AIRWAY MANAGEMENT IN THE CRITICALLY ILL

Robert J. Vissers MD
High Risk Emergency Medicine
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Objectives

• Review the **optimal airway management** for the crashing patient in the ED

• Prevent the **complications** seen with intubation of the critically ill

• Understand **appropriate ventilator settings** to avoid patient deterioration

• Develop a strategy for **airway obstruction**
Intubating the critically ill

- Planning is critical – no margin for error
- Assess and plan for difficulty
- Optimize physiology – focus on prevention of hypoxia and hypotension
- Airway may come second
- Use a checklist – inform the team
Intubating the critically ill

“I need to intubate the patient…but I know he’ll crash when I do.”

- 2% risk of cardiac arrest during intubation of critically ill
- Significant hypotension (< 80mmHg) in 30%
- < 70 mmHg in 10%
Intubating the critically ill: The Crash

Mechanisms of the post-intubation crash:

- Positive Pressure Ventilation causes decreased venous return
- Medication induced vasodilatation
- Reduced catecholamines with sedation and relaxation
Intubating the critically ill: The Crash

Post-intubation ventilation settings causing:

• Acidosis from failure to compensate for pre-existing metabolic acidosis
• Air-trapping due to inadequate exhalation
• Elevated plateau pressures exacerbating barotrauma and ARDS
Keys to success: Preparation

Make a plan “worst case scenario”

- Early anticipation of difficulties:
  - Anatomic
  - Physiologic
  - Time constraints
- Equipment needs
- Checklist
Keys to success: Teamwork

Teamwork

• Time out
• Share the plan
• Leadership
• Help
Intubating the critically ill

Optimize physiology

• Focus on prevention of hypoxia
• Prevention of hypotension
• Airway may come second
Cardiac arrest: The rise of “C”

“C” Circulation precedes Airway and Breathing

CPR is as easy as C-A-B

Compressions
Push hard and fast on the center of the victim’s chest

Airway
Tilt the victim’s head back and lift the chin to open the airway

Breathing
Give mouth-to-mouth rescue breaths

American Heart Association
Learn and Live

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Cardiac arrest: Compressions First

Key to success:

- High quality, uninterrupted chest compressions
- Airway can wait
- Passive ventilation may be superior to positive pressure ventilation
- Consider supraglottic airway without interruption

Cardiac arrest: Don’t pause for airway

Key to success:
- High quality, uninterrupted chest compressions
- Airway can wait
- Passive ventilation
- 30:2 compression/breath
- Supraglottic airway:
  - LMA, King-LT, combitube
Cardiac arrest: Capnography

- Confirm tube placement
- Assess quality of CPR
- Identify ROSC without pulse check
- Predict outcome

Cardiac arrest: Capnography

- Confirm tube placement
- Assess quality of CPR
- Identify ROSC without pulse check
- Predict outcome

- Highly reliable (Class 1 evidence)
- May be low after prolonged arrest
- Cannot identify right main stem
Cardiac arrest: Capnography

- Confirm tube placement
- Assess quality of CPR
- Identify ROSC without pulse check
- Predict outcome

- Ideally ETCO2 of 20-25 mmHg
- Correlates with quality of compressions, CPP
Cardiac arrest: Capnography

- Confirm tube placement
- Assess quality of CPR
- Identify ROSC without pulse check
- Predict outcome

- Sudden rise in ETCO2 suggests ROSC
- More sensitive than manual pulse checks
Cardiac arrest: Capnography

- Confirm tube placement
- Assess quality of CPR
- Identify ROSC without pulse check
- Predict outcome

- Persistent ETCO2 < 10 ROSC is unlikely
- <10 after 20 minutes, zero ROSC in studies

Intubating the shock patient

• Primary goal: avoid exacerbation of hypoperfusion
• Need to differentiate shock state
• Consider before intubation:
  • Assessment of volume status
  • IVFs as pretreatment before intubation
  • Vasopressor before intubation
  • A vs C: hemodynamic compromise vs hypoxia
CP/SOB/hypotensive

- 48 y.o. female hx of breast cancer
- Pleuritic chest pain, dyspnea, anxiety
- BP 92/58, P 132, RR 28, O2 sat 95%
- Lungs clear, JVD
- CXR borderline cardiomegaly
Massive PE vs Pericardial Tamponade

PE vs Pericardial tamponade

- Both present similar way
- Treatment very different
- Need to distinguish before intubation
Massive PE vs Pericardial Tamponade

- PE vs Pericardial tamponade
- Both present similar way – dyspneic, chest pain patient
- Both tachycardic, hypotensive, JVD
- Both can progress to PEA
- Similar risk factors, chronic disease, CA
- Need to distinguish before intubation
Massive PE vs Pericardial Tamponade

• Pulse oximetry
  • Usually normal in tamponade
  • Decreased in large PE
• Ultrasound helpful
  • Effusion in tamponade
  • RV septal bulging in PE
• EKG
  • Electrical alternans, low voltage, tachy in PT
  • Right axis, inverted T waves V1-3 in PE
Massive PE vs Pericardial Tamponade

- Ultrasound helpful
  - Effusion in tamponade
Massive PE vs Pericardial Tamponade

- Ultrasound helpful
  - RV septal bulging in PE
Massive PE vs Pericardial Tamponade

- **Pulmonary Embolism**
  - Preload sensitive, IVF may worsen RV overload
  - Pressors for hypotension
  - **Intubation may help** – reduced preload, O2
  - Lytics if unstable

- **Pericardial tamponade**
  - Need preload – IVF helpful
  - **Intubation may worsen** hypotension
  - Pericardiocentesis
Septic shock

- 32 yo male, hx of paraplegia from GSW, chronic decubitus ulcers, cocaine and non-compliance
- BP 92/58, P 132, RR 28, O2 98% RA
- Agitated, delirium, horrible deep buttock ulcerations to bone, maggots, no crepitus
Intubating the shock patient

• Favorite pre-treatment drugs:
Intubating the shock patient

Optimize physiology - Perfusion

- Almost all patients need volume
- 40mL/Kg in kids
- 1-2 liters in adults
- May delay intubation if hypotensive, or hypovolemic and O2 OK – perfusion priority
- Fluids/pressors
Intubating the shock patient

Optimize physiology – Oxygenation

- O2 reservoir for apnea
- Provides 2-3 L O2
- Goal of >90%
- Delays desaturation
- “Insurance policy”
Time to desaturation: Preoxygenated

Graph showing the time to desaturation for different conditions:
- Normal 70 kg Adult
- Normal 10 kg Child
- Moderately Ill 70 kg Adult
- Obese 127 kg Adult

The graph plots SaO₂ (%) against the time of VE = 0, minutes.
Peri-Intubation: Induction agent

Etomidate?
- 5% decrease (3-8%) in MAP in critically ill patients, ASA 4
- Propofol causes 18% decrease (10-25%)
- Probable associated catecholamine decrease
- Consider ketamine 2mg/kg as alternative

Etomidate: Adrenal suppression?

• No prospective studies showing increase in mortality
• No outcome data to suggest discontinuation in emergency RSI
• Consider hydrocortisone in sepsis
• Alternative agents may exacerbate shock

Etomidate or ketamine?

- Randomized, controlled study comparing etomidate and ketamine in critically ill
- 655 patients
- Higher percentage of adrenal insufficiency etomidate group (still 50% in ketamine)
- No difference in mortality, or morbidity (organ failure)

Peri-Intubation: Protection

Does Sellick’s maneuver cause airway obstruction?

- 10 articles on laryngeal view
- Improved with “BURP” and bimanual laryngoscopy, but view deteriorated in 29% with sellicks

Peri-intubation: Prevention

Improve outcome beyond the ED
- Elevate the head of the bed 30-45°
- Decompress stomach OG
- Sterile technique with procedures
Post-intubation in shock

- Consider acid/base balance before you change the ventilation.

- **Acidosis** associated with compensatory respiratory alkalosis (tachypnea, kussmaul’s).

- Post intubation **ventilate at their RR**, “normal rate” may lead to transient worsening of acidosis.

- Consider bicarb first in ASA poisoning.
Pediatric asthma

- 2 y.o. with hx of PICU admissions for asthma
- Wheezing
- Accessory muscles, retractions
- RR 60, P 180, Sat 84% RA
- Maximal therapy
- Seems to be fatiguing
- Decreased air entry
### GENERIC PEDIATRIC SEQUENCE
- Preparation: 100% oxygen
- Oxygenation
- Preanesthesia: Atropine, Succinylcholine
- Induction: Midazolam, Etomidate
- Maintenance: Propofol, Narcotics
- Ventilation: 15% - 150% of TLC
- C/S: 1:1
- MAP: 50 - 80 mm/Hg
- CPP: 35 - 45

### PEDIATRIC DRUGS AND EQUIPMENT
#### THE BROSELOW-LUTEN SYSTEM

<table>
<thead>
<tr>
<th>ZONE*</th>
<th>PINK</th>
<th>RED</th>
<th>PURPLE</th>
<th>YELLOW</th>
<th>WHITE</th>
<th>BLUE</th>
<th>ORANGE</th>
<th>GREEN</th>
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<tbody>
<tr>
<td>Length (cm)</td>
<td>59.5 - 68.5</td>
<td>66.5 - 74</td>
<td>74 - 84.5</td>
<td>84.5 - 97.5</td>
<td>97.5 - 110</td>
<td>110 - 122</td>
<td>122 - 137</td>
<td>137 - 150</td>
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<tr>
<td>Age/ wt (range)</td>
<td>6.5 kg (9-7)</td>
<td>8.5 kg (8-9)</td>
<td>10.5 kg (10-11)</td>
<td>13 kg (12-14)</td>
<td>16.5 kg (15-18)</td>
<td>20.5 kg (19-22)</td>
<td>27 kg (23-30)</td>
<td>36 kg (31-40)</td>
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<td><strong>PRETREATMENT</strong></td>
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<tr>
<td>Lidocaine</td>
<td>10 mg</td>
<td>14 mg</td>
<td>15 mg</td>
<td>20 mg</td>
<td>26 mg</td>
<td>20 mg</td>
<td>20 mg</td>
<td>10 mg</td>
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<tr>
<td>Opioid (fentanyl)</td>
<td>20 µg</td>
<td>25 µg</td>
<td>32 µg</td>
<td>40 µg</td>
<td>50 µg</td>
<td>62 µg</td>
<td>80 µg</td>
<td>100 µg</td>
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<tr>
<td>Atropine</td>
<td>0.03 mg</td>
<td>0.07 mg</td>
<td>0.1 mg</td>
<td>0.2 mg</td>
<td>0.33 mg</td>
<td>0.4 mg</td>
<td>0.5 mg</td>
<td>0.72 mg</td>
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<td>Dorsal fixation (pan/vec)</td>
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<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
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<tr>
<td>Etomidate</td>
<td>2 mg</td>
<td>2.5 mg</td>
<td>3 mg</td>
<td>4 mg</td>
<td>5 mg</td>
<td>5 mg</td>
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<td>10 mg</td>
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<tr>
<td>Midazolam</td>
<td>2 mg</td>
<td>2.5 mg</td>
<td>3 mg</td>
<td>4 mg</td>
<td>5 mg</td>
<td>6 mg</td>
<td>5 mg</td>
<td>10 mg</td>
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<tr>
<td>Ketamine</td>
<td>13 mg</td>
<td>17 mg</td>
<td>21 mg</td>
<td>26 mg</td>
<td>30 mg</td>
<td>40 mg</td>
<td>50 mg</td>
<td>70 mg</td>
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<td><strong>PARALYSIS</strong></td>
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<td>Succinylcholine</td>
<td>14 mg</td>
<td>18 mg</td>
<td>22 mg</td>
<td>26 mg</td>
<td>30 mg</td>
<td>40 mg</td>
<td>50 mg</td>
<td>70 mg</td>
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<tr>
<td>Rocuronium</td>
<td>6.5 mg</td>
<td>8 mg</td>
<td>10 mg</td>
<td>16 mg</td>
<td>16 mg</td>
<td>20 mg</td>
<td>27 mg</td>
<td>36 mg</td>
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<td><strong>MAINTENANCE</strong></td>
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<tr>
<td>Pan/vec</td>
<td>0.4 mg</td>
<td>0.4 mg</td>
<td>0.5 mg</td>
<td>0.6 mg</td>
<td>0.8 mg</td>
<td>1 mg</td>
<td>1.4 mg</td>
<td>1.8 mg</td>
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<tr>
<td>Lorazepam</td>
<td>0.3 mg</td>
<td>0.4 mg</td>
<td>0.5 mg</td>
<td>0.8 mg</td>
<td>1 mg</td>
<td>2 mg</td>
<td>2.5 mg</td>
<td>3 mg</td>
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<td><strong>EQUIPMENT</strong></td>
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<tr>
<td>E.T. Tube (mm)</td>
<td>3.5 uncff</td>
<td>3.5 uncff</td>
<td>4.0 uncff</td>
<td>4.5 uncff</td>
<td>5.0 uncff</td>
<td>5.0 uncff</td>
<td>5.0 cuffed</td>
<td>5.5 cuffed</td>
</tr>
<tr>
<td>Lip-Tip distance</td>
<td>10.5</td>
<td>10.5</td>
<td>12</td>
<td>13.5</td>
<td>15</td>
<td>16.5</td>
<td>18</td>
<td>19.5</td>
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<tr>
<td>Suction</td>
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<td>8F</td>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>10F</td>
<td>12F</td>
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<tr>
<td>Laryngoscope blade</td>
<td>1 straight</td>
<td>1 straight</td>
<td>1 straight</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
<td>2 straight/curved</td>
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<tr>
<td>Stylet</td>
<td>1F</td>
<td>1F</td>
<td>1F</td>
<td>6F</td>
<td>6F</td>
<td>6F</td>
<td>6F</td>
<td>10F</td>
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<tr>
<td>Oral airway</td>
<td>50 MM</td>
<td>50 MM</td>
<td>60 MM</td>
<td>60 MM</td>
<td>70 MM</td>
<td>80 MM</td>
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<tr>
<td>Nasopharyngeal Airway</td>
<td>14F</td>
<td>14F</td>
<td>18F</td>
<td>20F</td>
<td>22F</td>
<td>24F</td>
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<td>30F</td>
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<tr>
<td>BVM</td>
<td>INFANT</td>
<td>INFANT</td>
<td>CHILD</td>
<td>CHILD</td>
<td>CHILD</td>
<td>CHILD</td>
<td>CHILD</td>
<td>ADULT</td>
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<td><strong>VENTILATION</strong></td>
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<tr>
<td>Total volume</td>
<td>60-100 mL</td>
<td>75-125 mL</td>
<td>100-150 mL</td>
<td>125-200 mL</td>
<td>150-250 mL</td>
<td>200-300 mL</td>
<td>250-400 mL</td>
<td>400-800 mL</td>
</tr>
</tbody>
</table>

*The 3, 4, and 5 kilogram weights are not part of the color coded zones. The following applies to these patients: Equipment - same as pink zone. Drugs - 3 kg, 1/3 (33%) of pink zone doses, 4 kg, 2/3 (67%) of pink zone doses, 5 kg, 3/4 (75%) of pink zone doses.

**F1O2: 100%, PEEP: 3 - 5 cm H2O, Titidal Volume: 10 - 15 mL/kg, Inspiratory Time > 0.6 sec, PIP: 20 - 30 cm H2O.

**ETCO2 Detector:** PEDI: Pink, Red, Purple, Yellow, Adult: White, Blue, Orange, Green
Time to desaturation: Preoxygenated

![Graph showing desaturation time for different subjects]
Pediatric asthma

• Preparation critical!
  • Preoxygenation, fluids
  • Prevent dosing and equipment error – Broeslow-Luten system
  • Checklist, team plan
• Prepare for difficult bagging, NG
• Ventilator settings – permissive hypercapnia, low rate and tidal volume
Vent settings made simple

Assist control

- Preset rate and tidal volume
- Will deliver standard tidal volume
- Initial mode of choice for respiratory failure (most ED patients)
- Less work of breathing than SIMV or pressure support
Vent settings made simple

Oxygenation

• Primarily a function of FiO2 and PEEP
• Start FiO2 of 100%
• Start PEEP at 5 cm H2O
• Increase PEEP 2-3 cm q 15 min to increase oxygenation
Vent settings made simple

Ventilation (CO2)

- Primarily a function of RR and tidal volume
- Maintain pH 7.3-7.4
- Change in RR greater effect on pCO2 and pH than tidal volume
Vent settings made simple

Barotrauma/ARDS

• Primarily a function of plateau pressure (not peak)
• Keep plateau pressures below 30 cm H2O
• Reduce tidal volume in asthma, ARDS, high plateau pressures (6 cc/kg IBW)
• Increase peak flow (80-120l/min)
• Reduced RR to allow expiration, avoid air trapping (8-12 bpm)
• Permissive hypercapnia may be needed
Vent settings made simple

Barotrauma/ARDS

- Primarily a function of plateau pressure (not peak)
Angioedema

- Oral swelling occluding oropharynx
- Unable to assess posterior airway
- Presently alert, no stridor, sat 100%

Patient considerations:
- Difficult airway
- Apnea bad
- Cannot RSI
Awake look: Drug consideration

Awake look:
- Antisyalogogue – atropine or glycopyrrolate
- Anesthesia – lidocaine (2-4%), tetracaine
- Decongestant – oxymetazoline (afrin)
- Nebulize, atomize (MADgic®), viscous
- Sedation – ketamine, versed
Pediatric FB

• 5 yo girl, choked on peanuts last night
• Unable to sleep, trouble breathing
• Looks tired, resp distress, tripod
• Foreign objects can be lodged in the upper or lower airway, or esophagus.
• Stable partial obstruction – leave alone but prepare for the worst
Management

- BLS: Infant: 5 back blows/5 chest thrusts
Management

• BLS: Child: 5 abdominal thrusts
ED Management

- Laryngoscopy and removal with pediatric Magill forceps
- 1/3 of pediatric FBs are at cords or above
ED Management

• What if it is a tracheal obstruction?
• Abdominal thrusts
• May need to push into right mainstem
Thankyou!