

III. Acute Pulmonary Edema

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Learning Objectives:

1) Knowledge:

Subinterns should be able to:

- a) Understand the pathophysiology behind both cardiogenic and noncardiogenic causes
- b) Recognize the etiologies of cardiogenic pulmonary edema including:
 - myocardial ischemia
 - valvular disease (acute aortic insufficiency, mitral regurgitation, mitral stenosis)
 - renovascular hypertension
 - tachycardia
 - other underlying conditions that may precipitate pulmonary edema (fever, sepsis, thyroid disease, anemia)
- c) Recognize the etiologies of noncardiogenic pulmonary edema including:
 - ARDS
 - Re-expansion pulmonary edema
 - High altitude pulmonary edema
 - Neurogenic pulmonary edema
 - Transfusion related acute lung injury (TRALI)
 - Opiate toxicity
 - Salicylate poisoning
 - Reperfusion pulmonary edema
 - Pulmonary embolus
- d) Recognize the clinical symptoms and signs of pulmonary edema
- e) Assess the severity of a patient's condition based on clinical presentation, laboratory and radiographic data (ECG, CXR, ABG)
- f) Identify other conditions that may closely mimic acute pulmonary edema in clinical presentation (PE, pneumonia, ARDS)

- g) Describe indications for emergent treatment regimens in acute pulmonary edema such as:
- Oxygen
 - Diuretics
 - Vasodilators
 - Morphine
 - ACE inhibitors
 - Inotropic agents
- h) Describe the mechanisms of actions of the above medications in the treatment of pulmonary edema
- i) Describe the major indications for intubation and mechanical ventilation
- j) Recognize situations in which it is necessary to seek support from resident emergently.
- k) Recognize indications for transfer to higher care units (e.g. the intensive care unit).

2) Skills.

Subinterns should demonstrate skill in:

- a) Identifying symptoms of acute pulmonary edema
- b) Conducting a history specific for symptoms relating to pulmonary edema and a patient's decompensation from pulmonary edema
- c) Performing an appropriate physical exam including an assessment for hemodynamic stability and impending respiratory failure
- d) Creating a differential diagnosis for acute pulmonary edema based on specific clinical situations
- e) Interpreting laboratory/radiographic studies (ABG, CXR, ECG) to arrive at specific cause for acute pulmonary edema
- f) Developing a management plan for patients in acute pulmonary edema including emergent supportive care and follow-up care (measuring daily weights, urinary input-output)

Case I: Acute Pulmonary Edema

SCENARIO: You are on call for the general medicine team and are cross-covering for a colleague. A nurse from the 5th floor (telemetry) calls you about pt RD, “Dr., I am calling you about Dr. Smith’s patient, Mr. D. He is short of breath.”

Question: what additional questions would you like to ask the nurse?

Answers:

- a) *Questions to establish the stability of the patient and how rapidly you need to go see the patient.*
- b) *Respiratory rate, heart rate, BP*
- c) *Oxygen saturation*
- d) *Additional symptoms to help you develop a differential diagnosis.*
- e) *Chest pain and associated symptoms*
- f) *Acuity of onset*
- g) *Cough*
- h) *Medication status (when did he receive what medications)*
- i) *Whether they have recently received a blood transfusion or recent procedure.*
- j) *Recent labs or imaging results*

Question: are there any telephone orders you would like to give the nurse?

Answers:

Supplemental O₂ (caveat – CO₂ retainers), how much, how to administer.

As indicated by answers to question b - Chest X-ray, EKG

Question: What are your thoughts about a differential diagnosis as you proceed to the patient’s room?

Differential diagnoses for acute SOB: PE, MI, pulmonary edema, arrhythmia, ARDS, pneumonia, pneumothorax, acute bronchospasm

Additional information: how much fluid has the pt received, does he have edema, what are his wishes regarding advanced directives.

What factors will influence your decision to call your resident right away?

Question: What specific information do you want to look for on exam?

How does the pt look - does he appear acutely distressed?

What are his vitals?

What is his mental status?

Lung and heart and extremity exam?

Check for JVD

EXAM: On examination he is a middle-aged man who looks older than his stated age, tachypneic and in acute distress. He cannot answer any questions because of his extreme shortness of breath. He is restless and prefers to sit up in bed. BP 90/70, P 120 irreg., RR 28, T 98.5 Oxygen saturation 83%. JVP is elevated 12 cm. Chest: decreased breath sounds and dullness at both bases, with coarse crackles to above the scapula. Cardiac exam: PMI diffuse, laterally and inferiorly displaced, distant heart sounds, S3 gallop, intermittent midsystolic murmur at the apex. Abdominal exam is normal. Extremities are cool with thready pulses and without edema.

Question: what should you do next?

Assess mental status

Stabilize the patient

Work up the patient: EKG, CXR, monitor, enzymes, lytes, ABG.

Call in reinforcements

Get additional information/Read the chart

ADDITIONAL DATA:

Additional history from your quick chart review:

59 y/o man with ischemic cardiomyopathy (EF 30%) admitted for an acute CHF exacerbation as a result of increased dietary sodium intake. He has been in the hospital for three days and has been receiving IV lasix for diuresis. He has diuresed approximately 2 pounds each day. He received a contrasted CT scan today for the evaluation of abdominal pain. Shortness of breath began 10 minutes ago.

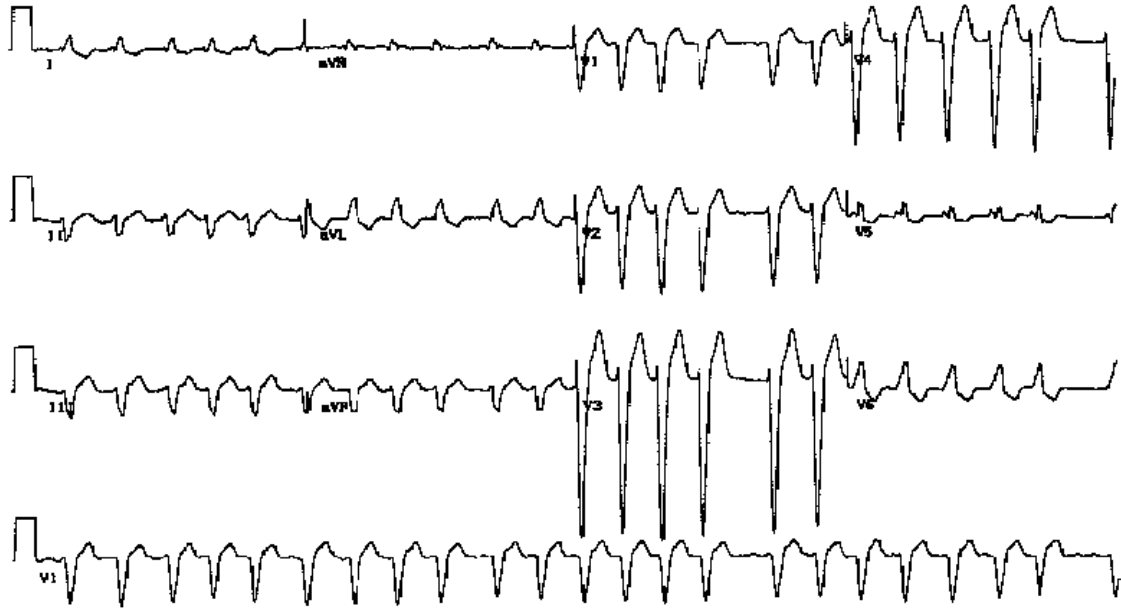
Lab:

Hct 38 WBC 12.9 75 P/28 L Plt 245 K

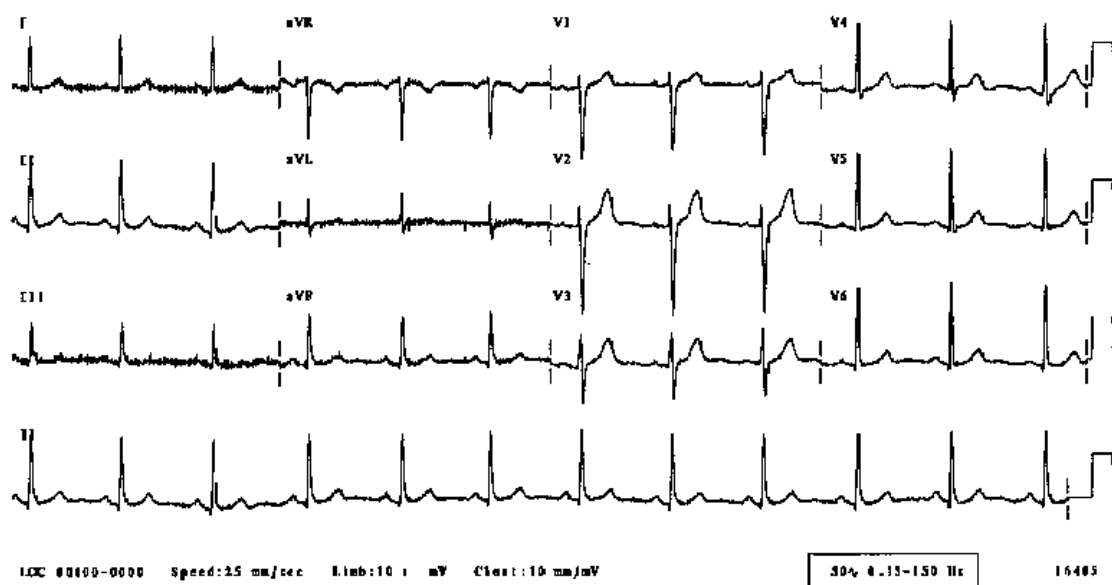
Na 129K 3.5 C1 96 HCO₃ 27 BUN 44 Creat 1.4 Glu 116

R.A. ABG pH 7.48 pO₂ 54 pCO₂ 34 HCO₃ 24

Current ECG:



EKG from admission:



CXR:



Additional questions:

What are possibilities to explain his presentation?

Cardiogenic Shock

MI with occlusion of LAD

Why the narrowed pulse pressure?

Decreased cardiac output

Interpret the ABG in relation to the clinical findings.

Acute uncompensated primary respiratory alkalosis

Hypoxia

What other tests would you order?

Magnesium levels

BNP

Cardiac enzymes

Transthoracic echocardiogram

How would you treat him?

Central venous and arterial access

Continuous oxygen

Narcotics for pain control

Cardiology consultation

ICU transfer with telemetry and pulse oximetry

Consider antiarrhythmics or electrical cardioversion

Consider inotropes and diuretics

Hold antihypertensive medications

Case II: Acute Pulmonary Edema

SCENARIO: You are on call on the general medical floor and Mr X, your new admission, just arrived on the unit from the emergency department. He is a 65 year old man with a history of alcohol abuse who comes in with a fever and shortness of breath. His symptoms have been present for the past 3 days. He has a cough productive of green sputum and chest pain while coughing. His admission vital signs include: BP 100/74, P 110, RR 24, T 102.4, SpO₂ = 92% on 4L nasal cannula. His pulmonary exam includes rales on left lower lung fields.

Labs:

Hct 33 WBC 18.8 Plt 111 K

Na 131 K 3.5 C1 100 HCO₃ 23 BUN 48 Creat 1.2 Glu 117

AST: 111 ALT: 60 T Bili:1.6

Question: What is your differential diagnosis?

Pneumonia- community acquired, aspiration, bronchitis, influenza, lung abscess, lung cancer, influenza

Question: What other tests would you order?

CXR

ABG

Blood culture

Sputum culture

Consider bronchoscopy

Question: How would you treat Mr X?

IVF

IV Antibiotics

Supplemental O2

FOLLOW UP: You diagnosis Mr X with community acquired pneumonia after finding a left lower lobe infiltrate on his chest x-ray. Overnight Mr X has become more hypoxic. His vital signs this morning include RR36 P 132 BP90/66, T 100.3 SpO2=92% on 100% nonrebreather mask. His physical exam this morning reveals that he is in obvious respiratory distress. He has crackles bilaterally on lung exam in all lung fields. He is hyperventilating and using his accessory respiratory muscles. He is more lethargic this morning. He has no JVD, no peripheral edema, and his cardiac exam is the same as last night, except he is now more tachycardic. His ABG is pH 7.33 pCO2 48 pO2 62 HCO3 25. His repeat CXR is below.



Question: What is the differential diagnosis to explain his decompensation acutely?

ARDS, cardiogenic pulmonary edema, diffuse alveolar hemorrhage, acute interstitial pneumonia

Question: What tests would you order to confirm a diagnosis?

*BNP, Echocardiogram, pulmonary artery catheterization, f/u CBC
Can consider bronchoscopy to rule out other etiologies*

Question: How would you interpret his ABG?

*Acute hypoxia
Acute (uncompensated) primary respiratory acidosis*

FOLLOW UP: Mr X is transferred to the ICU and subsequently intubated and placed on a ventilator. An echocardiogram is performed and this reveals a normal ejection fraction with no significant wall motion abnormalities, valvular disease, or effusions.

Question: What is your most likely diagnosis? Based on what criteria?

*ARDS
 $PaO_2/FIO_2 \leq 200$ mm Hg
bilateral infiltrates
no evidence of chf
acute onset*

Question: What are the most common causes of this condition?

sepsis or infection- especially from pneumonia
aspiration or near drowning
trauma
burns
blood transfusion (usually massive)
s/p transplant of lungs, bone marrow
drugs, alcohol
SIRS- including pancreatitis

Question: How would you manage his symptoms?

Mechanical ventilation
Continue treatment of underlying pneumonia with IV antibiotics
Careful monitoring of fluid balance, ideally attempting negative fluid balance if stable
Pulmonology/Critical Care consultations

References

General overviews:

ACC/AHA Guidelines for the Evaluation and Management of Chronic Heart Failure in the Adult: Executive Summary

[HTTP://CIRC.AHAJOURNALS.ORG/CGI/CONTENT/FULL/104/24/2996](http://CIRC.AHAJOURNALS.ORG/CGI/CONTENT/FULL/104/24/2996)

Sacchetti AD, Harris RH: Acute cardiogenic pulmonary edema. What's the latest in emergency treatment? *Postgrad Med* 1998, 103:145–147

Gandhi SK. Powers JC. Nomeir AM. Fowle K. Kitzman DW. Rankin KM. Little WC. **The pathogenesis of acute pulmonary edema associated with hypertension.**[comment]. [Clinical Trial. Journal Article] *New England Journal of Medicine*. 344(1):17-22, 2001 Jan 4.

Brochard L: Noninvasive ventilation for acute respiratory failure. *JAMA* 2002, 288:932–935. The authors review noninvasive ventilation indications and practical modalities in various types of acute respiratory failure.

Hollenberg SM. Kavinsky CJ. Parrillo JE. Cardiogenic Shock. *Annals of Internal Medicine*. 131 (1): 47-59, 1999 July.

Sharma S. Kumar A. **Septic shock, multiple organ failure, and acute respiratory distress syndrome.** [Review] [112 refs] [Journal Article. Review. Review, Tutorial] *Current Opinion in Pulmonary Medicine*. 9(3):199-209, 2003 May.

Bernard GR, Artigas A, Brigham KL, et al: **The American-European Consensus Conference on ARDS: Definitions, mechanisms, relevant outcomes, and clinical trial coordination.** *Am J Respir Crit Care Med* 149:818–824, 1994.

Diagnosis:

Martin GS. Ely EW. Carroll FE. Bernard GR. **Findings on the portable chest radiograph correlate with fluid balance in critically ill patients.**[comment]. [Clinical Trial. Journal Article. Randomized Controlled Trial] *Chest.* 122(6):2087-95, 2002 Dec.

Duane PG. Colice GL. **Impact of noninvasive studies to distinguish volume overload from ARDS in acutely ill patients with pulmonary edema: analysis of the medical literature from 1966 to 1998.** [Journal Article. Meta-Analysis] *Chest.* 118(6):1709-17, 2000 Dec.

Etiologies:

Kopko PM. Marshall CS. MacKenzie MR. Holland PV. Popovsky MA. **Transfusion-related acute lung injury: report of a clinical look-back investigation.** [Journal Article] *JAMA.* 287(15):1968-71, 2002 Apr 17.

Kirby RR. **Perioperative fluid therapy and postoperative pulmonary edema: cause-effect relationship?**[comment]. [Comment. Editorial] *Chest.* 115(5):1224-6, 1999 May.
Treatment

British Thoracic Society Standards of Care Committee: Non-invasive ventilation in acute respiratory failure. *Thorax* 2002, 57:192–211. A consensus statement from the British Thoracic Society on the use of noninvasive ventilation in acute respiratory failure.

L'Her E. **Noninvasive mechanical ventilation in acute cardiogenic pulmonary edema.** [Review] [53 refs] [Journal Article. Review. Review, Tutorial] *Current Opinion in Critical Care.* 9(1):67-71, 2003 Feb.

Case II CXR:

Courtesy of Michael B. Gotway, MD, Department of Radiology, University of California, San Francisco. **Mason: Murray & Nadel's Textbook of Respiratory Medicine**, 4th ed. 2005