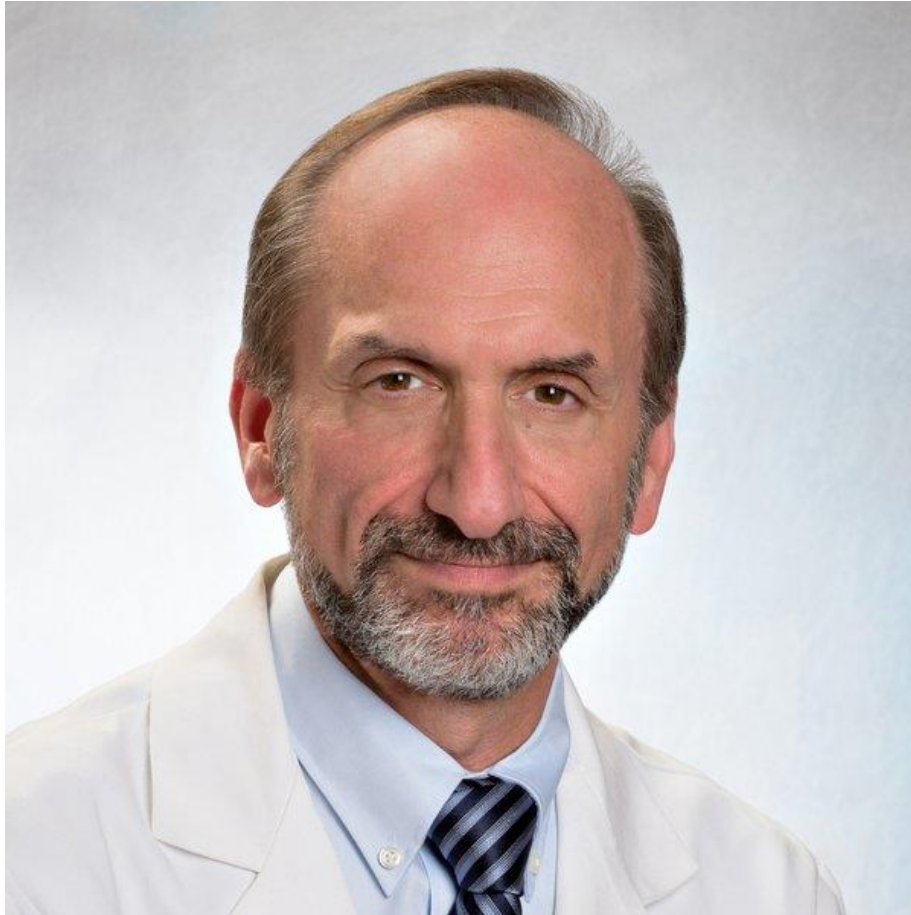


Critical Care Board Review

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- Assistant Professor of Medicine at HMS
 - Clinical and research interest in sleep and delirium in the critically ill.

Disclosures

- None

Case #1

- **60 yo man has a witnessed arrest. Bystander CPR is begun; EMS called.**
- **On arrival, he is pulseless. AICD identifies a shockable rhythm. He has ROSC and is transported to the ED where he is found to have ST elevations.**
- **He is transferred to the ICU as resources are being mobilized. He remains unresponsive but his SBP is 120 mm Hg.**

Case #1

Which of the following is true:

- A. Targeted temperature management has to wait until after revascularization
- B. CT head should be the priority to rule out intracranial bleed and EEG to rule out non-convulsive seizures
- **C.** Coronary revascularization is the priority
- D. Palliative care consult should be obtained to discuss goals of care before any procedure is done
- E. If he is still unresponsive six hours after the arrest then his prognosis can confidently be determined to be poor.

Active temperature control

Goal for active temperature control are:

- 33°C (also known as therapeutic hypothermia [TH]) for at least 24 hr for patients with moderate or severe brain injury (*loss of motor response and/or brainstem reflexes, cerebral edema, malignant EEG patterns*)
- Between 36 and 37.5°C (ie, targeted normothermia) for 24 hr for patients with mild brain injury, higher risk of bleeding, trauma, recent surgery, septic shock.

Clinical parameters associated with poor prognosis

<u>Clinical parameters</u>	<u>Unfavorable prognosis</u>
• Duration of anoxia	>8-10 minutes
• Duration of CPR	>30 minutes
• Pupillary light reaction	Absent on day 3
• Motor response to pain	Absent on day 3
• Brainstem reflexes	Absent
• Blood glucose on admission	>300 mg/Dl
• Glasgow coma score on day 3	<5

Favorable predictors of gaining independence

- **Pupillary light reflex and spontaneous eye movements on initial exam**
- **Motor withdrawal or better and eye opening on Day 1**
- **Motor withdrawal or better and spontaneous eye movements normal Day 3**
- **Obeying commands at one week**
- **Normal oculoccephalic response at 2 weeks**

Case #2

- 56 yo woman with a history of alcohol use disorder presents with cellulitis and is admitted to the hospital ward. On hospital day 2 she is found to be confused and agitated. Her blood pressure is 150/95 and she is tachycardic. She is transferred to the ICU for further care.

Case #2

Which of the following is true?

- A. Benzodiazepines should be avoided because of their association with ICU delirium
- B. She should have her antibiotics broadened because she is septic
- C. She should be loaded with phenobarbital immediately
- D. ICU transfer was not necessary; she could have been managed on the floor.
- **E.** CIWA scales are not specific for alcohol withdrawal

A few points

- **Alcohol withdrawal**
 - **Diagnosis predicated on history and clinical information.**
 - **Has a broad differential dx**
 - **Treated with benzodiazepines, not ethanol**
 - **Adjuncts may be used to further control HTN, hallucinosis, seizures, etc**

Case #3

- A 25 yo man with AML, s/p 2 cycles of chemotherapy, presents with 24 hr of worsening dyspnea, fever with T_{\max} 38.7 °C.
- BP= 96/55. WBC=0.8K
- 7.30 / 30 / 67 / 15
 - 40% FM

Interpretation: Pure metabolic acidosis with hypoxemia



Question #3a

- He is admitted to the ICU, placed on broad spectrum antibiotics, IV fluids, and increased to 60% O₂ by FM.
 - 6 hr later he seems more tired, breathless, but lucid.
 - ABG: 7.25 / 35 / 87 / 15
 - What would be the next most appropriate intervention?
- A. Intubate immediately for hypercarbic respiratory failure and begin assist control ventilation
 - B. Decrease the FiO₂ for possibly causing the increased pCO₂
 - C. Apply non-invasive positive pressure ventilation
 - D. Decrease the IVF for possible CHF
 - E. Extracorporeal membrane oxygenation (ECMO)

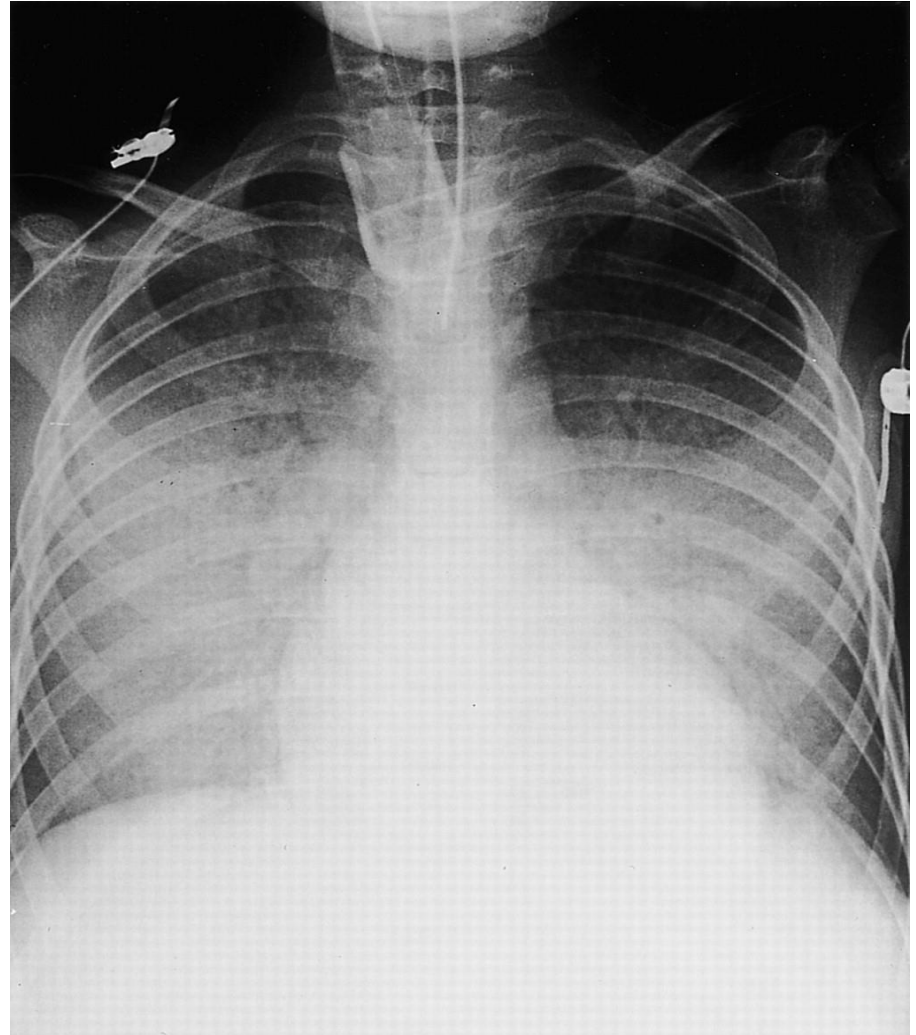
Question #3a-1

If his blood pressure does not respond to 2 liters balanced crystalloid, what would you do next?

- Consider more fluids? How would you determine if he needs more fluids?
- Start vasopressors?
- Would a PA catheter improve outcome?
- If vasopressors, which one(s)?

Case #3b: the story continues

- Despite appropriate care, the patient deteriorates within hours and is intubated for progressive, refractory hypoxemia. He is diagnosed with ARDS based on standard criteria:
- $\text{PaO}_2:\text{FiO}_2 < 200$
- Extensive b/l infiltrates
- No CHF or PCWP < 18

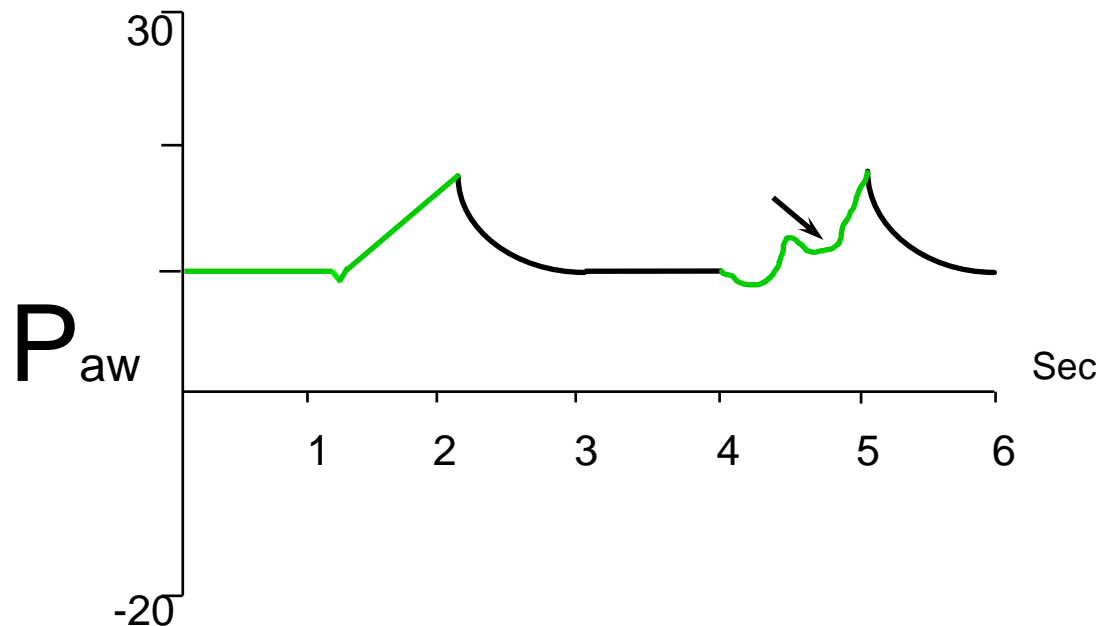


Question #3b

- You are called to evaluate him for agitation.
- He is on: AC ventilation, T_v 450 (6 ml/kg), PEEP 10 cm H_2O , FiO_2 0.6

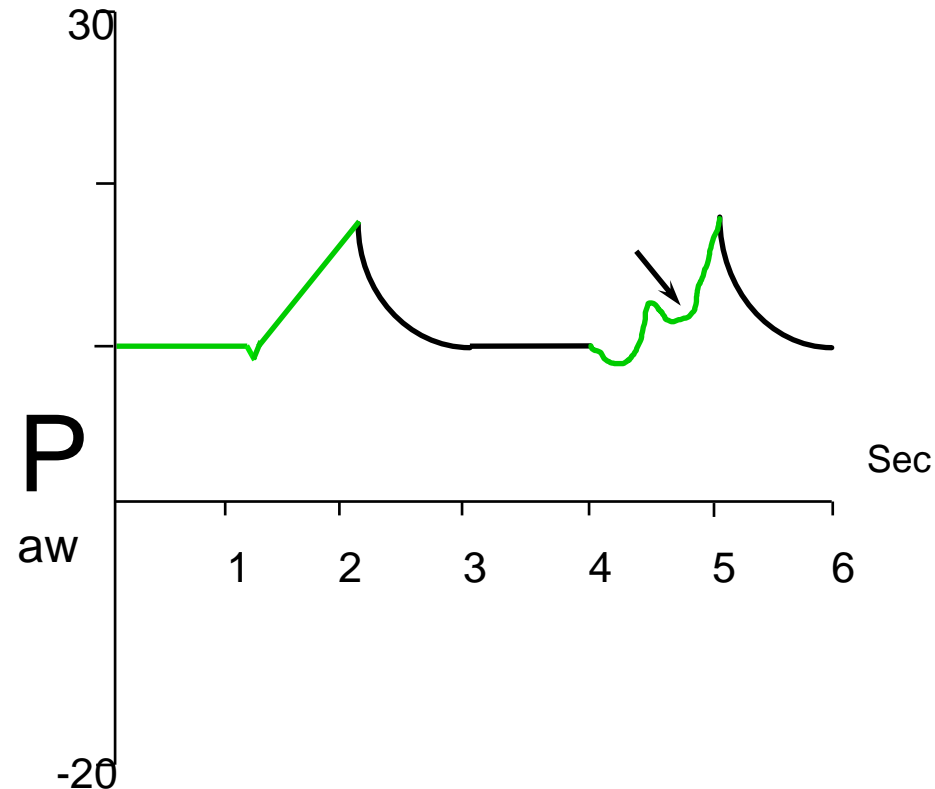
His pressure/time waveform is presented here:

What's going on
(at the arrow)
and what can be
done about it?



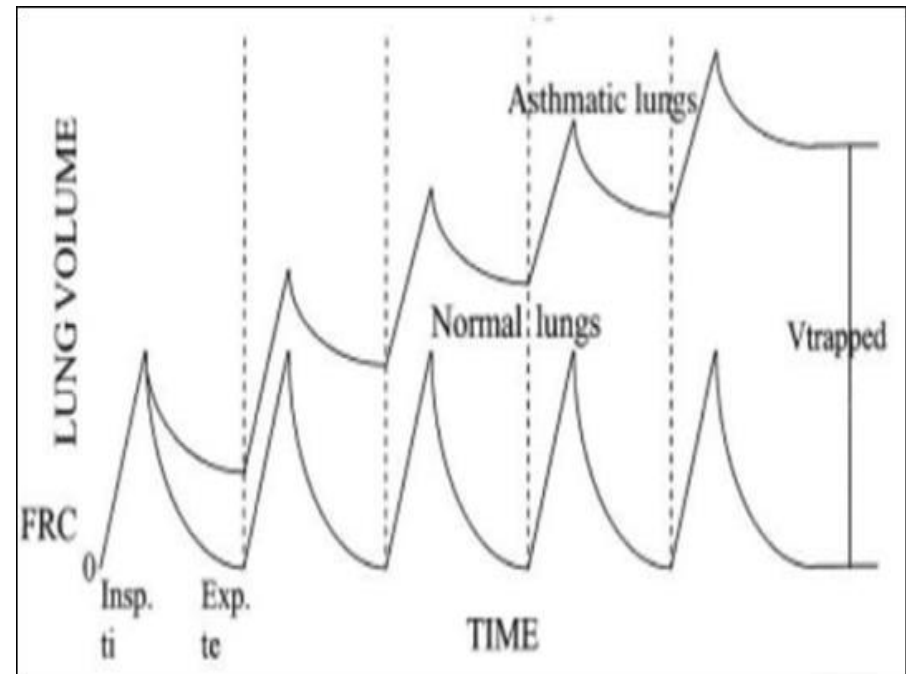
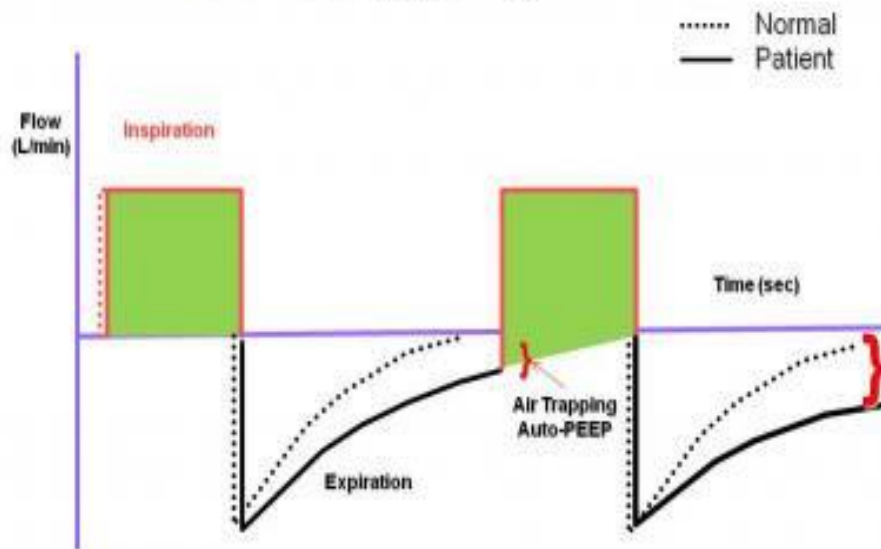
Question #3b continued

- A. Ventilator malfunction. Bag the patient and change the machine.
- B. Patient:ventilator dyssynchrony. Sedate the patient more heavily.
- **C. Air hunger. Increase the inspiratory flow.**
- D. Air hunger. Increase the tidal volume.
- E. Auto-PEEP. Increase set PEEP to match the auto-PEEP to lessen his workload.



Auto PEEP/Air-trapping

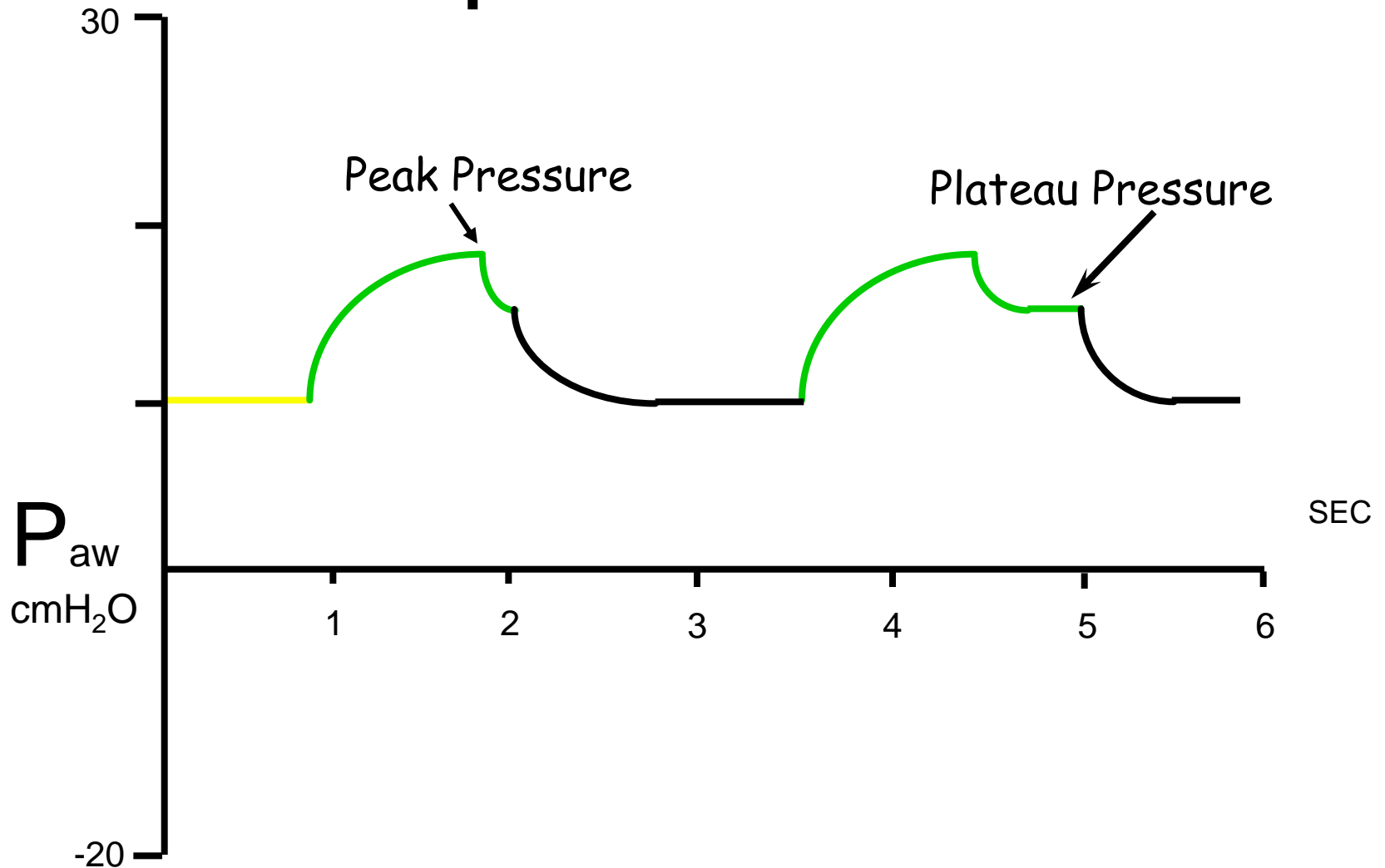
Air Trapping



Case 3c

- **After 6 days, the patient is improving. He is hemodynamically stable.**
- **Vent settings: Assist control ventilation, 10 breaths/min, Tidal volume 450 cc, PEEP 7.5, FiO₂ 0.4**
- **The respiratory therapist tells you that his peak inspiratory pressure increased from 22 to 34 and his plateau pressure from 15 to 17.**
- **Which of the following is most likely going on?**
- A. His endotracheal tube migrated into his right mainstem bronchus
- **B. Kinked ETT**
- C. CHF
- D. Pulmonary embolism
- E. This is part of the natural history of ARDS

Case #3c Explanation: Compliance/Resistance



Compliance/Resistance

↑P_{peak} ↑P_{plateau} ↑P_{peak} P_{plateau} without change

- ↓Compliance

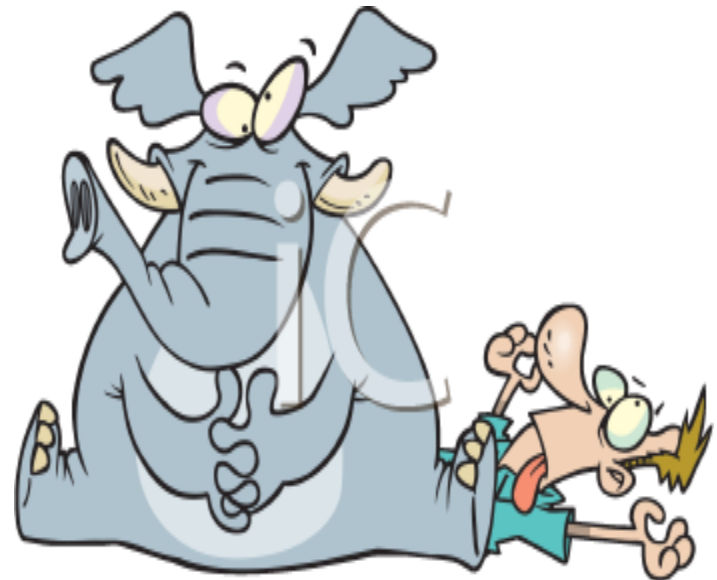
- CHF
- Pulmonary fibrosis
- Pneumothorax
- Mainstem intubation
- Abdominal compartment syndrome
- Circumferential burn of thorax

- ↑Resistance

- Bronchospasm
- Mucous plug
- Kinked endotracheal tube

One final point

- **Measurements of resistance and compliance on the mechanical ventilator reflect the sum of all forces on the respiratory system, not just the lung itself which is what is of most interest.**
- **Variables include:**
 - Chest wall
 - Abdominal wall/abdominal contents
 - Obesity



Case #4

- 73 yo man with htn, CRI, hypothyroidism, PVD, now POD #2 Whipple procedure for pancreatic cancer
- Becomes restless, combative
- BP- 140/95, HR- 110/min.
- Pt has a hx of 45 pk-yr cigarettes, 1-2 drinks with dinner, perhaps more sometimes.
- Since the OR he is receiving a PCA opioid for pain, lopressor to manage BP, synthroid, Lasix x 1 dose.

You are asked to come and evaluate

Question #4

- Uncooperative, belligerent, paranoid ideation
- 165/84 (normally 130/75)
- HR 115/min
- Na 134 creat 1.5
(baseline 1.4)
- TSH normal

What is the correct diagnosis?

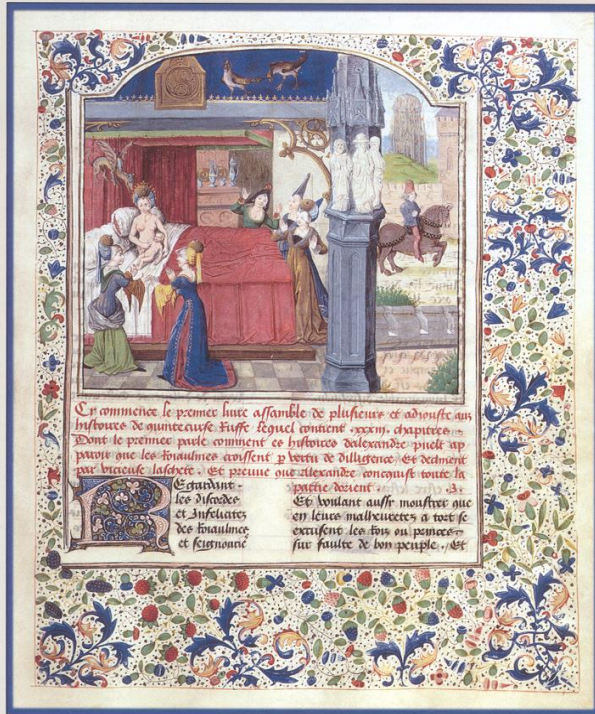
- A. Alcohol withdrawal
- B. Non-alcohol related ICU delirium
- C. Medical disorder (CNS infection, thyrotoxicosis, etc).
- D. Psychiatric disorder (ie psychosis).
- **E. Insufficient information**

ICU Delirium

JAMA[®]

April 14, 2004

The Journal of the American Medical Association



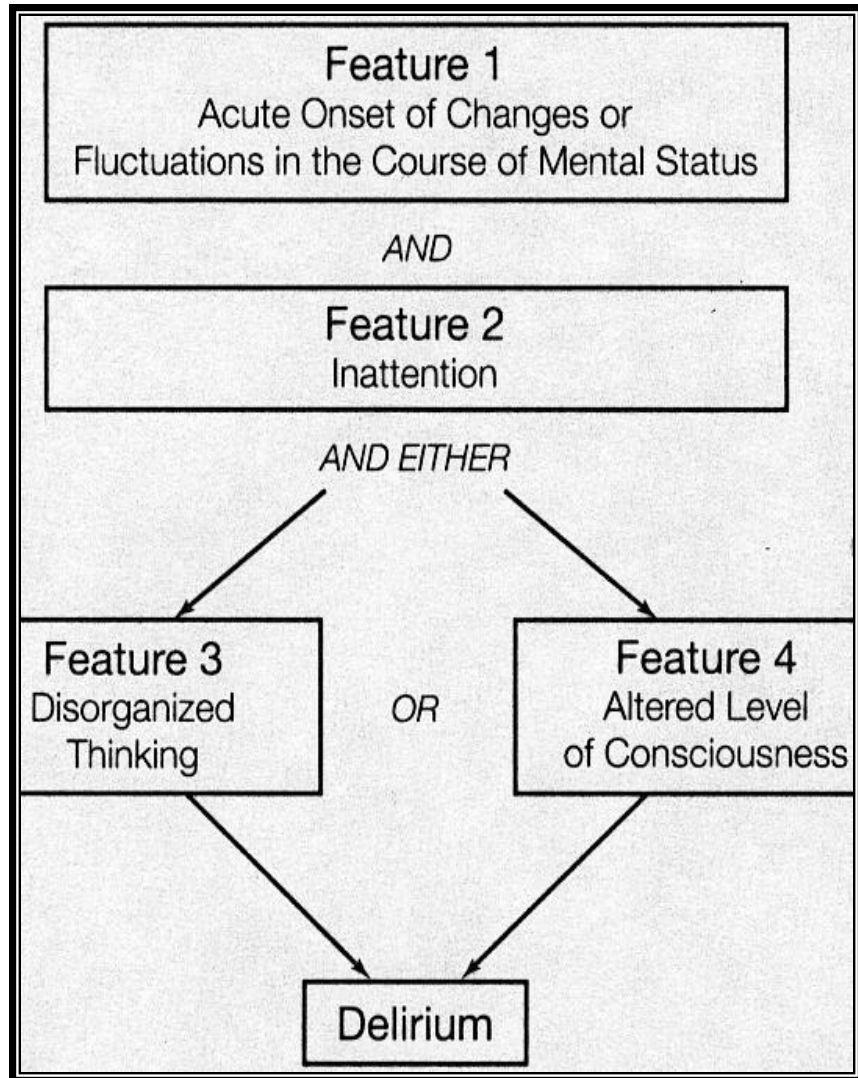
- **Implications:**
 - 3 times higher risk of death by 6 months
 - \$15k to \$25k higher hospital costs
 - 5 fewer ventilator free days (days alive and off vent), adjusted P=0.03

CARING FOR THE
CRITICALLY ILL PATIENT

Delirium as a Predictor of Mortality
in Mechanically Ventilated Patients
in the Intensive Care Unit

Ely EW et al, JAMA 2004;291-1753-1762

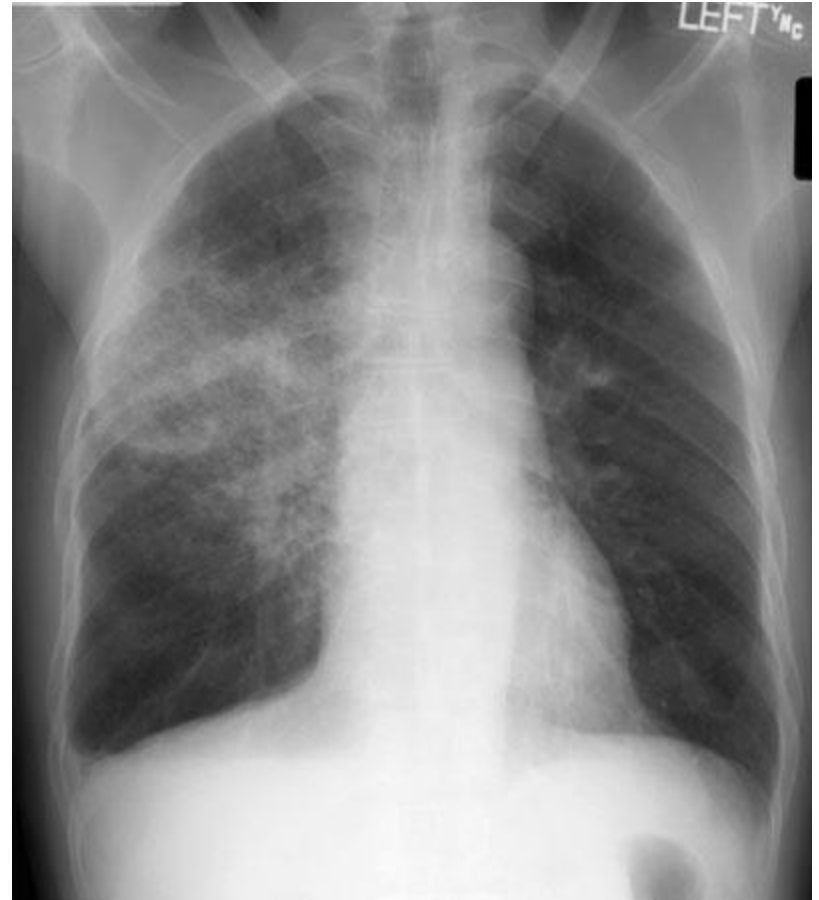
ICU Delirium



- **Treatment: the 4 “P’s”**
 - Prevention
 - Prevention
 - Prevention
 - Psychotropics ?
- Remember your ABC(DEF)’s
- Avoid Polypharmacy

Case #5

- An 81 yo man is admitted for pneumonia.
- Vital signs: BP 100/60 (normally 140/80), HR 110/min, T-101.8. Not on vasopressors.
- Initial labs:
 - WBC-12K
 - Electrolytes normal
 - Blood glucose 180 mg/dl



Question #5

- **Which of the following is true?**
- A. He should be started on full nutrition by any means possible asap
- **B. Early enteral nutrition should be started within the first 24-48hr of ICU admission when possible**
- C. If assessed to be undernourished at ICU admission, he should receive 200% of the recommended daily caloric requirement for ideal body weight
- D. Obese patients should receive low protein, low calorie diets
- E. If he is hyperglycemic, he should have a low carb diet

Nutrition nuggets

- Avoid holding enteral nutrition for more than one hour per day. Gastric residual volume measurements, if checked, should be less than 500 ml.
- If a patient is at high nutritional risk (severely malnourished) and unable to start enteral nutrition, then parenteral nutrition should start asap. Goal: 80% of energy need with adequate protein (> 1.2 g/kg/d)
- Blood glucose goal is 140-180 mg/dl for the general ICU population
- Obese patients should receive **high** protein (2 gm/kg for IBW BMI 30-40 and 2.5 gm/kg IBW BMI > 40). But they should have a hypo-caloric diet.

Case #6

- A 55 yo woman with a history of major depression, diabetes, and hypothyroidism is admitted for a deep soft tissue infection, possible early sepsis.
- Vital signs: T-100.4, HR-110/min, BP 100/60 (baseline in the office: 130/80).
- She is anxious but responding appropriately.
- Home Meds: citalopram, amitriptyline, aspirin, insulin, levothyroxine
- She is treated with linezolid and cefepime pending blood cultures. Her home medications are continued, and she is given a dose of trazadone to help her sleep.
- In the morning, approximately 10 hours after admission, her Temp is 103.5, BP 145/90, HR 130/min.
- She is tremulous, hyperreflexic, and mildly diaphoretic and agitated.

Question #6

- **Which of the following is true?**
 - A. She is probably withdrawing from alcohol and should be treated with benzodiazepines.
 - B. She is probably hypoglycemic and should receive D50 immediately.
 - C. She probably has neuroleptic malignant syndrome and should be treated with bromocriptine.
 - **D. If benzodiazepines don't help, cyproheptadine might be indicated.**
 - E. Her antibiotic coverage is probably inadequate and should be broadened.

Serotonin syndrome

- **Drugs:** SSRI, SNRI, MAOI
- **Signs/symptoms:** Clonus, agitation, ocular clonus, diaphoresis, tremor and hyperreflexia, hypertonia, fever > 38C
- **Treatment:** stop the drugs, sedate with benzos, oxygen, supportive care.
- If above not successful, then cyproheptadine

Serotonin syndrome: Differential diagnosis

Disorder	Causative Agent	Onset/Resolution	Symptoms
Serotonin Syndrome	Postexposure to serotonin agonists	Develops within 24 hours; resolves within 24 hours with treatment	Altered mental status, muscle rigidity (especially in the lower extremities), hyperreflexia, increased bowel sounds, diaphoresis
Neuroleptic Malignant Syndrome	Postexposure to dopamine antagonists	Develops over a period of days to weeks; resolves in approximately 9 days with treatment	Neuromuscular hypoactivity manifesting as rigidity and bradyreflexia
Malignant Hyperthermia	Postexposure to inhalational anesthetics or depolarizing muscle relaxants (succinylcholine)	Develops within minutes or within 24 hours; resolves within 24 to 48 hours with treatment	Rising end tidal carbon dioxide, mottled skin with areas of flushing and cyanosis, rigidity and hyporeflexia
Anticholinergic Toxicity	Postexposure to anticholinergic agents	Develops within 24 hours; resolves within hours to days with treatment	Urinary retention, decreased bowel sounds, hot and dry erythematous skin with normal muscle tone and reflexes

Serotonin syndrome: Treatment

Symptoms	Management
Mild Mild hypertension, tachycardia, mydriasis, diaphoresis, shivering, tremor, myoclonus, hyperreflexia	Discontinue the offending agent/agents Support via stabilizing vital signs, cooling measures Mild agitation, fever, hypertension, and tachycardia: benzodiazepines (diazepam) Observe for at least 6 hours
Moderate Above plus temperature of at least 40°C, hyperactive bowel sounds, ocular clonus, agitation, hypervigilance, pressured speech	All of the above Severe agitation and hyperthermia: 5HT-antagonist (cyproheptadine) Admission to hospital for cardiac monitoring and observation
Severe Above plus temperature greater than 41.1°C, dramatic swings in pulse rate and blood pressure, delirium, muscle rigidity	All of the above Severe hypertension/tachycardia: esmolol or nitroprusside Sedation and paralysis with a nondepolarizing agent and intubation/ventilation Admission to the intensive care unit

Case #7

- A 45 yo man with sarcoidosis is admitted to the ICU for hemoptysis. He estimates approximately 300 ml bright red blood over the past 6 hours.
- Recent pulmonary function:
 - FEV₁-1.3 L (40% predicted)
 - TLC- 55% predicted
 - DLCO- 40% predicted
- ABG on admission:
 - 7.54 / 25 / 67 / 21



Question #7

Which of the following is NOT true?

- A. Bleeding is most likely coming from a branch of the bronchial artery, not the pulmonary artery.
- **B.** Cough suppressants are contraindicated.
- C. A thoracic surgeon should be called.
- D. Inhaled tranexamic acid (TXA) could help stop the bleeding
- E. Bronchoscopy would be the better initial test compared with CT scan.

Case #8

- **A 41 yo man is intubated for respiratory distress, impending respiratory failure.**
- **Past medical history: obesity, DM, asthma.**
- **He weighs 280 lbs, BMI-39.**
- **Which of the following is true?**
- **A.** There is no specific recommended anticoagulant or specific dose for VTE chemoprophylaxis
- B. His ICU mortality is higher than someone of normal weight
- C. He is likely to have more central line complications than someone of normal weight.
- D. His actual body weight is used to determine all medication dosing
- E. When setting the tidal volume on his ventilator, his current weight rather than ideal body weight must be used.

Summary points

Case #1:

- -For comatose survivors of cardiac arrest, temperature management is a core strategy; the exact goal T is debated
- -Neuroprognosis is based on serial exams over time and cannot be done until the patient is re-warmed.

Case #2:

- Major alcohol withdrawal is a critical illness with 5% mortality.
- First line treatment is benzodiazepines.

Case #3:

- Non-invasive ventilation is appropriate for acute respiratory failure under some circumstances (COPD exacerbation, CHF, febrile neutropenia)
- Agitation on mechanical ventilation is often related to patient-ventilator asynchrony and should be treated accordingly rather than with sedation.
- Pulmonary mechanics may help distinguish between problems related to static vs dynamic compliance which can help lead to diagnosing the problem

Summary points

Case #4:

- ICU delirium is common, serious, not inevitable, and is best treated by prevention, not pharmacotherapy

Case #5:

- Early enteral nutrition is the goal for those who have no contraindication. Adequate protein is a priority
- Poor glucose control in a critically ill patient is associated with poor outcomes but “tight” control is associated with episodes of hypoglycemia which may negate the gains. 140-180 mg/dl is the goal

Case #6:

- Serotonin syndrome is characterized by clonus, diaphoresis, tremor and hyperreflexia, fever. It has a differential dx that includes NMS, MH, and CNS infection

Case #7:

- Hemoptysis is usually from the bronchial artery.
- Treatment priorities are to localize it, isolate it, and then consider the strategy for stopping it

Case #8:

- Obesity is associated with longer time on mechanical ventilation but NOT mortality.
- Care should be taken to consider medication dosing, nutrition, and an aggressive, tailored approach to liberation from mechanical ventilation