ABIM Board Certification Review:
Critical Care

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Lecture Outline

- Cardiopulmonary Failure
- Sepsis
- GI issues
- Odd and ends for $200

Question 1

A middle aged man collapses at the ballpark. He is unresponsive and has no pulse or respirations.
Correct interventions include:

A. Chest compressions alone at 100/minute
B. Use of AED only by ACLS trained personnel
C. 3 "stacked" shocks as soon as defibrillator is available
D. Rapid ventilation (bag or mouth)

CPR and Defibrillation for Sudden Cardiac Death

- Sudden cardiac death causes 300,000+ deaths/year
- Strongly associated with coronary artery disease*
- CAD + transient risk factors: ischemia, hypoxemia, acidosis, electrolyte imbalances, drugs → Vtach & Vfib → asystole
- Early bystander CPR can double or triple the victim's chance of survival


CPR

No breathing → Open airway
Still no breathing → 2 rescue breaths
CPR

CPR: Chest compressions, hard and fast in middle of patient’s chest with minimal interruptions. Hand over heal. 1½ – 2 inches. 100/minute.

New AHA motto: “Push Hard, Push Fast!”

Rate of Chest compressions to breaths 30:2

Continue CPR until an automated external defibrillator arrives and is ready for use or ACLS providers take over.

CPR

Changes in the 2005 Guidelines for CPR

<table>
<thead>
<tr>
<th>2000</th>
<th>2005</th>
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<tbody>
<tr>
<td>Unwitnessed cardiac arrest</td>
<td>Immediate defibrillation</td>
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<tr>
<td>Compression–ventilation ratio</td>
<td>15:2</td>
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<tr>
<td>Shocks</td>
<td>3 stacked shocks</td>
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BLS

CPR

AED

Open

Put pads on chest

Push On

Follow Instructions

It will advise shock and will charge for VTach & V Fib, but not for Asystole or PEA
Question 2

A 68 year-old man with a history of smoking, HTN and DM presents to the ED with confusion, lethargy, and increasing peripheral edema.

Exam: BP 135/90 HR 110
Moderately obese, tired but oriented.
Lungs with rales ½ up; rare wheezes. Cor: tachy without murmurs. 4+ edema to thighs.

Labs: Hct 52%
WBC: 22,000
BUN 28
Glucose 255

ABG: 7.30 PaCO2 62 PaO2 45

Question 2

68 year old with initial ABG: 7.30/ PaCO2 62/ PaO2 45

CXR: Moderate cardiomegaly and vascular congestion.

RX: O2, Diuretics, bronchodilators, antibiotics.

He is still lethargic, but oriented.

F/u ABG on 2 LPM O2:
7.29/ PaCO2 65/ PaO2 52

What is the most appropriate next step?

A. Give sodium bicarbonate
B. Increase O2 to 6 LPM
C. Intubate patient and begin assist control ventilation
D. Order sleep study
E. Start noninvasive positive pressure ventilation

Question 2

68 yo, initial ABG: 7.30/ PaCO2 62/ PaO2 45
F/u ABG 2 LPM O2: 7.29/ PaCO2 65/ PaO2 52

What is the most appropriate next step?

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NiPPV

When does NiPPV work for acute respiratory failure?

**BEST**
- COPD exacerbations with elevated PaCO2 or CHF

**Good data**
- Asthma, Cystic Fibrosis, post-extubation, DNI patients

Key is the balance between avoiding intubation with risk of VAP vs. delay in necessary intubation (risk of cardiac ischemia)

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**Good**

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<tbody>
<tr>
<td>Elevated CO2</td>
<td>Secretions or low CO2</td>
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<tr>
<td>Severe encephalopathy</td>
<td>Inability to protect airway or aspiration risk</td>
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<tr>
<td>Hemodynamic instability or unstable rhythm</td>
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Example: Coughing up thick secretions with ABG 7.33/25/45

\[ \rightarrow \text{Secretions, hypoxic with metabolic acidosis} \rightarrow \text{NiPPV ?} \]

\[ \rightarrow \text{NO!!} \]

---

**CPAP or BiPAP?**

**For CHF \rightarrow Either**

**COPD \rightarrow BiPAP**

- **CPAP**: Start 8-10 cmH2O (15 max)
- **BiPAP**: Start Inspiratory Pressure
  - (IPAP): @10 cmH2O \rightarrow increase (20 max)
  - (EPAP): @ 5 cmH2O \rightarrow increase (10 max)

Gradually increase as tolerated to relieve dyspnea

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**Question 3**

A 55 year old woman with asthma is admitted to the ICU following surgery for multiple fractures from a MVA. The patient is on a volume-control ventilation: RR 14 breaths/min, FiO2 0.4, PEEP 5 cm H20, and tidal volume of 500. On these settings, the patient develops acute respiratory distress and the peak pressure increases and alarms:

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<td>Peak pressure (cm H2O)</td>
<td>28</td>
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<tr>
<td>Plateau pressure (cm H2O)</td>
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Which of the following is most likely to account for this patient’s respiratory distress?

A. Pulmonary embolism
B. Cardiac ischemia with pulmonary edema
C. Pneumothorax
D. Bronchospasm
E. Leak in the ventilator circuit

---

**Question 3**

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D. Bronchospasm
E. Leak in the ventilator circuit
**Peak vs. Plateau Pressures**

All are plotted vs. time

**Ventilators: Inspiratory Pressures**

Proximal Airway Pressure

- Peak pressure
- Plateau pressure

**Acute Decompensation During Mechanical Ventilation**

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Which of the following is most likely to account for this patient’s respiratory distress?

- **A. Pulmonary embolism**  Shouldn’t change pressures
- **B. Cardiac ischemia with pulmonary edema**  Increased Pplateau
- **C. Pneumothorax**  Decreased Compliance e.g. Pneumothorax, CHF, ARDS, pneumonia
- **D. Bronchospasm**  Will increase both Plateau and Peak
- **E. Leak in the ventilator circuit**  Low pressures

**Question 3**

A 43 year old man with seizures has a witnessed aspiration and develops the acute respiratory distress syndrome. Mechanical ventilation is begun with a RR 30/min, tidal volume 6.5 mL/kg, FiO2 0.50, PEEP 10 cm H20. Plateau pressure is 34 cm H20. Chest X-ray: Bilateral opacities consistent with ARDS/

ABG: pH 7.28/pCO2 55/pO2 60.

**Question 4**

According to the Acute Respiratory Distress Syndrome Network protocol for ventilation management, which of the following should you do next?

- **A. Decrease tidal volume to 6.0 mL/kg and recheck plateau pressure**
- **B. Increase tidal volume to 8.0 mL/kg and recheck plateau pressure**
- **C. Increase FiO2**
- **D. Infuse bicarbonate**
- **E. Place the patient in the prone position**

ABG: pH 7.28/pCO2 55/pO2 60.
Question 4
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E. Place the patient in the prone position

Question 5
19 year old man with asthma is admitted with progressive symptoms. BP is 140/70, pulsus paradoxus 25, ABG 7.30/49/58. He is intubated and ventilated in volume-cycled mode with RR 15, TV 1000 mL, FiO2 0.5, PEEP 5. Inspiratory flow rate is 60 L/min.

Twenty minutes after intubation BP drops to 80/30. ABG: 7.20/57/50. Breath sounds remain symmetrically decreased.

Question 4
ABG: pH 7.28/pCO2 55/pO2 60
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Question 5
BP 140/70 → 80/30
ABG 7.30/49/58 → 7.20/57/50
Which of the following should you do now?

A. Briefly detach from ventilator
B. Echocardiography
C. Increase tidal volume to 1200 mL
D. Decrease flow rate
E. Place thoracostomy tube
Question 5
BP 140/70 → 80/30
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C. Increase tidal volume to 1200 mL
D. Decrease flow rate
E. Place thoracostomy tube

Dynamic Hyperinflation
- Major problem in obstructive lung diseases like COPD and asthma
- Increased airway resistance → inadequate time for expiration
- If there is not enough time for expiration, this can lead to gas trapping (i.e., auto-PEEP)
- Consequences of auto-PEEP include barotrauma (pneumothorax) and hypotension
- Need to allow adequate time for expiration

Set Ventilator Settings to Maximize Expiration and Avoid Hyperinflation
For serious hypotension, may need to briefly detach patient from ventilator. If DH is cause, BP should rise quickly
Then adjust ventilator settings to maximize exhalation time.
Our case: Rate 15, TV 1000 mL, Flow rate 60 L/sec
Rate 15 = 4 sec for each breath: 1 inspiration/3 expiration
If making only one change, decrease RR usually trumps increasing inspiratory flow, but can do both!
May increase PaCO2 → permissive hypercapnea is usually well tolerated

Question 6
A 60-year-old man presents to ED with shortness of breath.
Chest x-ray: bilateral diffuse airspace opacities.
ABG: PaO2 of 50 mm Hg on a 100% non-rebreather facemask. The patient is intubated and brought to the ICU.
A pulmonary artery catheter is placed; cardiac output is 3.0 liters per minute.
ABG: PaO2 of 60, sat’n 90% on FiO2 of 0.7. Hemoglobin: 8 mg/dL.

Which of the following interventions would result in the greatest increase in oxygen delivery to the patient’s tissues?
A. Add dobutamine to increase the cardiac output from 3.0 to 6.0
B. Transfuse to increase Hgb from 8 to 12 mg/dL
C. Increase in FiO2 to raise the PaO2 from 60 to 100
D. Increase in FiO2 to raise the oxygen saturation from 90 to 95%

Question 6
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D. Increase in FiO2 to raise the oxygen saturation from 90 to 95%
Oxygen Content and Delivery

Oxygen Content

\[ \text{CaO}_2 = (1.34 \times \text{Hgb} \times \text{SaO}_2) + \text{dissolved O}_2 \]

\[ = 1.34 \times 8 \times 0.90 + 0.003 \times 60 = 9.6 + .18 = 9.78 \text{ mg/dL} \]

Oxygen Delivery

\[ \text{DO}_2 = \text{CO} \times \text{CaO}_2 \]

Oxygen Content and Delivery

? is "What would increase" NOT what should you do...

<table>
<thead>
<tr>
<th>Initial</th>
<th>Hb</th>
<th>SaO2</th>
<th>CO</th>
<th>DO2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8.0</td>
<td>0.9</td>
<td>3.0</td>
<td>29.4</td>
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A. Increase CO

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<td>8.0</td>
<td>0.9</td>
<td>6.0</td>
<td>58.7</td>
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</table>

B. Increase Hb

<table>
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<th>CO</th>
<th>DO2</th>
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<tbody>
<tr>
<td>12.0</td>
<td>0.9</td>
<td>3.0</td>
<td>44.0</td>
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C/D. Increase O2

<table>
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<td>8.0</td>
<td>0.95</td>
<td>3.0</td>
<td>31.4</td>
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CaO2 = (1.34 \times \text{Hgb} \times \text{SaO}_2) + (0.003 \times \text{PaO}_2)

Question 7

- 31 yo man is brought to ER after being found unresponsive. Minimally responsive to deep pain. BP 136/82, pulse 124, RR 32. Pupils 6 mm/reactive. Normal exam.
- Na 136  K 4.7  Cl 98  CO2 10  Glucose 87
- BUN 26  Cr 1.6
- Measures serum osmolality: 332 mOsm/kg
- ABG 7.23/24/118

Urine Sediment

Question 7

Which of these is the most likely cause of his presentation?

A. Acetaminophen overdose
B. Ethanol overdose
C. Methanol ingestion
D. Ethylene glycol ingestion
E. Tricyclic antidepressant overdose

Differential Diagnosis of Osmolar Gap with Acidosis

Serum Osmolality = (Na x 2) + (Glu/18) + (BUN/2.8)

- Methanol
- Ethylene glycol
- Paraldehyde
- Formaldehyde
- ESRD
- Diabetic ketoacidosis
- Alcoholic ketoacidosis
- Lactic acidosis
Ethylene Glycol

Treatment of Ethylene Glycol Overdose
- Support basic functions
- Airway/Breathing/Circulation
- NaHCO3 for acidemia
- Inhibit alcohol dehydrogenase with either fomepizole or alcohol
- Dialysis for metabolic acidosis, ethyl gly > 50, or end-organ damage

Question 8
A 75 year old man with lung cancer and newly discovered 1.5 cm brain mass presents with productive cough, fever to 104 F (40.0 C), pulse 115, BP 70/40. Exam: lethargic man with crackles in the right base.
Labs: Hgb 10.5 mg/dl, WBC 18K with left shift, BUN of 54, lactic acid level 6 meq/L (nl .6-1.8)

After 2L NS, pulse 110, BP 75/50

At this time, you should:
A. Give 100 mg Hydrocortisone IV
B. Insert a central line and measure CVP
C. Start activated protein C (drotrecogin) IV
D. Start vasopressin IV
E. Transfuse packed RBCs

Septic shock and resuscitation

Fill the tank, then squeeze, is the basis of Early Goal Directed Therapy (EGDT) in the resuscitation management of septic shock (don't want to forget about airway/need for intubation/ early source identification/ antibiotics)

**Septic shock and resuscitation**

*Fill the tank*: We are not good at estimating low intravascular volume on exam. Even with higher BP, elevated lactic acid level in this setting suggested decreased tissue perfusion.

**EGDT**: place CVP line then give volume until CVP goal of 8 to 12 mmHg

Other goals:
- MAP > 65 mmHg
- Urine output > 0.5 mL/kg/hour
- Mixed venous oxygen saturation ≥70%

*Early* means get to goal within 6 hours.

---

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A 75 yo man with...

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**Want you to know when NOT to use, so look for bleeding risks**

---

**Question 9**

A 48 yo woman... BP 65/40.

You should order (in addition to volume resuscitation):

A. Abdominal CT scan
B. Ceftriaxone + Vancomycin
C. Glucagon
D. Hydrocortisone
E. Thyroxine

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**Question 9**

48 year old woman with Graves Disease and early menopause, chronic fatigue presents with nausea and vomiting. While walking into the ED, she passes out. Her BP is 65/40.

*Relative adrenal insufficiency may be considered if pressor dependent AFTER volume resuscitation*

Labs: Hct 36% Glucose 67 mg/dl
BUN 28 mg/dl Creat 1.0 mg/dl
Sodium 134 meq/L Potassium 5.1 meq/L
Chloride 98 meq/L Bicarb 25 meq/L

**Chronically ill in the ICU → restrictive transfusion better**

**Acutely ill in the ICU → part of EGDT**

*May improve oxygen delivery, but has risks; fill tank first*
Question 9
Relative adrenal insufficiency proposed as a mechanism for persistent hypotension in sepsis.

**Benefit:** Annane D et al. JAMA. 2002;288:262 criticized because etomidate used in many which can inhibit glucocorticoid synthesis

**No benefit:** CORTICUS study: Sprung CL et al. NEJM 2008;358:111

Don’t let this controversy make you miss true (but rare) Addisonian crisis.

Question 9
This woman: Other autoimmune endocrine problems (Graves Disease), early menopause (ovarian failure?), with classic symptoms of fatigue, then with signs (N/V) and syncope, hypotension.

Labs: Clues are
- Glucose 67 loss of glucocorticoid
- Sodium 134 loss of mineralocorticoid
- Potassium 5.1 loss of mineralocorticoid

If CBC with differential, look for elevated eosinophil count

This woman: likely has autoimmune adrenalitis (most common cause of Addison’s disease in US)

You should order (in addition to volume resuscitation):
- A. Abdominal CT scan
- B. Ceftriaxone + Vancomycin
- C. Glucagon
- D. Hydrocortisone
- E. Thyroxine

Meningococcemia can cause adrenal crisis, but nothing on exam

If adrenal insufficiency possible, Never given thyroid replacement first

Is a treatment for hypoglycemia if no IV access, if IV access, just give glucose (in this case need D5NS – need glucose & volume)

Question 10
57 year-old man with obesity, hyperlipidemia, HTN underwent CABG this morning. He is still intubated and on vasopressors. Post–op glucoses are in the 200-230 mg/dl range. You recommend:

A. Stopping epinephrine drip
B. Obtain Hgb A1c
C. Sliding scale sq regular insulin
D. IV insulin drip
E. Nothing

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**Question 10**

Patient with metabolic syndrome and not surprising that with stress of surgery + exogenous epi/norepi (counter-regulatory hormones) glucose is elevated post-op.

Why intervene?  
- Intensive insulin therapy to keep glucose ≤ 110 decreased morbidity in mortality in SICU
- Benefit greatest in patients in SICU for > 5 days
- It has become a Practice Guideline

Is it good for everyone?

- Intensive insulin therapy to maintain glucose 80-110 mg/dl vs. conventional sliding scale
- Target: MICU patients who were considered to need ICU care for at least 3 days.
- MORBIDITY: Intensive insulin → decreased ICU length of stay, faster vent weaning
- MORTALITY: No change overall, AND HIGHER if short length of stay

**Question 11**

45 year old man presents with alcoholic pancreatitis. A feeding tube is placed and the following x-ray is obtained.

45 year old man … pancreatitis.  You should:
A. Place central line for TPN, patient will not be able to tolerate full enteral feedings  
B. Insert feeding tube further until tip is in jejunum  
C. Start semi-elemental enteral feedings  
D. Start semi-elemental enteral feedings only when amylase has returned to normal  
E. Remove tube and order chest x-ray

**Pancreatitis & Nutrition**

Enteral feedings
- Lower infectious complications
- Maintains intestinal barrier
- No TPN infection risks
- Pancreatic stimulation decreases the further away from pylorus
- Place early, patients have high metabolic demands
- Not going to be able to wait for normalization of labs
- If unable to achieve goal (pain, ileus), may need supplemental TPN
**Question 11**

This patient however…. Tip of tube in LLL bronchus

![Image of tube in bronchus](image_url)

You should:

- A. Also place central line for TPN, patient will not be able to tolerate full enteral feedings for caloric needs
- B. Insert feeding tube further until tip is in jejunum
- C. Start semi-elemental enteral feedings
- D. Start semi-elemental enteral feedings only when amylase has returned to normal
- E. Remove tube and order chest x-ray

**Question 12**

52 year old man is 1 day post-op from repair of liver/spleen/pancreas lacerations from blunt trauma (MVA). Intra-op, he required 8 units of pRBCs, 8 L of Lactated Ringers. In last few hours, BP has decreased from 110/80 to 90/55. On ventilator, peak and plateau airway pressures have increased. Urine output has fallen to < 20 ml/hr. CVP has increased from 10 cm to 16 cm H2O.

Exam reveals good bilateral breath sounds, tachycardia without murmurs. Abd: distended, heavily bandaged without change in dressing color.

CXR: Bilateral elevated hemidiaphragms, No pneumothorax, no free air

ECG: Sinus tachycardia, no ischemic changes

ABG: This morning 7.44/41/87
   Now on same vent settings 7.28/55/60

Lactic acid level is 4.0 meq/L

You should…

- A. Cross table lateral KUB to check for free air
- B. IV norepinephrine (Levophed)
- C. NaHCO3 in anticipation of stat abdominal CT scan
- D. Stat Echocardiogram to rule out tamponade
- E. Urinary bladder pressure

**Question 12**

52 yo post-op abd trauma, PRBC/volume resuscitated. Now with dropping BP, urine output, elevated lactate, poor gas exchange, smaller lungs.

You should order:

- A. Cross table lateral KUB to check for free air
- B. IV norepinephrine (Levophed)
- C. NaHCO3 in anticipation of stat abdominal CT scan
- D. Stat Echocardiogram to rule out tamponade
- E. Urinary bladder pressure
**Abdominal Compartment Syndrome**

Increase in abdominal pressure which compromises tissue perfusion locally AND pressure backs blood up (rising CVP & PCWP)

- Also presses diaphragm up, so increased airway pressures, smaller lung volumes
- Can also increase ICP
- Suspect if tensely distended abdomen, progressive oliguria, and increased ventilatory requirements.
- **Measure bladder pressure**

---

**Question 13**

What is the MOST common cause of abdominal compartment syndrome?

A. Abdominal trauma  
B. Burns  
C. Ischemic bowel  
D. Massive ascites  
E. Necrotizing pancreatitis

---

**Question 14**

65 yo man s/p MVA w/ bilateral femoral & pelvic fractures & splenic laceration. In OR: stabilization of fractures and splenectomy. Resuscitated with 5 units RBCC/ 7 L LR. Extubated.

48 hours post-op, agitated and tachypneic.


Labs: Hct 37%  WBC 14K  Platelets 70,000  BUN/creatinine – normal  ABG on 60% FM 7.49/28/50

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**Measure bladder pressure**

- Normally 0, but slight increase on vent
- Inject 50 cc of sterile saline into aspiration port, clamp drainage tube, jab another 18 gauge needle into aspiration port and attach to pressure transducer
- < 10 mmHg normal; > 25 mmHg severe
- Manage – back to OR to decompress

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B. Burns  
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Anything with vigorous volume resuscitation, inflammatory process with capillary leak, space occupying (retroperitoneal bleed, ascites) or with non-distending skin (burns)

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**Question 14**

65 yo with MVA...

The deterioration is MOST consistent with:

A. Abdominal compartment syndrome  
B. Air embolism  
C. Fat embolism  
D. TRALI  
E. TTP (Thrombotic thrombocytopenic purpura)
Question 14
65 yo with MVA…

The deterioration is MOST consistent with:
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C. Fat embolism
D. TRALI
E. TTP (Thrombotic thrombocytopenic purpura)

TRALI?
Transfusion Related Acute Lung Injury
- Leukoagglutination: reaction of anti-granulocyte antibodies (donor) and granulocytes (recipient) → endothelial injury → ALI
- Risk from all blood products, greatest with FFP
- Problem with donor, not recipient, esp. multiparous donors
- Blood bank implications → that donor cannot donate
- Recipient is not at higher risk for another reaction
- Fever, tachycardia, and tachypnea within first few hours post transfusion
- Supportive care, typically resolves by 48 hours

Air vs. FAT Embolism

<table>
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<tr>
<th>Air embolism</th>
<th>Fat embolism</th>
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<tbody>
<tr>
<td>After neuro or ENT surgery or central vein manipulation</td>
<td>After long &amp; pelvic bone fracture, SCA, lipid infusions</td>
</tr>
<tr>
<td>Acute dyspnea “air lock” can plug PA</td>
<td>24-72 hours post fx: Acute dyspnea → ALI</td>
</tr>
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| If to arterial side, stroke or other organ damage | CNS – confusion
Fat emboli to skin, eyes |
| Low platelets if endothelial injury | DIC syndrome |
| Dx: Echo or CT Rx: If R heart air, L decub Trendelenberg, remove air, support, hyperbaric | Dx: Clinically Rx: Supportive |

Oscar Award for Best Name in Transfusion Medicine

- TACO Transfusion-Associated Circulatory Overload

Think Outside the Blood

Question 15
75 year old man from nursing home on chronic antibiotics for lung abscess develops diarrhea. He presents with fever, hypotension, and increasing abdominal distention 2 days after starting po metronidazole for C. difficile. Abdominal CT shows marked colonic dilatation and wall-thickening; pt taken to OR for subtotal colectomy/end ileostomy/mucus fistula.

What next?

You should:
A. Look for another cause of the colonic distension; C. diff does not do this
B. Grab the nearest can of alcohol foam to clean your hands
C. Switch to IV metronidazole & po vancomycin
D. Start IV vancomycin → he looks sick!

Question 15
60 year old s/p subtotal colectomy…

What next?
**Question 15**

60 year old s/p subtotal colectomy..
What next?

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- C. Switch to IV metronidazole & po vancomycin
- D. Start IV vancomycin → he looks sick!

**Severe C. difficile Colitis**

- No consensus definition
  - WBC > 20k
  - Elevated creatinine
  - Esp. with first episode (rather than relapse)
  - Can have no diarrhea! Or if diarrhea decreases while abdomen expands → think toxic megacolon
- Switch to oral vancomycin & IV metronidazole; add pr if bad ileus may be slowing delivery
- Metronidazole & vancomycin equally effective for the treatment of mild dis, but vancomycin is superior for treating patients with severe dis.