EMS Subspecialty Certification Review Course

1.1.2 Airway Compromise / Respiratory Failure
   - 1.1.2.1 Devices for securing airway
   - 1.1.2.2 Portable ventilator management
   - 1.1.2.3 Pros and cons of drug-assisted intubation
   - 1.1.2.4 Tracheotomy complications

Learning Objectives

Upon the completion of this program participants will be able to:

• Describe basic categories of device to secure airway
• Provide initial ventilator settings for the uncomplicated patient
• Highlight pros and cons of drug-assisted intubation
• List 3 major tracheotomy complications

Which of the following is NOT a key advantage to supraglottic airways?

a) Blind insertion
b) Often results in tracheal intubation
c) Skill retention tends to be longer than endotracheal intubation techniques
d) Skill can be used in varying levels of certification/practice
Learning Objectives
Upon the completion of this program participants will be able to:
• Describe the airway methods used in EMS
• Describe the pros and cons of different airway methods
• Define the role of drug facilitated intubations
• Speak to the use of non-invasive ventilation
• Summarize the controversies in airway methods

Airway Compromise / Respiratory Failure
• Goals:
  — Recognize severity of disease
  — Provisional diagnosis to guide course of treatment

There are two major goals in assessing airway compromise or respiratory failure:
First, the severity of the disease prioritizes urgency.
Second, provisional diagnosis guides therapy. Coming up with a correct diagnosis in the field can be difficult. Discerning between COPD exacerbation, pneumonia, pleural effusion, pneumothorax, congestive heart failure or pulmonary edema of other cause is helpful to direct therapy.

Studies have shown that paramedic provisional diagnosis agrees with emergency physician 81% of the time, so remembering that 1/5 times the medic will come to a different clinical conclusion than the physician makes constructing protocols properly all the more critical.

There must be a balance between diagnostic certainty and likelihood of harm if diagnosis is incorrect.
Assessment

- History
- General: Appearance, mental status, agitation/somnolence, diaphoresis, vital signs
- Dyspnea: Position, ability to speak, respiratory rate and depth, breath sounds, [heart rate], SpO2, ETCO2

History: Hospitalized, ICU admission, prior intubation, steroid use.
Onset time: gradual, rapid
Associated symptoms
Medical history: renal disease, liver disease

General:
- Mental status
- Agitation/somnolence?
- Diaphoresis?
- Is the patient looking tired?
- Tachycardic?

Dyspnea:
- Tripod position?
- How many words can the patient speak?
- Respiratory rate fast? Rapid and shallow?
- Quiet breath sounds?
- SpO2 decreasing?
- ETCO2 elevating?

Trending of vital signs, SpO2 and ETCO2 are more important than a single value in monitoring for patient status change. For example, “normalizing” of the ETCO2 in a persistently tachypneic patient is a sign of decreased minute ventilation, decompensation, and impending respiratory failure.

Differential Diagnosis

- Which organ system is causing dyspnea?
  - Pulmonary
  - Cardiac
  - Psychogenic
  - Infectious
- Management options
  - Target: adequate ventilation / gas exchange
  - Do no harm
In the critically ill patient, providing for adequate oxygenation and ventilation is of central importance. Protocols should address those two items first. Interventions that are specific to one disease process that could exacerbate another should be limited to patients in whom the diagnosis is more certain. For example, diuretic use should be limited to patients who have fluid overload but not pneumonia / sepsis, who could be worsened by administration of a diuretic. This could potentially be accomplished using field ultrasound to assess for pulmonary edema, pneumothorax or effusion.

Management should be directed by assessment, with the goal being to assure adequate alveolar minute ventilation and oxygenation. Additional medication options may include bronchodilators, steroids, magnesium. Noninvasive positive pressure ventilation can improve oxygenation/ventilation in patients with multiple pulmonary disease processes without increasing long-term risk to the patient from intubation and its related complications.

Oxygen: Indication

• Standard practice
  – Provide O2 to all patients with actual or potential hypoxia
• Best to base O2 supplementation on clinical findings
  – Beware of “treating the machine”, i.e. Sp02
• Tachypnea may precede hypoxia, hypercapnia and apnea

Ventilation

• Bag Valve Mask (BVM)
  – Primary method for providing ventilation without invasive device
  – Key components
    • Self inflating bag
    • Oxygen reservoir
    • Conforming face mask
  – Primary indications
    • Hypoventilation
    • Apnea
Bag-Valve-Mask (BVM) Ventilation

- Difficult to perform
- Two (or more) operators recommended
- Even more difficult in EMS situations
  - Moving ambulance
  - Prolonged resuscitation
  - Difficulty is a driver for advanced airway techniques
- Complications
  - Gastric insufflation/regurgitation/aspiration

Invasive Airway Management

- Placement of airway tube (either in trachea or obturating esophagus) to facilitate oxygen delivery and ventilation
- Indications
  - Hypoventilation or apnea
  - Potential for airway compromise

BVM is a very difficult technique for even airway experts. The EMS medical director needs to clearly understand the importance of training and re-training on this technique as well as the need for a team approach. It hinges upon the proper establishment of an airway, good mask seal and frequent re-adjustments. This is an excellent example of the differences in EMS vs hospital medicine and our recognition of the strengths and weaknesses, as well as frank hazards, of this technique. Additionally the rate and volume, i.e. minute ventilation requires specific training and direction. Insufflation of the stomach with aspiration creates a very difficult management problem in the field and can be catastrophic for the patient. Gastric distention can be limited by slow (1-2 second) synchronous and asynchronous ventilations are used in cardiac arrest, i.e. ventilations performed as compressions are being performed, versus interspersed between compressions in a pause. Given the demonstrated decrease in survival with pauses in compressions, synchronous ventilations should be used when possible.
1.1.2.1 Devices for securing airway

- Supraglottic airways
- Endotracheal intubation
- Cricothyrotomy

Supraglottic Airway / Extraglottic Airway
aka “Alternate Airway”

- Invasive airway device to facilitate ventilation without endotracheal intubation
- Used as either a primary or backup airway
- Numerous options with varying (if any) level of evidence to support efficacy

Supraglottic Airway / Extraglottic Airway
aka “Alternate Airway”

- Characteristics:
  - Blind insertion
  - Goal is NOT to place in trachea (some can function in this position also)
  - Skill acquisition and retention generally easier than endotracheal intubation
  - Broader range of providers may use – most are within scope for EMT and advanced
Supraglottic Airway / Extraglottic Airway
aka “Alternate Airway”

• Some types of supraglottic airway
  – King
  – LMA
  – SALT
  – Igel
  – Combitube

• Some have inflatable component(s) to seat the device and seal off esophagus to limit aspiration

Other Intubation Techniques

• Gum elastic bougie (aka Eschman stylet)
• Video laryngoscopy
• Digital Intubation
  – Corkscrew ETT recommended by some
• Lighted stylet
• Retrograde intubation

Other techniques

• Nasotracheal intubation is significantly less prevalent in EMS in recent years
• Apneic oxygenation – use of continuous high flow nasal oxygen during intubation
• Use of magills for foreign body removal
**Confirmation of Airway Placement**

- Confirmation and reconfirmation is crucial in EMS
- Previously recommended using multiple methods
  - Auscultation
  - EDD (bulb)/Syringe
  - ETC02 (color / digital / waveform)
- Recheck with every patient movement and prior to handoff at hospital

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**End-Tidal CO2 and ETI**

- Colorimetric
- Digital
- Waveform
  - Most accurate and best device for prehospital use
  - Allows for continuous verification
  - Graphically displayed
- Effectively, continuous waveform capnography has become standard for verification and monitoring of endotracheal tube placement

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Colorimetric is convenient and relatively inexpensive. It is a helpful adjunct for the initial tube placement and for the immediate time afterwards to detect a loss of ETC02 from dislodgement or cardiac arrest. A "good tube" shows a change in color from purple to yellow. The test is limited by the amount of time it is used, rarely good for more than 2 hours. It does not work if there are secretions such as vomitus that comes in contact with the device.

Sidestream capno is commonly used as it is convenient and reliable. There can be a lag in the reading and the dead space in the tubing may lead to inaccuracies in infants with very small tidal volumes as there can be dead space mixing in that case. Mainstream is nearly instantaneous as the sensor is positioned at the ETI. Earlier models were somewhat bulky.

Waveform capnography allows more sophisticated field practitioners to evaluate the quality of the signal, rapidly look at respiratory rate, potentially diagnose obstructions to outflow due to bronchospasm among other things.

The application of the use of ETC02 goes beyond simple airway patency and can be used to judge the effectiveness of CPR, the likelihood of successful resuscitation etc.
Securing the Airway

- High risk of tube dislodgement in field
- Methods
  - Adhesive tape wrapped around neck (Lillehie method)
  - Umbilical twill tape
  - IV or O2 tubing
  - Commercial tube holders
- Supraglottic airways must be secured using tape or commercial holder (Carlson and Wang PEC 2009)
- Manually holding tube strongly discouraged
- Consider C-Collar

Special Considerations

Trauma Intubation

- Must perform ETI with manual in-line cervical stabilization
  - Limits head extension and glottic exposure
- Some experts question value of manual stabilization
- Some studies have shown increased mortality in intubation in penetrating trauma patients

Special Considerations

Pediatric Intubation

- Larynx more superior and anterior
  - More difficult laryngoscopic technique

- ET Tube Size
  - $4 + \lfloor \text{Age (years)} / 4 \rfloor$

- ET Tube Depth (cm)
  - $\lfloor \text{Age} / 2 \rfloor + 12$
**Drug Facilitated Intubation (DFI)**

- "Use of IV sedative and/or neuromuscular blocking agents to facilitate ETI in patients with intact protective airway reflexes"
- Includes:
  - RSI (rapid sequence intubation/induction)
  - Sedation assisted intubation
- An "extremely advanced" procedure

**Rapid Sequence Intubation (RSI)**

- Indication: Need for emergency airway and ventilatory control in patient with intact protective airway reflexes
- Goals
  - Rapid ETI with optimal exposure
  - Minimal disruption of physiology
  - HR, BP, ICP
- Basic drugs: sedative + paralytic agent

**RSI Additional Considerations**

- Complete abolition of airway reflexes and ventilatory drive
- Airway skills must be superior
- Alternate/rescue airway must be readily available
  - Some use RSA (rapid sequence airway with SGA)
- May require enhanced airway training, clinical decision training
- Low success post second intubation attempt, consider limiting number
For systems using RSI there must be defined pathways for the process of intubation such as the number of attempts, approach to maintaining oxygenation during attempts such as the use of apneic oxygenation and limiting the duration of attempts as well as when to move to an alternative airway up to and including cricothyrotomy.

It should be stressed that the procedure should be limited to those practitioners who have been credentialed to do so by virtue of a process defined by the medical director that may include the number of successful intubations performed, didactic sessions as well as review of individual and service level data.

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**Sedation Assisted ETI**

*Controversial Practice in EMS*

- Sedation-only without paralytic
  - Benzodiazepines or Etomidate
- Thought to be safer by anesthesia tradition
- Controversial
  - Less optimal intubating conditions
  - Same physiologic risk as RSI
  - Same training requirements as RSI

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**Noninvasive Ventilation (NIPPV)**

**CPAP & BIPAP**

- High-pressure ventilatory pressure support through tight face mask
- **CPAP**: continuous positive pressure through both inspiration and exhalation
- **BiPAP**: separate pressures for both inspiration and expiration
1.1.2.2 Portable ventilator management

- Guide by using waveform capnography
- Pressure-cycle
  - Pressure support
- Volume-cycle
  - Continuous mechanical
  - Assist-control
  - Synchronized intermittent mandatory ventilation (SIMV)

### Parameters Initial settings

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Initial settings</th>
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</thead>
<tbody>
<tr>
<td>Mode</td>
<td>Assist control</td>
</tr>
<tr>
<td>FiO2</td>
<td>100%</td>
</tr>
<tr>
<td>Tidal volume</td>
<td>10 mL/kg</td>
</tr>
<tr>
<td>Respiratory rate</td>
<td>12 / min</td>
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<tr>
<td>Inspiratory flow</td>
<td>60 L/min</td>
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<tr>
<td>Inspiratory:Expiratory ratio</td>
<td>1 : 2</td>
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<tr>
<td>PEEP</td>
<td>5 cm H2O</td>
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### Ventilation goals

<table>
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<th>Parameters</th>
<th>Goal</th>
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<tr>
<td>PaO2</td>
<td>60-90 mm Hg</td>
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<tr>
<td>PacO2</td>
<td>40 mm Hg</td>
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<tr>
<td>pH</td>
<td>7.35-7.45</td>
</tr>
<tr>
<td>FiO2</td>
<td>40-60%</td>
</tr>
<tr>
<td>Peak insp pressure</td>
<td>&lt; 35 cm H2O</td>
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Passive patient ventilation is determined by:
- Inspiratory pressure
- I:E ratio
- Inspiratory pressure increment (PI-PEEP)
- Mechanical properties of resp system (airway resistance)
- Pressure preset:
  - delivers specific inspiratory pressure
  - more comfort
  - Greater control over peak airway pressure
  - Patient has greater control over inspiratory flow
  - PI (total), PEEP = PI - PEEP = pressure support amount
  - Pressure control allows lung-protective vent strategy
Volume preset: delivers tidal volume regardless of pressure

Ventilator parameters should be determined by the pathophysiology underlying the particular form of respiratory failure;

Whenever the adequacy of oxygen exchange is in question, the initial fraction of inspired oxygen (FIO2) should be 1.0;

Typical ventilator settings for the patient with normal lung mechanics and gas exchange

• include an FIO2 of 0.5,
• tidal volume of 8 to 12 mL/kg, and
• respiratory rate of 8 to 12 breaths/min;

• if mechanical ventilation has been instituted to rest fatigued respiratory muscles, deep sedation may be necessary to minimize respiratory muscle activity.

Consider issues related to positive pressure ventilation and decreased preload / cardiac output potential with higher pressures.

The patient with severe airflow obstruction often develops hypoperfusion after institution of positive-pressure ventilation as a result of occult positive end-expiratory pressure (autoPEEP; this responds to temporary cessation of ventilation and vigorous volume resuscitation while measures are used to reduce airflow obstruction.

The goals of ventilator management in severe airflow obstruction

• plateau airway pressure below 30 cm H2O,
• autoPEEP below 10 cm H2O, or
• end-inspiratory lung volume smaller than 20 mL/kg; even if this results in hypercapnia, short expiratory times must be avoided.

The patient with acute hypoxic respiratory failure resulting from pulmonary edema

• lung-protective ventilation (6 mL/kg ideal body weight and rate approximately 30 breaths/min).

The initial FIO2 of 1.0 can be lowered to nontoxic levels by raising PEEP, which is guided by pulse oximetry.

### 1.1.2.2 Portable ventilator management

- Pros
  - Frees provider for other tasks
  - Consistency

- Cons
  - Cost
  - Complexity
  - No ability to rapidly assess changes in compliance
Airway Controversies

• Does prehospital intubation improve survival?
  — Prehospital ETI has not been shown to provide a survival benefit
  — Gauche RCT: BVM vs. [ETI or BVM], no improvement in survival or neuro outcome in children
  — Davis: Worse outcome with RSI of TBI
  — (Other data in TBI lecture)

Airway Controversies

• Adverse events associated with EMS ETI
  — Katz & Falk: 25% ET tube misplacement (pre-EtCO2)
  — Dunford: Hypoxemia or bradycardia during RSI
  — Davis: Post RSI hyperventilation
  — Aufderheide: “Death by hyperventilation” in cardiac arrest

Airway Controversies

• Difficult to acquire and retain ETI skill
  — ETI complex and difficult
  — National shortage in operating room training opportunities for EMT ETI training
  — Decreasing opportunities for ETI in field
Airway Controversies

- BLS ETI?
  - Optional module in national EMT-Basic curriculum
  - Ability of EMT-Basic to attain and maintain ETI skill unclear
  - 2 Studies: Suboptimal ETI success (<50%) make it unlikely to see broad application.
- "Alternate airways" as primary airway device?
  - Strategy to improve CPR continuity

1.1.2.4 Tracheotomy complications

- Tube obstruction
- Granulation tissue
- Stenosis
- Tracheo-cutaneous fistula
- Bleeding: thyroid vessels, tracheoinnominate artery
- Post-Tracheostomy bleeding may be controllable by hyperinflation of cuff

Trach tube mechanics:
- Removable inner cannula to promote removal of secretions; rounded obturator to promote placement—must be removed to allow respiration
- Cuff to inflate / deflate to protect lower airway
- Tract takes > 7 days to mature – risk of creating false passage, which is greater in obese or with neck mass
- If ventilating, inflate trach cuff to limit leakage
- Laryngectomy patients cannot be orally intubated. Trach alone can.

Tracheostomy Site Bleeding
Bleeding can occur immediately after a tracheostomy and in the late postoperative period. Sources of hemorrhage:
- Granulation tissue in the stoma or trachea, and erosion of thyroid vessels or the thyroid itself, the tracheal wall (frequently from suction trauma), or the innominate artery.
Tracheoinnominate artery fistula is a rare, but life-threatening complication of tracheostomy. Bleeding results from vessel erosion caused by either direct pressure of the tip of the tracheal cannula against the innominate artery, or from a cuff with inappropriately high pressures after being overinflated. Present within the first 3 weeks after tracheostomy, with the peak incidence of presentation between the first and second week. 50% of patients may present with a sentinel arterial bleed or hemoptysis. If patients present with massive bleeding, the first maneuver to control brisk bleeding while planning operative intervention is to hyperinflate the cuff. This technique has been successful in 85% of cases.

**Take-Home Points**

- Airway management is essential EMS skill
- Many techniques, approaches and considerations for quality EMS airway management
- Must use multiple methods for tube confirmation
- Drug-facilitated intubation presents unique requirements and challenges
- Alternate airways provide additional airway options with less skill retention issues
- Airway skill attainment and maintenance are challenges
- Many unanswered questions in airway management

**Which of the following is NOT a key advantage to supraglottic airways?**

a) Blind insertion
b) Often results in tracheal intubation
c) Skill retention tends to be longer than endotracheal intubation techniques
d) Skill can be used in varying levels of certification/practice
Which of the following is NOT a key advantage to supraglottic airways?

a) Blind insertion  
b) **Often results in tracheal intubation**  
c) Skill retention tends to be longer than endotracheal intubation techniques  
d) Skill can be used in varying levels of certification/practice