A 17 year old football player presents for an emergency appendectomy. Upon arrival in the PACU the nurse’s assessment describes prolonged exhalation, wheezing, rales and inability to maintain adequate pulse oximetry. We were told that there were no problems in the O.R. but he just wouldn’t awaken.

Within 15 minutes the patient starts to cough frothy pink tracheal secretions. His Respiratory rate increases

Any Ideas?

Pulmonary Edema

- Fluid in the alveoli
- Inhibits gas exchange by impairing diffusion pathways between alveolus and capillary
- Caused by increased left atrial and ventricular pressures
- Excessive accumulation of serous or serosanguineous fluid in the interstitial spaces and alveoli of the lung

Pulmonary Edema

- Causes:
  - increased hydrostatic pressure
  - decrease in interstitial pressure
  - Increase capillary permeability
Increased hydrostatic pressure

- Result of:
  - Left ventricle failure
  - Fluid overload
  - Mitral valve dysfunction
  - Ischemic heart disease

Decrease in Interstitial Pressure

- Often seen after prolonged airway obstruction

Increased Capillary Permeability

- May be the result of:
  - Sepsis
  - Aspiration
  - Transfusion reaction
  - Trauma
  - Anaphylaxis
  - Shock
  - DIC
  - Upper airway obstruction

- Patients cough up a frothy pink sputum.
- Stage I characterized by interstitial edema
  - Engorgement of perivascular and peribronchial space
  - Increased lymphatic flow

Pulmonary Edema

- Stage II
- Alveolar edema resulting from fluid moving into the alveoli from interstitium.
- Eventually blood plasma moves into alveoli faster than lymphatic system can clear it
- See interference with:
  - Diffusion of oxygen
  - Depression of arterial partial pressure of oxygen
  - Leading to tissue hypoxia

- Accumulation of fluid in the interstitium and alveoli of the lungs
- Classified as:
  - Cardiogenic
  - Noncardiogenic
Types of Pulmonary Edema

- **Cardiogenic (originates in the heart)**
  - ↑ pressure in pulmonary capillaries because of heart disease
  - Severe left ventricular failure
  - Mitral valve disease
  - Mild: engorgement of pulmonary vasculature
  - Moderate: fluid extravasates into interstitial space
  - Severe: Alveolar filling

- **Noncardiogenic**
  - ↑ alveolar-capillary membrane permeability (ARDS)
  - ↓ plasma oncotic pressure
  - ↑ negativity of pulmonary interstitial pressure
  - Lymphatic insufficiency or obstruction

Causes

- **Cardiogenic**
  - CHF
  - Heart attack with L ventricular failure
  - Severe dysrhythmias
  - Hypertensive crisis
  - Pericardial effusion with tamponade
  - Fluid overload (kidney failure, IV OD)

- **NonCardiogenic**
  - Inhalation toxic gases
  - Multiple blood transfusions
  - Severe infection
  - Aspiration
  - Medications (OD/Naloxone)
  - Upper airway obstruction
  - Near drowning
  - Reperfusion injury
  - Ascent to high altitude (>8000 ft)

Early Stage Pathophysiologic changes

- Hypoxia
  - ↓ Ability for diaphragm to expand
  - ↑ Pulmonary pressures
  - Fluid filled lungs
  - ↓ CO & ↑ Pulmonary vascular resistance
  - Dyspnea on exertion, tachypnea, cough, tachycardia.
  - Orthopnea
  - ↑ BP
  - Dependent crackles
  - Jugular vein distention

Late Stage Pathophysiologic changes

- Hypoxia
  - Fluid-filled lungs
  - Peripheral Vasoconstriction
  - ↓ CO, Shock
  - Labored, rapid respirations, ↑ tachycardia, cyanosis, dysrhythmias
  - Diffuse crackles, Cough (frothy bloody sputum)
  - Cold, clammy skin
  - Diaphoresis, ↓ BP, thready pulse

Diagnosis

- **Cardiogenic**
  - End Inspiratory crackles
  - 3rd Heart sound (S3) indicative of cardiogenic pulmonary edema
  - Confirmation with x-ray
  - See increased fluid in the alveolar walls

- **Noncardiogenic**
  - Hypoxemia due to intrapulmonary shunting
  - Pulmonary findings may be relatively normal in the early stages
  - Dominated by the findings of the precipitating condition
Radiographic Diagnosis

**Cardiogenic**
- Kerley B lines
- ↑Vascular filling
- Pleural effusions
- Upper lobe diversion

**Noncardiogenic**
- Patchy alveolar infiltrates with air bronchogram

Kerley B lines on x-ray
- Kerley B lines are an X-ray finding that represents visible interlobular septa in the lung (lower lobes).
- Backing up of fluid in the pulmonary vasculature eventually breaches the blood vessel wall and floods the interstitium, of which the interlobular septa are a part.

Most common condition causing Kerley B lines is cardiac failure.

Flash Pulmonary Edema
- A medical emergency
- Sudden accumulation of fluid in lungs
- Associated with MI or Mitral Regurgitation- ACUTE decompensation of heart
- Leads to eventual organ failure
- Symptoms present in matter of minutes:
  - Feel like drowning
  - Cannot take full deep breath
  - Panicky
  - Pallor
  - Chest pain
  - Heart palpitations

Signs & Symptoms
- Breathlessness
- Anxiety
- Sensations of suffocating
- Pink frothy liquid
- Feel as if drowning
- Increased RR
- Use of accessory muscles
- Flared nostrils
- Loud inspiratory & expiratory gurgling
- Profuse diaphoresis
- Cold, ashen, cyanotic skin- Low CO
- ABG early - Resp. alkalosis
- ABG late -Resp Acidosis
- Hypoxemia

Flash Pulmonary Edema Treatment
- OXYGEN
- Diuretics to diminish fluid retention
- Ventilatory support
- If accompanies Heart Attack, need to decrease afterload to alleviate stress on heart
  - Antihypertensives
  - ACE inhibitors
  - ARBs
  - Calcium Channel blockers
Decrease Afterload

- Block Angiotensin Converting Enzymes (ACE) in lungs so Angiotensin I is not converted to Angiotensin II preventing vessel constriction
- Angiotensin Receptor Blockers (ARBs): Block chemical receptors for Angiotensin II on small arteries therefore arteries cannot constrict
- Calcium Channel blockers

HAPE

- A 35 year old microbiologist from Sweden arrived in Keystone, CO for a skiing vacation in Jan, 1990. Upon arrival at Frisco at an altitude of 9036 feet he complained of dizziness, lightheadedness, and SOB. He went to his room and was found dead the next morning.
- Autopsy showed he died of respiratory failure due to high altitude pulmonary edema

High Altitude Pulmonary Edema (HAPE)

**Symptoms**
- Headaches
- Insomnia
- Fluid retention
- Cough
- SOB
- Low grade fever
- Can be Fatal without appropriate care

**Treatment**
- Avoid Alcohol
- Avoid sleeping pills
- Avoid intense exertion
- Drink Lots of Water
- If these measures do not help – go to lower altitude

Life Threatening

- Get Help if:
  - Trouble breathing
  - Bubbly, wheezing, gasping sound
  - Pink frothy sputum
  - Profuse sweating with difficult breathing
  - Blue or gray tone to skin
  - Severe drop in BP
- Oxygen
- Descend to lower altitude (Below 8,000 ft)
- Some hikers take Diamox to prevent HAPE
- Stay hydrated – breathe more rapidly as you ascend

Treatment

- Patients who retain fluid as a result of renal failure may require dialysis
- Afterload reduction use NTG or Nipride to decrease myocardial work
- Maintain colloid osmotic pressure and require a CVP and PAOP as low as possible consistent with good ventilatory function

COCOA TEA

Coca Coca tea is often recommended for travelers in the Andes to prevent altitude sickness. A cup of coca tea prepared from one gram of coca leaves (the typical contents of a tea bag) contains approximately 4.2 mg of organic coca alkaloid. (In comparison, a line of cocaine contains between 20 and 30 milligrams.) is often recommended for travelers in the Andes to
Neurogenic Pulmonary Edema

- Clinical syndrome characterized by the acute onset of pulmonary edema following a significant central nervous system (CNS) insult.
- Etiology is thought to be a surge of catecholamines that results in cardiopulmonary dysfunction.

NEUROGENIC PULMONARY EDEMA

**Major causes**
- Subarachnoid hemorrhage
- Cerebral hemorrhage
- Epileptic seizures
- Head injury

**Minor causes**
- Multiple Sclerosis with medullary involvement
- Nonhemorrhagic strokes
- Bulbar poliomyelitis
- Air embolism
- Brain tumors
- Electroconvulsive therapy
- Bacterial meningitis
- Cervical spinal cord injury
- Intracranial endovascular therapy

Neurogenic Pulmonary Edema

- See Onset of SOB minutes/hours after neurologic insult
- Hemodynamic measurements (BP, CO, PCWP all normal by time of diagnosis)
- Do see ↑ICP
- TREATMENT
- Airway support
- Alpha adrenergic antagonists (phentolamine)
- Beta adrenergic agonists (Dobutamine, low dose dopamine)

Treatment

- Oxygen
- Ventilatory support
- Chest x-ray confirms
  - Enlarged cardiac silhouette
  - Pulmonary venous congestion
  - Interstitial edema
- Direct treatment towards reducing hydrostatic pressure in the lungs
- Relieve symptoms and enhance cardiac performance

Following initial management

**Treatment focus is:**

- (1) reduction of pulmonary venous return (preload reduction) (Diuretics)
  - Preload reduction decreases pulmonary capillary hydrostatic pressure and reduces fluid transudation into the pulmonary interstitium and alveoli
- (2) reduction of systemic vascular resistance (afterload reduction) (NTG, Nipride)
  - Afterload reduction increases cardiac output and improves renal perfusion, which allows for diuresis in the patient with fluid overload.
- (3) inotropic support

MAN DOG Treatment

- **M** - Morphine - Vasodilatation & ↓ venous return, ↓ anxiety
- **A** - Aminophylline- treat bronchospasm/wheezing
- **N** – Nitrates: Nitroglycerin to improve Coronary blood flow & ↓ afterload; Nipride: vasodilator
- **D** – Diuretics - ↓ Preload, eliminate fluid
- **O** - Oxygen
- **G** - Arterial Blood Gases (early resp. alkalosis & as failure ensues respiratory acidosis)
L-M-N-O-P

- L – Lasix
- M – Morphine
- N – Nitrates
- O – Oxygen
- P – Positive Pressure/Position

Treatment

- Chest x-ray confirms
  - enlarged cardiac silhouette
  - Pulmonary venous congestion
  - interstitial edema
- Directed towards reducing hydrostatic pressure in the lungs
- Relieve symptoms and enhance cardiac performance

Treatment

- Insert Pulmonary artery catheter to follow LV function
- Manage fluid overload
- Improve cardiac output by decreasing SVR and increasing contractility (Dopamine, Dobutamine)
- Afterload is decreased by vasodilators (NTG, Nipride, IABP)
- Angiotension converting enzymes may alter chamber remodeling

Treatment

- Patients who retain fluid as a result of renal failure may require dialysis
- Afterload reduction use NTG or Nipride to decrease myocardial work
- Maintain colloid osmotic pressure and require a CVP and PAOP as low as possible consistent with good ventilatory function

Prevention

- Control BP
- Watch Blood Cholesterol
- Don’t smoke
- Eat a heart healthy diet
- Limit salt
- Exercise regularly
- Maintain a healthy weight
- Get enough folic acid (reduces blood levels of homocysteine-an amino acid to build tissues)
- Manage stress
- To treat HAPE – acclimate to altitude slowly

So, Could we have prevented our patients from developing Pulmonary Edema?

PATIENCE                  WISDOM
THANK YOU!

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