

Episode 12: Air Embolism

On this episode: Dr. Jed Wolpaw and Dr. David Mintz

In this episode, Dr. [David Mintz](#), one of our neuroanesthesiologists here at Johns Hopkins, fellow Brown University Alum, and generally all around great guy, to the show to talk about air embolism, what it is, how it happens and how to manage it. A big thanks to Dave for taking the time to prepare this information and for being the first ever guest on ACCRAC.

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Which scenarios are more concerning for PE?

- Anytime vein is higher than heart, particularly
 - o Great veins
 - o Uncollapsible veins
- Neurosurgery
 - o Venous sinus adheres to dura → tented open and not collapse
 - o Seated craniotomies → high risk of PE so shifted to park bench, but seated being done
- Other organs
 - o Uterus mobilized during C-section
 - o Liver surgeries
 - o Occasionally open shoulder surgery

What are some signs of PE?

- Two flavors
 - o Air completely occludes outflow from PA or entire right heart – immediate/sudden **cardiac collapse**
 - o Smaller bubbles enter pulm circulation → response analogous to pHTN response: ↓ CO but not complete; **hypotension, tachycardia**
 - Suspect PE if in setting of PE risk, and struggling to maintain perfusion!
 - Typical monitors
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| <ul style="list-style-type: none"> ○ Tachycardia ○ Hypotension ○ Possible ↓ in tidal CO₂ [physiologic dead space!] - Specialized monitors <ul style="list-style-type: none"> ○ Gold standard: Echo [TEE] ○ Precordial doppler <ul style="list-style-type: none"> ▪ 2nd and 3rd intercostal space in right side when upright ▪ position changes if incline ▪ test with some saline mixed with air because if you don't prove it works when you want it, it might not work when you need it! ○ More specific <ul style="list-style-type: none"> ▪ End Tidal Nitrogen ○ Less specific <ul style="list-style-type: none"> ▪ PA catheters [pressure ↑] ▪ End Tidal CO₂ | $PVR = (\text{Mean PA} - \text{PCWP}) / \text{CO}$ |
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What should you do when suspecting a PE?

- Communicate with team, **recruit help!!**
- Surgical team should be trained to respond appropriately
 - Flood field with saline
 - Neurosurgery with bone wax
 - Heavy use of electrocautery
 - Potentially change position
- Supportive care
 - Open fluids wide
 - Discontinue nitrous
 - Inotrope
 - Jugular vein occlusion on side of air entrainment: can entrain while showing surgeon bleeding site via backpressure
 - Multi-orifice catheter placed in right heart/ junction: pull back to suck air out of heart
 - If no cardiac output, then initiate CPR!
 - TEE showed chest compressions can break up fluid bubbles

What would you see on end tidal nitrogen monitors?

- Exam pearl: in terms of sensitivity/specificity, it's the third best monitor
 - TEE > precordial doppler > ET nitrogen
- Not used frequently because need separate mass spectrometer module
- If running 100% or any mix, should see 0% nitrogen
- If you start entraining air, then will see increase in % of nitrogen
- Advised not to use mix oxygen when using this

Why administer inotropes for PE?

- Epinephrine or inotrope to **help right side push air**
- Not phenylephrine: recruits more fluid to right side of heart, ↑ afterload, and venous vasoconstriction
 - Pressor of choice: epinephrine, if dilute not available, just use small doses (100-200 mcg)
- Relatively good sign if patient becomes tachycardic and hypertensive

What's the best position?

- Place apex of right heart as high as possible to trap air here, and not in RV outflow track
- Recommended: head down, right side of patient up, but highly impractical for neurosurgery

What concerns for central line placement?

- Awake and breathing on negative ventilation vs unconscious and breathing on positive ventilation
- **More** vitally important to cover catheter for awake due to negative pressures
- PEEP is somewhat preventative for air entrainment
 - o **↑ thoracic pressure → ↑ great vein pressure → prevent air reaching heart**
- If suspecting PE, turn PEEP off!
 - o If patient has PFO, the air can possibly cross, especially with thinner walled right ventricle being more compressed

How do you prevent and manage PE? What are your thoughts?

New York Times articles about evidence-based practice

- [Feeling guilty about not flossing? Maybe there's no need](#): Flossing your teeth has never been shown to be effective for preventing, but still effective removing bits of foods.
 - [Why 'useless' surgery is still popular: spinal fusion](#) – 4 clinical trials show no better than alternative therapies, yet rates actually increased. [NEJM 2009 vertebroplasty](#) vs sham – no benefits, but rates still rose! Torn **meniscus repair** – multiple trials showed no benefits vs sham!
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Review Questions

Link jumps to appropriate section

1. [What are some signs of a PE?](#)
2. [First step when suspecting a PE?](#)
3. [What additional monitors can be used to monitor for PE?](#)
4. [Why prefer epinephrine over phenylephrine?](#)
5. [How does the use of PEEP for PE explain why awake central line placements are more risky?](#)

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Notes by [Brian Park](#)