complete.
Part II  Abbreviated Pharmacology of Rapid Sequence Intubation

Neuromuscular Blocking Agents (NMB)- Two classes:

Non-competitive, depolarizing NMB:
  succinylcholine

Competitive, non-depolarizing NMB:
  aminosteroids:
    atracurium
    mivacurium
  benzylisoquinilines
    pancuronium
    rocuronium
    vecuronium

The characteristics of the ideal NMBA would be:
  rapid onset
  short duration
  no adverse effects
  metabolized outside of liver or kidney

Succinylcholine

Mechanism:
  Stimulates muscarinic and nicotinic ACh receptors;
  Depolarizing neuromuscular blocker;

Metabolism:
  plasma pseudocholinesterase outside NMJ;
  only a fraction of IV dose reaches NMJ, so overdose, don’t underdose.

Dose:
  Adults: 1.5mg/kg IV or 3mg/kg IM
  Children: 2-3 mg/kg IV

Onset of action:
  fasciculations: 15 sec
  paralysis: 45-60 sec

Duration of action: 5-10 minutes

Adverse effects:
  fasciculations
  hyperkalemia
  bradycardia
  prolonged NM blockade
  malignant hyperthermia
  trismus-masseter muscle spasm

Succinylcholine Adverse Effects

Fasciculations:
  Cause: stimulation of nicotinic ACh receptors
  Effects: increased ICP, IGP, IOP, myalgias
  Treatment: Pretreat with defasiculating dose
  10% of paralyzing dose of competitive, non-depolarizing agent is adequate;
  Be prepared to intubate!

Hyperkalemia
  Cause: Binding of extrajunctional ACh receptors, especially in conditions of increased
density and sensitivity (burns, crush, denervation, neuromuscular disorders, intra-
abdominal infection.
  Effects: Increased potassium 0.5-10 mEq/L.
  Treatment: Absolute contraindications!!
Bradycardia
Causes: heightened vagotonic state in children or in adults receiving multiple doses.
Treatment:
- Pretreatment of children less than 10 years with atropine 0.02 mg/kg.
- Keep atropine on hand for adults.

Prolonged NM Blockade
Cause: congenital absence or abnormality of pseudocholine esterase, or acquired deficiency of pseudocholine esterase.
Effects:
- Acquired: 20-30 minutes
- Congenital: up to 3 hours
Treatment: Supportive.

Acquired plasma pseudocholinesterase deficiency:
- Organophosphate/cocaine toxicity
- Chronic disease: malignancy, CRF, liver disease, hypothyroidism, pregnancy, malnutrition
- Medications: cytotoxic drugs, metoclopramide, bambuterol.

Malignant Hyperthermia
Cause: genetic skeletal membrane abnormality (halogenated anesthetics, SUX, vigorous exercise, anxiety)
Effect: Mortality is 60%.
Muscular rigidity, hypoxia, hypotension, lactic acidosis, hyperkalemia, myoglobinemia, DIC, hyperthermia, masseter spasm
Treatment:
- Remove known or suspected precipitant
dantrolene 2.5 mg/kg IV every 5 minutes until muscles relax or you reach 10 mg/kg.

Trismus-Masseter muscle spasm:
Causes: succinylcholine causes mild increase in masseter tone.
Effects: Masseter spasm sometimes occurs, especially in children. If other muscles become involved, consider malignant hyperthermia.
Treatment: Usually, none is necessary.

Succinylcholine: Contraindications
Absolute
- Personal or family history of malignant hyperthermia
- Burns: 3d-1 year
- Crush: 7d - 90d
- Denervation or NM disease: 7d-
- Intraabdominal infections > 7d
Relative
difficult intubation or inability to BVM

Competitive Non-depolarizing Agents
Mechanism:
- Competitive inhibitor of ACh at NMJ.
two groups:
  - Benzylisoquiniline (atracurium, mivacurium)
  - Aminosteroids (pancuronium, rocuronium, vecuronium)
Indications:
- When succinylcholine is contraindicated;
- Post-intubation management;
- Defascication prior to succinylcholine.
Aminosteroid group does not cause histamine release.
Of aminosteroid group, pancuronium causes tachycardia.
All are less desirable than succinylcholine because of the onset and duration of action.
**Sedatives and Induction Agents**

- **Barbiturates**
  - Thiopental, methohexital.
  - Mechanism: enhances and mimics GABA.
  - Pharmacology: rapid onset, short duration
  - Adverse effects: significant, with venodilation and myocardial depression predominating (may cause hypotension, especially in hypovolemic patients).

- **Benzodiazepines**
  - Midazolam
    - Mechanism: GABA-ergic
    - Pharmacology: midazolam has most rapid onset (30-60 sec) and shortest duration (minutes), because of its high lipid solubility and rapid redistribution.
    - Dosage: 0.1-0.3 mg/kg IV
    - Adverse effects: reduces SVR; myocardial depressant.

- **Etomidate**
  - Mechanism: hypnotic imidazole derivative, most hemodynamically stable hypnotic.
  - Cerebroprotective.
  - Pharmacology: rapid onset (20-30 sec) and short duration (7-14 min).
  - Dose: 0.2-0.3 mg/kg IV
  - Adverse Effects:
    - myoclonus on induction;
    - nausea/vomiting on emergence;
    - blocks serum cortisol and aldosterone.

- **Propofol**
  - Mechanism: phenol derivative with hypnotic properties, attenuates rise in ICP, but reduces CPP.
  - Pharmacology: highly lipid soluble, rapid onset (seconds), short duration (minutes).
  - Dose: 0.5-1.2 mg/kg IV.
  - Maintenance infusion: 5 – 30 micrograms/kg./min or 0.3 – 2.0 mg/kg/hr

- **Ketamine**
  - Mechanism: PCP derivative causing amnesia, anesthesia, and analgesia.
  - Pharmacology: rapid onset (15-30 sec) and short duration (10-15 minutes)
  - Dose: 1-2 mg/kg IV or 4-6 mg/kg IM
  - Stimulating Effects:
    - increase in laryngeal reflexes
    - increase in pharyngeal and bronchial secretions
    - susceptibility to laryngospasm
    - catecholamine release (BP, HR)
    - myocardial depressant
    - increase in cerebral cortical activity
    - relaxes bronchial smooth muscle making it the agent of choice in asthma.
Drugs Used in Pre-Medication Phase of RSI

**Purpose:**
Attenuate the normal physiologic and pathophysiologic reflex responses from airway manipulationphysical presence of the endotracheal tube
Increased ICP, HR, BP, and airway resistance.

**Goal:**
Achieve peak drug effect at the precise time the patient is undergoing laryngoscopy.

**Lidocaine**
Mechanism: suppresses cough reflex and attenuates airway resistance.
Recommended: all patients with reactive airway disease or increased intracranial pressure
Dose: 1.5 mg/kg IV three minutes prior.

**Opioids**
Fentanyl has rapid onset and short duration.
Mechanism: attenuates reflex sympathetic activity during intubation
Recommended: increased ICP, ischemic heart disease or pulmonary edema (without cardiogenic shock), and vascular catastrophes.
Dose: 3 ug/kg three minutes prior

**Defasciculating Agents**
Non-depolarizing, competitive NMBA
Mechanism: blocks fasciculations,
Recommendation: increased intracranial pressure.
Dose: 10% of usual paralyzing dose. Be ready to intubate.

**Part III - Case Studies**

**Case 1  Acute CHF**
HPI: 64 year old man developed the sudden onset of shortness of breath which woke him from sleep 1 hour ago. He had chest tightness for 30 minutes which resolved en route.
PMH: hypertension on a thiazide, elevated cholesterol taking a "statin"
BP = 148/72  P = 126  R = 36  O2sat = 86% on partial non-rebreather mask
EKG shows sinus tachycardia with nonspecific anterior ST changes

**Case 2 - Hypertension and AMS**
HPI - 35 yo woman found by husband lying in living room floor. Unable to follow commands.
Left sided weakness noted by EMS.
PMH: hypertension - out of medications
BP = 212 /143  P = 110  R = 8  snoring respirations  O2sat = 89% on 4L nasal O2
EKG - sinus tachycardia, LVH
Case 3 - Acute Angioedema
HPI: 67 yo woman noted rapid development of itching and facial swelling
PMH: hysterectomy, asthma on no medications
BP = 128 / 52    P = 128   R = 26   slight stridor    RA O2 sat = 96%
EKG - sinus tachycardia

Case 4 - Status Asthma
HPI: 20 yo college student noted rapidly worsening wheezing and SOB over the past 6 hours
PMH: asthma  Meds: Serevent, albuterol, triamcinolone MDI,s
BP = 117 / 63    P = 144   R = 32  labored   RA O2 sat 90 %

Case 5 - Massive UGI bleed
54 yo Coke executive became suddenly weak diaphoretic during meeting.  No chest pain.  Mild SOB. EMS called. Vomits bright red blood en route.
PMH - none   SHx - distance runner
BP -  92 / 74  P = 64   R = 10   RA O2 sat 84%
EKG - sinus rhythm

Case 6 - COPD with pneumonia
76 yo with 3 days of progressive SOB, fever, productive cough, lethargy
PMH - lymphoma, spinal cord compression with completeT10 level 3 mos ago undergoing radiation, HTN, COPD
BP = 134 / 86    P = 132   R = 36   O2 sat 85% on partial non-rebreather mask
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Preoxygenation


Sellick’s Maneuver


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Intubation and Confirmation

Advanced Airway Management I
Rapid Sequence Intubation

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Objectives
- Identify situation in which emergent intubation is necessary
- Discuss the use of neuromuscular blocking agents
- Explain the technique of rapid sequence intubation

Course Overview
- Introduction
- Part 1 - Rapid Sequence Intubation - the technique
- Part 2 - Abbreviated Pharmacology of RSI
- Part 3 - Case scenarios

Indications for Intubation and RSI
- Hypoxemia
  - \( \text{PaO}_2 \) < 60 with \( \text{FiO}_2 \) > 0.5
- Hypoventilation
- Protection of airway from aspiration of gastric contents
- Protection of airway patency
- Expected clinical course threatens
- Facilitate emergent special procedures

Indications for Intubation
- Hypoxemia
- Hypoventilation
- Protection of airway from aspiration of gastric contents
- Protection of airway patency
- Expected clinical course threatens
- Facilitate emergent special procedures

Indications for Endotracheal Intubation and RSI
- Hypoxemia
- Hypoventilation
- Protection of airway from aspiration of gastric contents
- Protection of airway patency
- Expected clinical course threatens
- Facilitate emergent special procedures

RSI technique - 7 steps:
- Planning and Preparation
- Pre-oxygenation
- Pre-medication
- Administration of Anesthesia and Paralysis
- Laryngoscopy
- Intubation and Confirmation
- Post-procedure sedation and treatment
Each time we see a seriously ill or injured patient in the ED . . .

We must ask

1. Does this patient need ET intubation now?
2. Will this patient need ET intubation in the near future?
3. How long do I have to complete the procedure?

When we conclude that the patient needs urgent ET intubation ...

We must ask

- What is my best approach?
- What will I do if my first approach fails?
- Do I have the means and materials at the bedside for both?

Airway Protection
- Patent airway is essential to adequate oxygenation and ventilation
- Airway patency does not necessarily protect from aspiration
- Artificial airways are temporizing

Ventilation and Oxygenation
- Oxygenation of vital organs is the primary
- Maintenance of pO2 > 60 - essential for cellular metabolism
- Ventilation and CO₂ disposal - is essential for acid base balance
- Enzymatic activity fails with pH < 7.1
What is the expected clinical course?

Clinical Course

- Consider future airway difficulty
  - Trauma patients
  - Hypotensive patients
  - Angioedema
  - Pneumonia
- Consider special studies to be performed
- Ultimate patient destination

Rapid Sequence Intubation - RSI

- A technique of orotracheal intubation
- Shortly after the rapid administration of an anesthetic agent and a muscle relaxant
- Without using bag valve-mask (BVM) ventilation

Rapid Sequence Intubation - RSI

- This method of intubation assumes a full stomach
- Provides optimal protection against aspiration of gastric contents
- Requires adequate preoxygenation

Modified RSI

- When spontaneous respiration fails to provide adequate preoxygenation
- Clinical settings include
  - Drug overdose
  - Pneumonia
  - Myasthenia gravis
  - Fatiguing COPD

Modified RSI

- Utilizes bag-valve-mask ventilation for optimal preoxygenation
- Allows an adequate safe apneic interval for laryngoscopy
- Requires Sellick’s maneuver during BVM ventilation
**Rapid Sequence Intubation**

**Contraindications**
- There are no absolute contraindications to RSI
- Relative contraindications
  - A potentially difficult intubation
  - **Anticipated difficulty with BVM ventilation**
  - Require a careful pre-intubation plan

**RSI - Planning**
- Anatomic features or injuries which contribute to difficult laryngoscopy
- Anatomic features or injuries which may prevent effective BVM ventilation
- Prior adverse reactions to anesthetic agents
- History of prior failed intubation attempts

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**Rapid Sequence Intubation**

**Complications**
- 219 intubations with RSI protocol by emergency physicians
- Complications
  - 24 hypotension
  - 3 pulmonary aspiration
  - 3 bradycardia
  - 2 ventricular bigeminy
  - 1 acute mortality
- All patients successfully intubated

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**Burn no bridges**

Take nothing you cannot return or replace

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**Rapid Sequence Intubation**

**Complications**
- Emergency Physicians
- 119 intubations
- Complications
  - 2 bradycardia
  - 1 ventricular tachycardia
  - 4 ventricular arrhythmias
  - 4 failed intubations

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**Rapid Sequence Intubation**

**Complications**
- Trauma patients
- Anesthesiologists or nurse anesth.
- 97% performed in the ED
- 97.4% successfully intubated
- 1(0.4%) aspirated
- No other documented complications
### Preparation
- Obtain assistance - a second pair of hands
- Organize all necessary equipment at bedside
- Intravenous access, two lines preferable
- Position patient

### Sniff Position
- Requires approximately 35 degrees of neck flexion
  - 10 cm. of padding under adult head
  - plus marked extension of the head on the neck at the atlanto-occipital joint
  - optimal alignment of laryngoscopic axes

### Difficult Airway
- Expected difficulties
  - Swollen tissues secondary to inflammation, edema, hematoma, tumor
  - Swollen epiglottis, abscess
  - Macroglossia
  - Distorted anatomy secondary to inflammation, laryngeal trauma, bleeding, hematoma

### External Features to Predict Difficult Airway
- **Mallampati**
  - I - See pillars, soft palate and uvula
  - II - see pillars, palate, uvula is masked by the tongue
  - III - only soft palate
  - Limited value when used alone

### Wilson Criteria
- Laryngeal exposure with a macintosh blade
  - Grade I - full exposure
  - Grade II - 1/2 cords
  - Grade III - only arytenoids
  - Grade IV - only epiglottis
  - Grade V - inability to expose epiglottis

### External Features to Predict Difficult Airway
- **Thyromental Distance**
  - <6.5 correlated with mallampati III
- **Interincisor Distance**
- **Atlanto-occipital mobility**
- **Overbite**
- **Anteriorly tilted larynx**
**Preoxygenation**
- Provides washout of normal nitrogen reservoir in the lungs
- Saturates body tissues
- Requires 4-5 minutes of 100% oxygen at normal tidal volumes
- 4 - 5 vital capacity breaths

**Safe apneic interval**
- Time required for oxygen saturation to decrease to 90%
- Following maximal preoxygenation
  - In normal nonobese patients ~ 6 minutes
  - In the obese ~ 4 minutes
  - In the morbidly obese < 3 minutes

**Safe apneic interval**
- Nearly doubled with O2 insufflation
  - 3 L / min of O2 through soft nasopharyngeal airway
- Arterial pCO2 continues to rise during apneic interval

**Premedication - goals**
- Blunt adverse effects of laryngoscopy and ET intubation
  - Bronchospasm and laryngospasm
  - Increased ICP
  - Tachycardia and increased BP
- Improve laryngoscopic conditions
- Prevent complications of other agents

**Premedication - common agents**
- Atropine
- Lidocaine
- Opioids - esp fentanyl
- Non-narcotic sedatives - esp midazolam
- Defasciculating dose of non-depolarizing NMB
- Antisialogues

**Premedications - downside**
- Add complexity
- Consume time and manpower
- Benefits difficult to prove
- Exception
  - Atropine in the pediatric patient
**Induction and Paralysis**

- Rapidly acting induction agent is given in conjunction with a neuromuscular blocking agent.
- Timing depends on agents chosen.
- Always apply Sellick’s maneuver as patient is losing consciousness.
- Maintain Sellick’s maneuver until ET tube cuff inflated.

**Intubation - technique**

- Select appropriate ET tube
  - Adult women = 7.0 - 8.0 mm.
  - Adult men = 7.5 - 8.5 mm.
  - Pediatric = (age in yrs. + 16)/4
- Use stylet
- Curve tube or bend as hockey stick.

**Intubation - technique**

- Insert tube from right side of mouth
- Insert to proper depth
  - Adult women = 21 cm.
  - Adult men = 23 cm.
  - Measure to lower incisors
- Inflate cuff and confirm placement.

**Confirming of ET placement**

- Best bets
  - Fiberoptic visualization of tracheal rings through the tube
  - EtCO2 detection
- Second line signs
  - Tube misting
  - Breath sounds

**End tidal CO2 detection**

- Becoming standard of care
- Detects esophageal intubation
- False negative (no CO2 but tube in trachea)
  - Circulatory arrest
  - Severe bronchospasm
  - Mucous plug or kinking of tube

**External Laryngeal Manipulation**

- While lifting epiglottis with laryngoscope
- Performed with right hand
  - Grasp thyroid cartilage
  - Initially apply BURP (backwards upwards rightward pressure)
  - Bring glottis into view
- Can markedly improve laryngoscopic view
**Sellick's maneuver**

- **essential**
- reduces gastric insufflation during BVM ventilation
- prevents passive regurgitation of gastric contents
- requires light pressure
- too much force may obstruct airway and prevent intubation

**Laryngoscopy - technique**

- **Left hand**
  - holds and slowly advances laryngoscope
  - blade sweeps tongue from right to left
  - elevating epiglottis to identify cords
- **Right hand**
  - opens mouth then extends head
  - optimizes sniff position

**Laryngoscopy - pitfalls**

- pushing the laryngoscope blade too far
  - folds epiglottis down onto glottis
- getting too close to the patients mouth
  - loss of stereoscopic vision
- rocking the laryngoscope backwards to lift the epiglottis
  - breaks teeth and obscures view
- hurrying

**Post-intubation Sedation/Analgesia**

- **Benzodiazepines**
  - midazolam - begin 2 - 4 mg./hr. & titrate to effect
- **Narcotics**
- **Propofol**
  - Infusion: 5 - 30 micrograms/ kg./min. or 0.3 - 2.0 mg./kg./hr.
  - titrate to effect

**Comparison of Intubation Techniques**

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**Case 1 - Acute CHF**

- 64 yo man with the sudden onset of SOB which woke him from sleep 1 hour ago. Arrived by private car.
- **PMH**: hypertension on a thiazide, elevated cholesterol taking a statin
- **BP**: 116/92  P = 126  R = 36  O2sat = 86% on partial non-rebreather mask
- **EKG**: sinus tachycardia with 2 mm. anterior ST depression
Case 2 - Hypertension and AMS

- 35 yo woman found by husband lying in living room floor. Unable to follow commands. Left sided weakness noted by EMS.
- PMH: hypertension - out of medications
- BP = 212 / 143  P = 110  R = 8  snoring respirations  O2 sat = 89% on 4L nasal O2
- EKG - sinus tachycardia, LVH

Case 3 - Acute Angioedema

- 67 yo woman noted rapid development of itching and facial swelling
- PMH: hysterectomy, asthma on no medications
- BP = 128 / 52  P = 128  R = 26  slight stridor  RA O2 sat = 96%
- EKG - sinus tachycardia

Case 4 - Status Asthma

- 20 yo college student noted rapidly worsening wheezing and SOB over the past 6 hours
- PMH: asthma  Meds: Serevent, albuterol, triamcinolone MDI,s
- BP = 117 / 63  P = 144  R = 32  labored RA O2 sat 90%

Case 5 - Massive UGI bleed

- 54 yo Coke executive became suddenly weak diaphoretic during meeting. No chest pain. Mild SOB. EMS called. Vomits bright red blood en route.
- PMH - none  SHx - distance runner
- BP = 92 / 74  P = 64  R = 10  RA O2 sat 84%
- EKG - sinus rhythm

Case 6 - COPD with pneumonia

- 76 yo with 3 days of progressive SOB, fever, productive cough, lethargy
- PMH: lymphoma, spinal cord compression with complete T10 level 3 mos ago undergoing radiation, HTN, COPD
- BP = 134 / 86  P = 132  R = 36  O2 sat 85% on partial non-rebreather mask