



HEAVY BREATHING

Safe Practices for Assessing and Assuring adequate Ventilation and Oxygenation

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Objectives

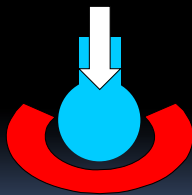
- Differentiate between ventilation, perfusion, and diffusion as they relate to respiratory physiology
- Identify signs and symptoms that indicate that the airway is obstructed and intervention is required
- Identify signs and symptoms that indicate that ventilation is inadequate and intervention is required
- Identify signs and symptoms that indicate that oxygenation is inadequate and intervention is required
- Describe the decision-making strategy for choosing the appropriate intervention for airway obstruction, inadequate ventilation, and hypoxia
- Discuss the risks to patient safety associated with the current prehospital airway management paradigm

Introduction to Pulmonary Physiology

- The pulmonary system, in tandem with the cardiovascular system, works to carry out **three** functions:
 - Ventilation
 - Perfusion
 - Diffusion
- The result: oxygen delivery to tissues

Ventilation

- Movement of air from the external environment to the alveoli
- Components:
 - Brain
 - Innervation
 - Chest wall
 - Upper airways
 - Lower airways



What can go Wrong?

- Neurologic
- Chest wall impairment
- Upper airway obstruction
- Lower airway obstruction

Ventilation Assessment

Airway

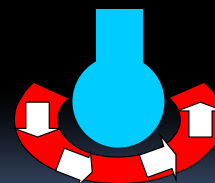
- Look, listen, feel
- Choking/stridor
- Retractions/use of accessory muscles
- Trauma/obstruction

Ventilation

- Look, listen feel
- Chest wall movement
- Chest wall inspection
- Breath sounds
- Capnography

Perfusion

- Adequate blood flow through the pulmonary capillary bed
- Components:
 - Intact pulmonary capillary bed
 - Adequate cardiac function
 - Adequate blood volume



What can go Wrong?

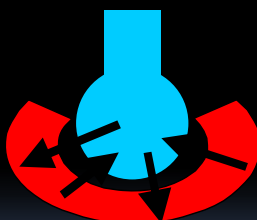
- Damaged pulmonary circulation (pulmonary embolus or contusion)
- Diminished cardiac function (left heart failure)
- Inadequate blood volume (hypovolemia; sickle-cell anemia)

Perfusion Assessment

- Skin color/capillary refill
- Mental status
- Pulse/blood pressure
- Pulse oximetry signal

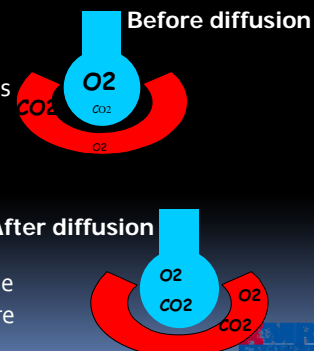
Diffusion

- Definition of diffusion: movement of gases between the alveoli and the pulmonary capillary bed
- Components:
 - Alveolus
 - Basement membrane (interstitial space)
 - Capillary wall



Diffusion?

- The passive exchange of gases along a concentration gradient (high to low)
- Exchange continues until the concentrations are equal



What can go Wrong?

- Alveolar damage
- Widened basement membrane
- Thickened capillary wall

Diffusion Assessment

- Skin color
- Mental status
- Pulse oximetry

Why Do We Care?

Understanding these functions will allow you to:

- Perform an intelligent assessment:
 - Ventilation: look, listen, feel; breath sound, capnography
 - Perfusion: blood pressure, pulse, evaluation of blood volume, mental status
 - Diffusion: skin color, pulse oximeter, mental status

And-- better yet--

You'll be able to provide *generic* treatment based on the physiology:

Ventilation:

- open the upper & lower airways
- provide ventilation

Diffusion:

- high flow oxygen
- reduce fluid in interstitial space

Perfusion:

- maximize cardiac output and blood volume
- high flow oxygen



The Call & Patient

Rollover accident. 21 y/o female driver was ejected from the car.

- Unconscious and unresponsive
- "Noisy" respiration, rate of 28
- Vehicle occupants said that she had stopped breathing after the accident. They had provided mouth-to-mouth ventilation for < 1 minute when spontaneous ventilations occurred.
- Vital signs: 112, 28, 114/74

Paramedic Care

- Nasal intubation without difficulty.
- Patient allowed to ventilate spontaneously (good rate and depth) with supplemental O₂
- Spinal immobilization, 2 IVs, EKG (sinus tach)
- 9 minutes on scene, 14 minute emergent transport to trauma center

Enroute

- Patient developed respiratory distress
- Paramedic initiated BVM ventilation with 100% oxygen
- Became difficult to bag; breath sounds diminished but present in all fields.
- Vitals: 124, BVM, 122/78

Paramedic Care

- Paramedic visualized the pharynx: the tube was visible passing through the cords
- Because of proximity to the hospital, paramedic performed no additional care and prepared for transfer to ED

In the ED

- Patient remained difficult to ventilate
- ED EtCO₂: 8
- After visualizing the tube through the cords the ED physician removed the ET tube

The Tube

- Here's what the ED physician saw
- Reintubation
- EtCO₂ afterward: 34



What are the signs of airway compromise?

- Noisy breathing
 - Visible obstruction
 - Evidence of trauma
 - Breath sounds
 - Stridor
 - Wheezing
- Hypoxia**
- Tachycardia > 130
 - **Retractions or use of accessory muscles**
 - Cyanosis or pallor
 - **Absent breath sounds**
 - Altered mental status

Airway interventions

- Position
- Suction
- Nasal/oral airway
- "Rescue" airways
 - Combitube
 - Easy tube
 - King airway
 - Cobra
 - LMA
- Endotracheal intubation
 - Oral
 - Nasal
 - Drug-assisted
- Surgical airways
- Bronchodilators

How do we decide?

- Vomitus (or potential?????)
- Mental status
- Local protocol
- Distance from hospital
- Personal skill and comfort

How do we know we've succeeded?

- No visible obstruction
- Ability to ventilate
 - Chest rise & fall
 - Breath sounds
 - EtCO₂

What is "aggressive"?

- "If you're thinking about intubating you should"
- "If the patient needs intubation you'll know it"
- Control the airway so the patient won't aspirate

Rescue Airways in EMS

- | | |
|---|--|
| <p><u>Significant EMS data</u></p> <ul style="list-style-type: none"> ▪ Combitube ▪ Easytube ▪ King airway | <p><u>Scant or unfavorable EMS data</u></p> <ul style="list-style-type: none"> ▪ LMA ▪ Cobra |
|---|--|

Patient Safety

- We have lots of questions:
- Are paramedics proficient at intubation?
 - How often does inadvertent esophageal intubation occur?
 - How many tubes are needed for paramedics to remain proficient?
 - Are rescue airways safer than endotracheal intubation?

What do we know?

Study	Data	
Davis 2006	Success: 81%	N=703
Wang 2006	Success: 91.8% overall; 73.7% non-arrest	N=1,941
Colwell 2005	Success: 84% overall; oral 97%; nasal 74%	N=278 (154-N/ 124-O)
Wang 2005	Frequency: median 1; 39%=0, 67% ≤ 2	N=11,950 successful ETI
Rocca 2000	Success: 96% arrest; 74% non-arrest; 94% oral; 63% nasal	N=453

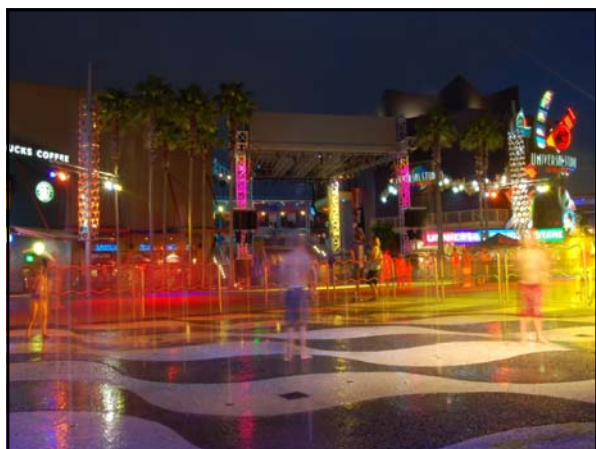
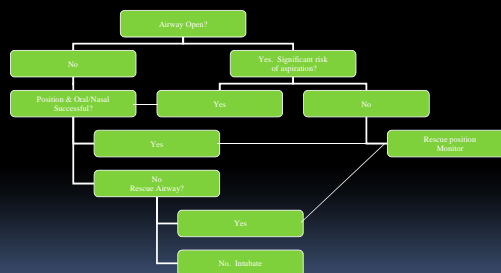
The “Cost” of bad decisions

- Unrecognized esophageal intubation
- Cause vomiting
- Delays on scene
- Hospital ET complications including
 - Tracheal stenosis
 - Ventilator weaning
 - Pneumonia

Recommendations

- Use the LEAST invasive tool necessary to maintain airway patency
- Reduce “prophylactic” intubations except in very long distance transports
- Get more data
 - Frequency of vomiting in patients who are not intubated
 - Advanced airway patient benefits

Proposed Airway decision tree



Prehospital Presentation

79 year old male called EMS c/o shortness of breath x 2 days and dysphagia for 4-5 days. PMH: myasthenia gravis.

- Initial: AAO x 4
 - normal skin color and temperature
 - strong radial pulse
 - 2 word dyspnea, use of accessory muscles

Prehospital Presentation

- Focused History/Exam
 - wheezes in apex of lungs
 - minimal air movement in lower lobes
- Vital Signs: 110, 160/P, 48

Prehospital Intervention

- Oxygen 6 lpm via cannula
- IV, NS, TKO
- Nebulized ventolin treatment

E.D. Assessment

Dyspneic, drooling, 1-2 word dyspnea.

During first 10 minutes in ED respiratory distress increased.

- Head/neck: secretions posterior pharynx; drooling; eyelids drooping
- Chest: wheezing, little respiratory effort
- Abdomen: normal
- Extremities: unable to raise arms
- Vitals: 120, 162/94, 36

E.D. Treatment

- Suction
- Oral intubation without difficulty
- IV versed for agitation
- Mechanical ventilator

Transferred to another facility (insurance purposes) with a diagnosis of myasthenia gravis crisis. Lost to follow-up.

What are the signs of inadequate ventilation?

- | | |
|-----------------------------------|---|
| ▪ Quiet/no sound | ▪ Hypoxia |
| ▪ No, limited chest wall movement | ▪ Tachycardia > 130 |
| ▪ Breath sounds | ▪ Retractions or use of accessory muscles |
| ▪ Abnormal EtCO ₂ | ▪ Cyanosis or pallor |
| | ▪ Absent breath sounds |
| | ▪ Altered mental status |

Ventilation interventions

- Positive pressure ventilation
 - Bag valve MASK
 - Advanced airway and BVM
 - Advanced airway and ventilator
- "Non-invasive" positive pressure ventilation
 - CPAP
 - BiPAP
- Medications
 - Naloxone
 - Dextrose

How do we decide?

- Respiratory rate & depth
- Chest wall movement
- Color (??)
- Protocol
- Capnography
- Personal skill & comfort

How do we know we've succeeded?

- Patient ventilation
 - Chest rise & fall
 - Breath sounds
 - EtCO₂ 35-45
- Assisted ventilation
 - Breath sounds
 - Compliance
 - EtCO₂ 35-45

Patient Benefit

- Duh.....

Patient Safety

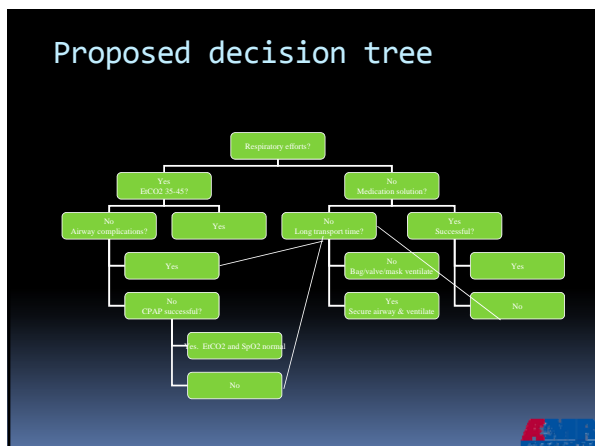
- Mask vs. advanced airway ventilation
 - Ventilation
 - Gastric distension/vomiting/aspiration
- **Hyperventilation (EtCO₂ < 35)**
 - Lowered ROSC
 - Brain death
 - Worsening head trauma

The "cost" of bad decisions

- Unnecessary intubation
- Hypoventilation/acidosis
- Hyperventilation/alkalosis
- Brain death/inability to resuscitate
- Difficulty with ventilator weaning

Recommendations

- If patient ventilation is adequate monitor carefully
- Utilize CPAP for patients with EtCO₂ > 45 who have respiratory effort and no airway complications
- Utilize capnography to direct CPAP or ventilation; maintain 35-45



Prehospital Presentation

- Called to a 21 yr. male unresponsive at home.
- Initial: unconscious, no deep pain response
 - Circumoral cyanosis
 - Respirations extremely slow

Prehospital Presentation

- Focused: pupils pinpoint
 - No evidence of trauma
 - 62, 132/P, 4
 - PMH: shooting heroin the previous evening with girlfriend

Prehospital Intervention

- Initial
 - Unsuccessful intubation attempt; assisted ventilations, O₂
 - IV, NS, 14 angio
 - Dextrose 50%, Narcan
 - Following treatment, patient awoke and became combative
- Ongoing: no changes en route. Transport to hospital took 14 minutes.

Emergency Department Assessment

Upon arrival the patient remained extremely combative & disoriented.

- Head/neck: normal
- Chest: normal
- Abdomen: normal
- Extremities: Spontaneous movement on all extremities
- 120, 104/70, 34

E.D. Diagnostic Testing

- ABG's (100% O₂)
 - pH: 6.94
 - PaCO₂: 70
 - PaO₂: 20
 - O₂ Sat: 48%
- Electrolytes: normal

E.D. Intervention

- Intubation; mechanical ventilation; 100% O₂
- Additional Narcan due to repeated periods of lethargy

The patient was admitted to ICU 1 hour after arriving in the E.D.

Hospital Course

- Patient became increasingly combative and hypoxic for the next 24 hours despite intubation, ventilation, and high flow oxygen.
- Mental status deteriorated day 2.
- Patient died of profound respiratory failure on day 3.
- Cause of death: Pulmonary Edema & ARDS

Prehospital Presentation

51 y/o female c/o acute SOB. Significant distress with 1-2 word dyspnea. Hx of "pneumonia" x 1 month (untreated), asthma, HTN (doesn't take meds).

- Initial: alert, agitated, fighting
 - Pale, diaphoretic, cyanotic nailsbeds & lips
 - Visible respiratory distress
 - Strong radial pulse

Prehospital Presentation

- Initial intervention
 - Unsuccessful nasal intubation attempt
 - Oxygen via non-rebreather
- Focused Exam
 - No JVD/pedal edema (pt was moderately obese)
 - Loud crackles bilaterally
 - EKG: Sinus tachycardia without ectopy
- Vitals: 130, 230/120, 28

Prehospital Intervention

- Paramedic called to base hospital to request IV morphine and furosemide. Order was denied.
- While making the call the patient became so disoriented that she pulled out her IV.
- IV was restarted and patient transported
- Times: scene 20; transport 8 minutes

E.D. Assessment

Patient arrived combative, confused, and pulling off oxygen.

- Head/neck: cyanotic lips; + JVD
- Chest: loud crackles all lobes; normal heart tones
- Abdomen: normal
- Extremities: cyanotic nailbeds; - pedal edema
- Vitals: 140, 234/132, 40

E.D. Diagnostic Testing

- ABGs
 - pH: 7.07
 - PaCO₂: 53
 - PaO₂: 55
 - O₂ Sat: 74%
 - HCO₃: 16
- Xray
 - cardiac enlargement
 - severe pulmonary edema



E.D. Intervention

- Continued efforts to administer oxygen
- Morphine 10 mg IV
- Furosemide 40 mg IV

Morphine and furosemide improved patient's condition and she became less combative. Private MD elected not to intubate. Patient was transferred to ICU.

Hospital Course

Condition improved dramatically. Continued to receive morphine, furosemide, and aminophyllin. Discharged from ICU on day 2 and hospital day 5.

At 4 hours:

- ABGs (100% O₂)
 - pH: 7.33
 - PaCO₂: 44
 - PaO₂: 138
 - O₂ Sat: 99%

What are the signs of hypoxia?

- Altered mental status
- Skin color
- Pulse oximetry < 90%
- **Hypoxia**
- **Tachycardia > 130**
- Retractions or use of accessory muscles
- **Cyanosis or pallor**
- Absent breath sounds
- **Altered mental status**

Hypoxia interventions

- Oxygen
 - Various flow rates and devices
- CPAP/BiPaP
- Medications
 - Nitroglycerine
 - Lasix
 - Morphine

How do we decide?

- Skin color
- Mental status
- Pulse oximeter (??)
- Protocol
- Myths

How do we know we've succeeded?

- SpO₂ > 90% AND
- Improved skin color
- Improved mental status
- Reduced cardiac/neurologic symptoms

Patient Benefit

- Oxygen is good, but giving more than is necessary for prolonged periods may be harmful
- CPAP has been proven effective in improving oxygenation and maintaining ventilation. May be used by BLS in some systems.

Patient Safety

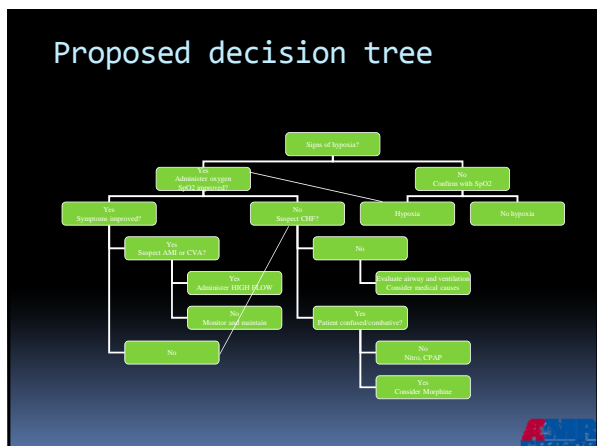
- Risks of high flow oxygen
- Missed CHF diagnosis
- Risk of intubation
- CHF pharmacology
 - Nitro
 - Lasix
 - Morphine

The "cost" of bad decisions

- Prolonged hypoxia resulting in CVA, AMI, seizure, pulmonary damage
- Inadequate therapy for primary hypoxic disorders (AMI, CVA)
- Respiratory depression (morphine)

Recommendations

- Confirm assessment with SpO₂
- For primary respiratory disorders titrate oxygen administration to maintain SpO₂
- High flow oxygen for ALL primary hypoxic disorders (regardless of SpO₂)
- Nitroglycerine as primary CHF medication
- Avoid morphine unless the patient is too agitated to manage otherwise



- ### Summary
- Revise protocols
 - Utilize pulse oximetry and capnography in making decisions and monitoring their impact on the patient
 - During case reviews ask the following: could this patient have been adequately managed using a LESS RISKY approach?

