Acute Respiratory Failure

Recognition
Etiology
Airway assessment and management
RSI/induction agents
Alternate devices

Dx Acute Resp Failure
“Difficult to define but I know it when I see it”
Very subjective diagnosis

Signs and Symptoms
subjective feeling of shortness of breath
tachypnea
using accessory muscles of respiration
paradoxic abdominal movements with breathing
inability to talk w/o gasping for air
cyanosis (mucus membranes, nail beds)
skin mottling
decreased mental status
unstable vital signs
abnormal lung sounds
cough and purulent sputum

Important Signs and Symptoms
tachypnea
using accessory muscles of respiration
paradoxic abdominal movements with breathing
inability to talk w/o gasping for air

Stages of ABG’s

<table>
<thead>
<tr>
<th>Stage</th>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
<th>Note</th>
</tr>
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<tbody>
<tr>
<td>0</td>
<td>7.40</td>
<td>40</td>
<td>100</td>
<td>normal</td>
</tr>
<tr>
<td>1</td>
<td>7.53</td>
<td>20</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>7.53</td>
<td>20</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>7.44</td>
<td>37</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>7.20</td>
<td>60</td>
<td>50</td>
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</table>
Stages of ABG’s

<table>
<thead>
<tr>
<th>Stage</th>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
<th>RR</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>7.40</td>
<td>40</td>
<td>100</td>
<td>16</td>
</tr>
<tr>
<td>1</td>
<td>7.53</td>
<td>20</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>2</td>
<td>7.53</td>
<td>20</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>7.44</td>
<td>37</td>
<td>70</td>
<td>30</td>
</tr>
<tr>
<td>4</td>
<td>7.20</td>
<td>60</td>
<td>50</td>
<td>20 - 40</td>
</tr>
</tbody>
</table>

ABG Stages in COPD

<table>
<thead>
<tr>
<th>Stage</th>
<th>pH</th>
<th>pCO₂</th>
<th>pO₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>7.36</td>
<td>50</td>
<td>60 baseline</td>
</tr>
<tr>
<td>1</td>
<td>7.48</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>7.48</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>7.36</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>7.00</td>
<td>150</td>
<td>30</td>
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</table>

Etiology Resp Failure

<table>
<thead>
<tr>
<th>Lung Parenchymal Disease</th>
<th>Hypoventilation</th>
</tr>
</thead>
<tbody>
<tr>
<td>COPD</td>
<td>Drug overdose</td>
</tr>
<tr>
<td>Pneumonia</td>
<td>Head injury</td>
</tr>
<tr>
<td>CHF</td>
<td>Neuromuscular disease</td>
</tr>
<tr>
<td>Sepsis</td>
<td>Pulmonary Embolism</td>
</tr>
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</table>

Pulmonary Pathophysiology

CO₂ diffuses across the alveolar membrane 200 x better than O₂
Hypoxia with normal pO₂ is always lung parenchymal disease
Hypoxia with an elevated pCO₂ could be primary hypoventilation or could be severe lung parenchymal disease
Hypoxic resp failure vs Hypercapnic resp failure

A-a gradient

Alveolar to arterial oxygen gradient
A is estimated from a formula
a is from the ABG

A is estimated from the following formula:
A = FIO₂(Pb - PH₂O) - pCO₂/RQ
A = FIO₂(760 - 47) - pCO₂/RQ
A = FIO₂(713) - pCO₂/RQ
A = FIO₂(700) - pCO₂
A-a gradient = FIO₂(700) - pCO₂ – pO₂
In the normal individual breathing room air with a normal pO$_2$ of 100 and a pCO$_2$ of 40:

\[ A = 0.21(700) - 40 \]
\[ A = (147) - 40 \]
\[ A = 107 \]

A-a gradient = 107 - 100 = 7

The normal A-a gradient is < 10

**FORMULAS TO REMEMBER**

A-a on room air

\[ A = 150 - pCO_2 - pO_2 \]

A-a on oxygen

\[ A = (FiO_2 \times 700) - pCO_2 - pO_2 \]

**Resp Failure Differential Diagnosis**

<table>
<thead>
<tr>
<th>A-a</th>
<th>Inc</th>
<th>FiO$_2$</th>
<th>Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>hypoventilation</td>
<td>nl</td>
<td>PaO$_2$, inc</td>
<td>Drugs, head injury</td>
</tr>
<tr>
<td>dead space</td>
<td>inc</td>
<td>PaO$_2$, inc</td>
<td>COPD</td>
</tr>
<tr>
<td>shunt fraction</td>
<td>inc</td>
<td>PaO$_2$, not inc</td>
<td>pneumonia, CHF, PE</td>
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**Resp Failure Differential Diagnosis**

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Really only applies at high FiO$_2$ levels > 60%

100% oxygenation FiO$_2$ challenge and calculate the change in the pF ratio (pO$_2$/FiO$_2$)

**Pulmonary Embolism**

Yes, in autopsy series there are some missed PEs.

In the real world, common things happen commonly.

If your patient presents with a good explanation for their resp failure there is no reason to add PE to the list.

D-dimer only helpful when negative; negative means no PE; positive means nothing; a very high D-dimer still means nothing; Not all D-dimers are created equal; know which one your hospital uses; Use a prediction score; Wells score.
Wells Criteria

Clinical symptoms of DVT (leg swelling, pain with palpation) 3.0
Other diagnosis less likely than pulmonary embolism 3.0
Heart rate >100 1.5
Immobilization (≥3 days) or surgery in the previous four weeks 1.5
Previous DVT/PE 1.5
Hemoptysis 1.0
Malignancy 1.0

Probability Score
High >6.0
Moderate 2.0 to 6.0
Low <2.0

Data needed to make decisions

History
- Acute—HPI
- Chronic—Past Med Hx

Exam
- Vital signs
- General assessment “How do they look”
- Lung sounds

ABG
CXR

Do they need mechanical support

In shock?
Hypercapnic with complications?
  - Hypotension, hypoxia, widened QRS complex, etc.
Hypoxia not resolved with O2?
Look Bad?
  - Increased work of breathing
  - Decreased level of consciousness

What kind of mechanical support?

Non-Invasive Ventilation (NIV)
  - BiPap or CPAP
Endotracheal intubation

Indications for NIV

Acute Respiratory Failure
intact mental status
airway protected
absence facial trauma
patient will tolerate

success rate 25%

Non-Invasive Ventilation

Takes patience to initiate
Try several different masks to find right fit
Start with low settings and work up to full settings and mask fitting
May need some sedation
versed
How long to try
After get patient settled on NIV
15-20 minutes
Should look better in one hour
If not better consider intubation

Indications for intubation
Acute Respiratory Failure
failure of NIV
decreased mental status
unprotected airway
shock
emergencies
need high pressures

Transport Decisions
Complex question
Equipment and personnel available
Distance of transport

Intubation and Sedation
Please keep your patient comfortable
post intubation
– Sedation and analgesia
– If hypotension develops then
  • More fluid
  • Early pressors
Avoid repeat doses of neuromuscular
blockers for transport

Medications for Transport
Sedation
Analgesia
Isotonic fluids
Vasopressor
Paralytics rarely needed for transport

Airway Management
Endotracheal Intubation is by far and
away the best, safest and preferred
technique to management the acute
respiratory failure patients airway
Novice

Intubation is perceived as scary
Reality is that is not that hard a skill to master
First resource for training should be on a dummy
One hour once in a lifetime sufficient
In OR do some elective intubations
Repeat that every 1-2 years

RAPID SEQUENCE INTUBATION

“RSI is the standard of care in emergency airway management for intubations not anticipated to be difficult.
Simultaneous administration of a sedative and a neuromuscular blocking agent to render a patient rapidly unconscious and flaccid in order to facilitate emergent endotracheal intubation and to minimize the risk of aspiration.
Multiple studies confirm the high-success rate of RSI using the combination of a sedative and a paralytic drug”

Induction Agents

midazolam (Versed)
Propofol
Fentanyl
Ketamine
Etomidate
Neosphyenine
Fluids

midazolam (Versed)
Dose 2-4 mg
(induction dose is listed as 0.1-0.3 mg/kg)
Onset 1-5 minutes
Duration 5-30 minutes
Amnesic effect

Propofol

<table>
<thead>
<tr>
<th>Dose (1.5-3 mg/kg)</th>
<th>60 kg</th>
<th>100 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset seconds</td>
<td>15-45</td>
<td></td>
</tr>
<tr>
<td>Duration minutes</td>
<td>5-10 minutes</td>
<td></td>
</tr>
<tr>
<td>Reduces airway resistance, decreases ICP, good antiepileptic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Does vasodilate– cause hypotension</td>
<td></td>
<td></td>
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</table>

Fentanyl

Personal experience more than guidelines
Dose 0.5 mcg/kg
Onset minutes
Duration minutes 5-15
## Rocuronium

<table>
<thead>
<tr>
<th>Dose</th>
<th>60 kg</th>
<th>100 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>1-2 minutes (typically faster)</td>
<td>1-2 minutes (typically faster)</td>
</tr>
<tr>
<td>Duration</td>
<td>5-15 minutes (typically quicker)</td>
<td>5-15 minutes (typically quicker)</td>
</tr>
<tr>
<td>Nondepolarizing agent</td>
<td>Nondepolarizing agent</td>
<td></td>
</tr>
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</table>

## Succinylcholine

<table>
<thead>
<tr>
<th>Dose</th>
<th>60 kg</th>
<th>100 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>1.5 mg/kg</td>
<td>90 mg</td>
</tr>
<tr>
<td>Duration</td>
<td>seconds</td>
<td>45-60</td>
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<tr>
<td>Depolarizing agent</td>
<td>Depolarizing agent</td>
<td></td>
</tr>
<tr>
<td>Hyperkalemic cardiac arrest</td>
<td>Hyperkalemic cardiac arrest</td>
<td></td>
</tr>
<tr>
<td>(Are defined risks groups but can occur in anyone)</td>
<td>(Are defined risks groups but can occur in anyone)</td>
<td></td>
</tr>
<tr>
<td>No longer recommended in any patients</td>
<td>No longer recommended in any patients</td>
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</table>

## Etomidate

<table>
<thead>
<tr>
<th>Dose</th>
<th>60 kg</th>
<th>100 kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Onset</td>
<td>0.3 mg/kg</td>
<td>20 mg</td>
</tr>
<tr>
<td>Duration</td>
<td>0.5-1 minute</td>
<td>0.5-1 minute</td>
</tr>
<tr>
<td>Causes less hypotension</td>
<td>Causes less hypotension</td>
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</tr>
<tr>
<td>Adrenal insufficiency, inc mortality in septic patients, no longer used in the ICU</td>
<td>Adrenal insufficiency, inc mortality in septic patients, no longer used in the ICU</td>
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## Ketamine

<table>
<thead>
<tr>
<th>Dose</th>
<th>60 kg</th>
<th>100 kg</th>
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</thead>
<tbody>
<tr>
<td>Onset</td>
<td>1-2 mg/kg</td>
<td>60-100 mg</td>
</tr>
<tr>
<td>Duration</td>
<td>5-15 minutes</td>
<td>5-15 minutes</td>
</tr>
<tr>
<td>Less hypotension</td>
<td>Less hypotension</td>
<td></td>
</tr>
<tr>
<td>May increase ICP (evidence weak)</td>
<td>May increase ICP (evidence weak)</td>
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</tr>
<tr>
<td>Can be used for awake intubations (preserves resp drive)</td>
<td>Can be used for awake intubations (preserves resp drive)</td>
<td></td>
</tr>
<tr>
<td>Reemergence phenomenon concerning</td>
<td>Reemergence phenomenon concerning</td>
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</tr>
</tbody>
</table>

## Phenylephrine

**Neosynephrine**
- IV bolus dosing 100 mcg q 5 minutes
- IV infusion dose 0-4 mcg/kg/min
- 100-200 mcg/minute
- Hypotension is so common Neo should be part of your induction agent medical list

## Most Patients are Dry

- Have NS hanging and do not hesitate to give 1-3 liters
- Have not been eating well
- Induction agents will vasodilate
- Even the CHF patient may be intravascular dry and need some fluid
What do I do

Versed 4 mg IV given while I set up to intubate
50-100 mcg fentanyl and 50-100 mg of propofol
Start to bag mask ventilate as they fall asleep (eyelash test)
Look, if fail then more sedation +/- rocuronium

What do I do (2)

3 attempts with laryngoscope
Watch sat’s and heart rate
abort attempt and bag when pulse starts to fall
Glidescope
Consider a intubating stylet
Cricothyroidotomy (kit)

To RSI or Not to RSI

Most fellowship trained ED MDs always RSI
I will usually try once without paralytic and use it if I think I will get a better view on the second attempt
More likely to use RSI if no concerns after an LEMON airway assessment, TBI, overdose patient, full stomach

Intubation Failure Rates

Difficult intubation rate quoted as 30 % more than one attempt
Unsuccessful intubation rate 10 %

Prediction of the Difficult Airway

LEMON approach
Look externally
Evaluate 3-3-2 rule
Mallampati score
Obstruction/Obesity
Neck mobility

Look externally

Clinician’s general impression
abnormal facies or body habitus
unusual anatomy
facial trauma
Specific but not sensitive
If it looks like a difficult airway then it most likely will be
Absence of external signs of a difficult airway does not predict success
3-3-2 Rule

A. Extent of mouth opening
Patient should be able to fit three of their own fingers between the incisors

B. Size of the mandible
Patient should be able to place three of their own fingers along the floor of the mandible between the mentum and the neck/mandible junction

C. Distance between mentum and hyoid bone
Patient should be able to place 2 of their own fingers in the superior laryngeal notch
If larynx is too high (anterior) hard to see
Mallampati
Predicts the view during laryngoscopy based on the view looking into the patient's open mouth
Class I or II easy laryngoscopy
Class III difficult
Class IV extreme difficulty

M score in the ED
Often patients unable to cooperate
Open the mouth with tongue blade of laryngoscope blade and try to get the best view possible

O: Obstruction/Obesity
Upper airway obstruction (rare)
mass, foreign body, infection
Redundant tissues obese patient can make views difficult, may want a bigger laryngoscope blade

N: Neck Mobility
Ideal position for intubation sniffing position
Flexing neck forward and elevating the head
Trauma patients with concern neck injury require in-line stabilization which can limit views
Medical conditions like RA, ankylosing spondylitis, DJD in the elderly
**How to use LEMON**

Do as much assessment of the airway as possible prior to intubation

If factors present that predict difficult intubation then plan ahead

gather special supplies

alert personnel

Proceed with intubation +/- paralysis

**Alternative devices**

Glidescope

Awake intubation/nasal intubation

Extraglottic airway devices

LMA/Intubating LMA

Combitube, Kingair, others

Intubation over a bronchoscope

Surgical airway (cric/trach)

**Glidescope**

Plastic lighted laryngoscope with a camera

Extraglottic Airway Devices

LMA
Combitube
Kingair

LMA
Laryngeal Mask Airway
Video regarding use and placement
NEJM Nov 4, 2013 e26
Not as easy to place as pictures and videos imply
Should practice on dummy or in OR