

Pulmonary Edema: Back to Basics in Diagnosis and Treatment

An Interactive Discussion & Debate

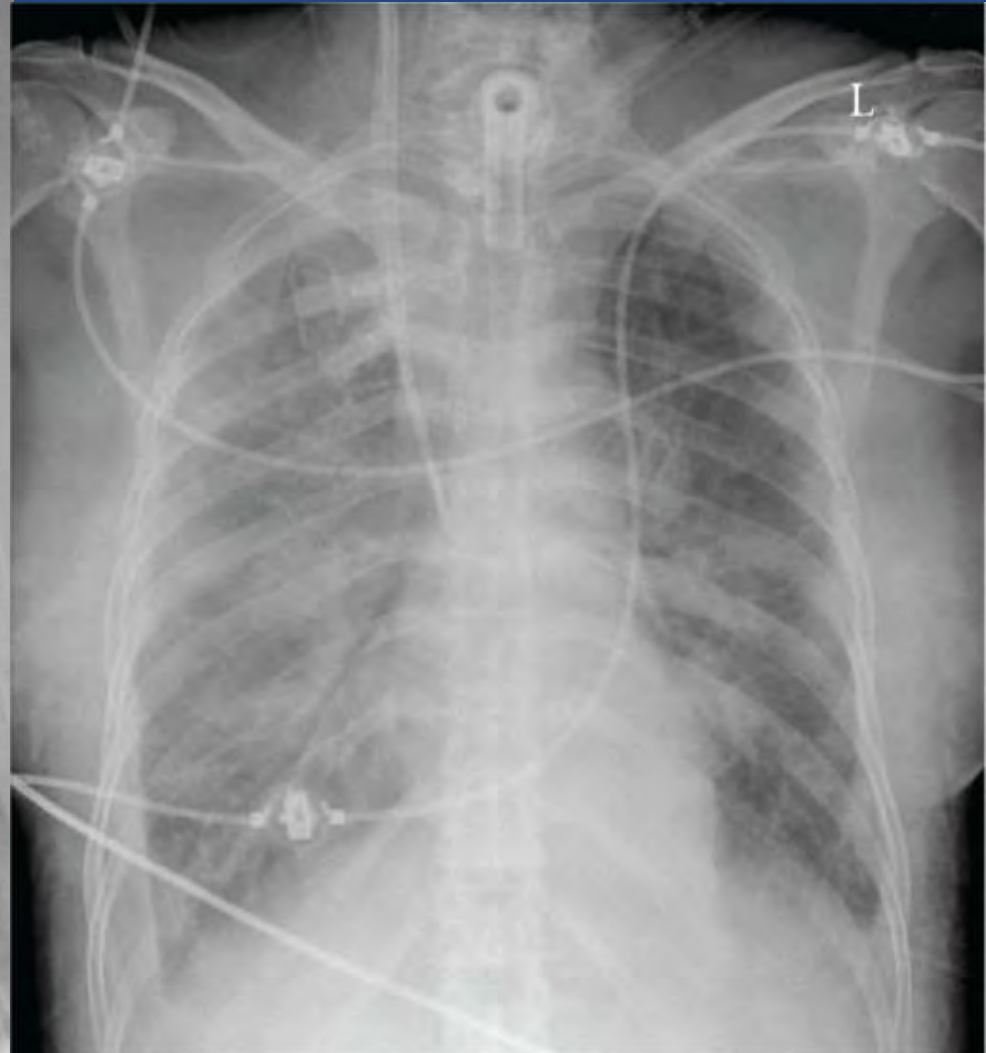
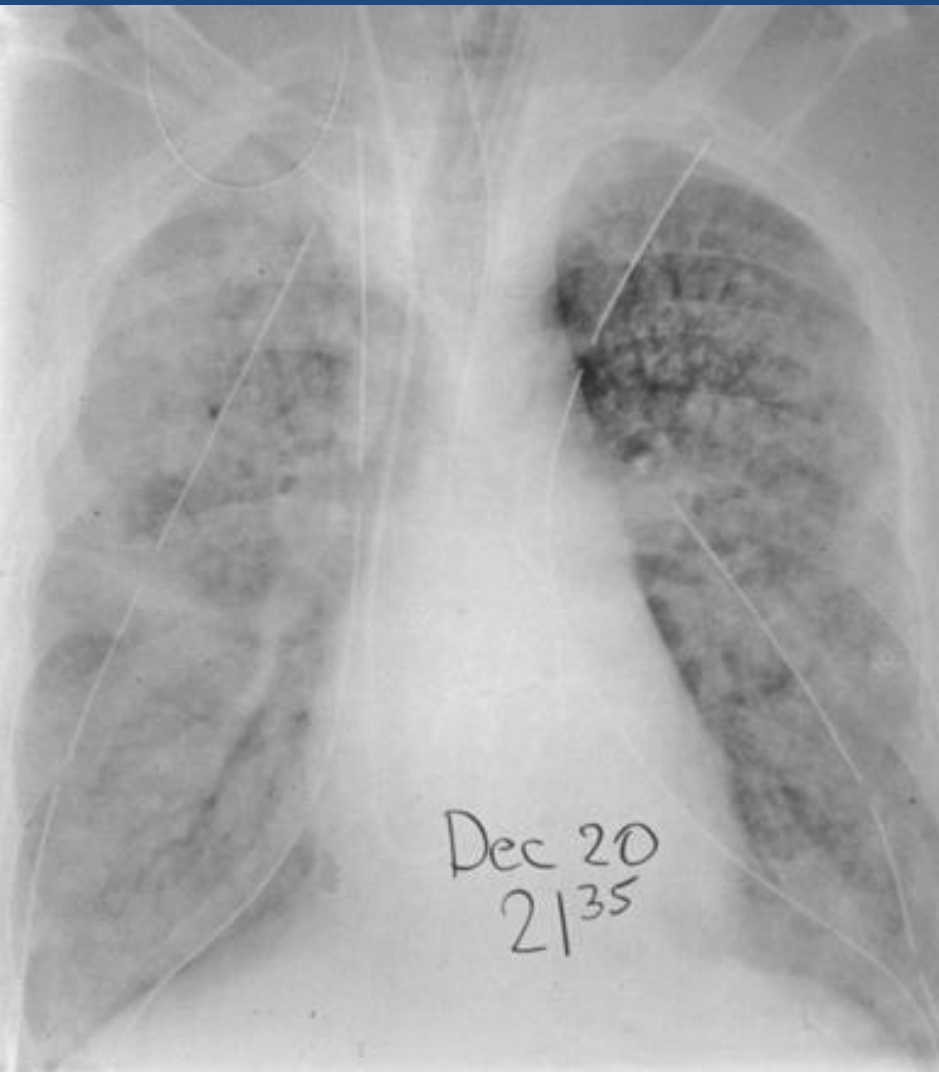
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Pulmonary Edema: Questions

1. What is Pulmonary Edema?
2. What is Edema (oedema): Transudate vs Exudate?
3. What are the Symptoms of Pulmonary Edema?
4. What are the Clinical Signs of Pulmonary Edema?
5. What are the Causes of Pulmonary Edema?
6. What is Noncardiogenic pulmonary edema?
7. What is Cardiogenic Pulmonary Edema?
8. What is the pathophysiology leading to pulmonary edema: Cardiogenic vs Noncardiogenic vs Mixed?
9. How can you confirm your clinical diagnosis?
10. What is the treatment of Pulmonary Edema?
11. What is the evidence to support your opinion?
12. What is optimal cost effective care in Pulmonary Edema?

What Is Pulmonary Edema?



What are the causes of Pulmonary Edema?

- List Causes and Diagnoses that are associated with
 - Cardiogenic
 - Non Cardiogenic
 - Mixed

Post Obstructive Pulmonary Edema

Pulmonary Edema after Narcan

Altitude Sickness

FES

- Does Fat Emboli Syndrome cause pulmonary edema?

Amniotic Fluid Embolism

- Does amniotic fluid embolism cause pulmonary edema?

Air Embolism

- Does air embolism cause pulmonary edema?

What are the pathophysiologic mechanisms that lead to Pulmonary Edema?

Cardiogenic <> Noncardiogenic <> Mixed

- Whole Body?
- Organ?
- Cellular?
- Molecular?
- Other?

Factors at work in preventing pulmonary edema?

Any edema?

- Hydrostatic pressure (PUSHING OUT)
- Oncotic Pressure (PULLING IN)
- Membrane (blood vessel) integrity
- Any combination of the above

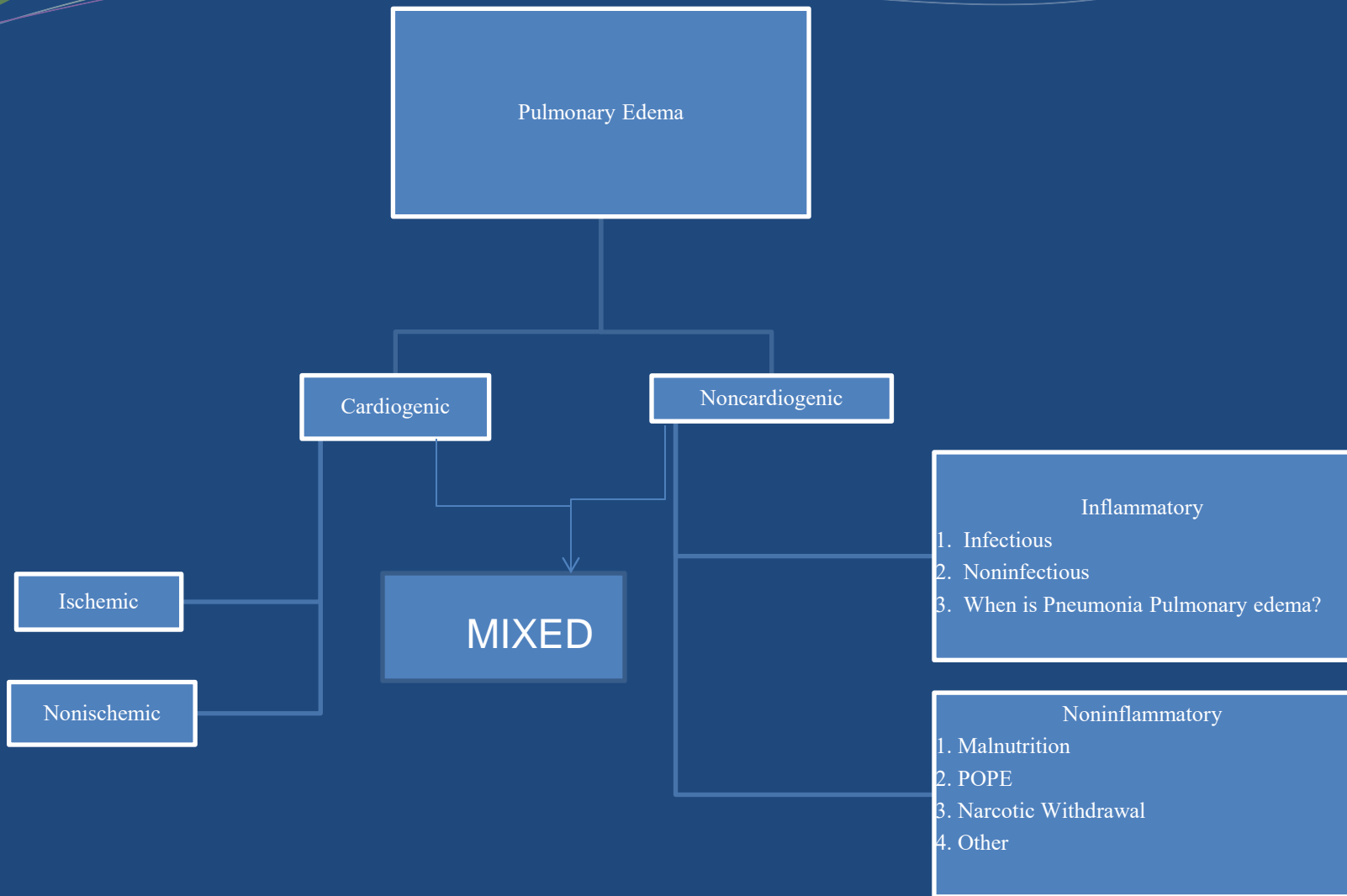
Pulmonary Edema: Case #1

- You are called to the PACU to admit a patient who required reintubation for acute respiratory failure after “uneventful” surgery for cholecystectomy.
 - What else would you like to know? Hx, PE, Lab, Imaging
 - What is your differential diagnosis?
 - How will you make a clinical diagnosis?
 - How will you confirm your clinical suspicion?
 - How will you treat the patient?
 - What evidence do you have to support your thinking?

Pulmonary Edema: Case #2

You are called by the obstetrics team, because one of their patients is short of breath and supplemental Oxygen requirements are increasing. “Help, please.” What will you look for in the history and physical examination to help you make a definitive diagnosis and start proper treatment asap?

Pulmonary Edema: Dx Algorithm



PULMONARY EDEMA: DISCUSSION

- PRO vs CON = DISCUSS & DEBATE
 - Evidence
 - Cost
 - Effectiveness
 - Cost of Care vs Value of Life & Quality of Life
 - Value
 - Net Present Value
 - Potential Years of Life Lost
 - Expected Years of Life Lost
 - End of Life Care

Pulmonary Edema: Diagnosis

Causes/Thoughts/considerations

- Clinical diagnosis: Acute vs Chronic?
- Confirmation of the diagnosis?
- Causes:
 - Hydrostatic Pressure Increases (Pump failure)
 - Increased Capillary Leakage (Inflammation/Trauma)
 - Oncotic or Colloid Osmotic Pressure Decrease
 - Mixed
- Post Obstructive
- Malnutrition
- Heart Failure
- Renal Failure
- Dietary Considerations: Salt vs Salt
- Other

Pulmonary Edema: Treatment Considerations

- How to treat?
- Where to treat? Office, Hospital, Home?
- Monitoring requirements?
- Evidence for each?

Pulmonary Edema: Pathology & Pathogenesis

Cardiogenic, Noncardiogenic & Mixed

Cardiogenic

- Myocardial Ischemia (CAD)

Noncardiogenic

Pulmonary Edema: The Larger Picture, Thoughts & Discussion

- “In Critical Care, every intervention is a therapeutic trial.”
- “Compassion without knowledge is dangerous.”
- “First do no harm. Do Good.”
- Minimize Morbidity and Mortality
- Optimize Outcome
- Promote Return to Baseline Performance
- What is Optimal Human Performance?
- Metrics for Human Performance
- Activities of Daily Living
- Does time to definitive diagnosis and treatment have an impact on outcome?

Pulmonary Edema: Differential DX

- Distinguish between Cardiogenic and Non Cardiogenic Pulmonary Edema
 - Clinical: Hx, PE, Monitoring
 - Lab
 - Imaging
 - Other

Pulmonary Edema: Considerations in Diagnosis and Treatment

- Working Differential Diagnosis
- Therapeutic Trial
- Frequency of evaluation
- End point of therapy
- Why therapeutic trial depends upon the cause of pulmonary edema
- Added Value: Hx, PE, Lab, Imaging, Therapeutic trial
- Cost Effectiveness and Safety
- Evidence for each step of the diagnosis and treatment after History and Physical exam?

Pulmonary Edema: Symptoms

Cardiogenic

Non Cardiogenic

What is BNP? What is ANP?

Do you have evidence to support your opinion?

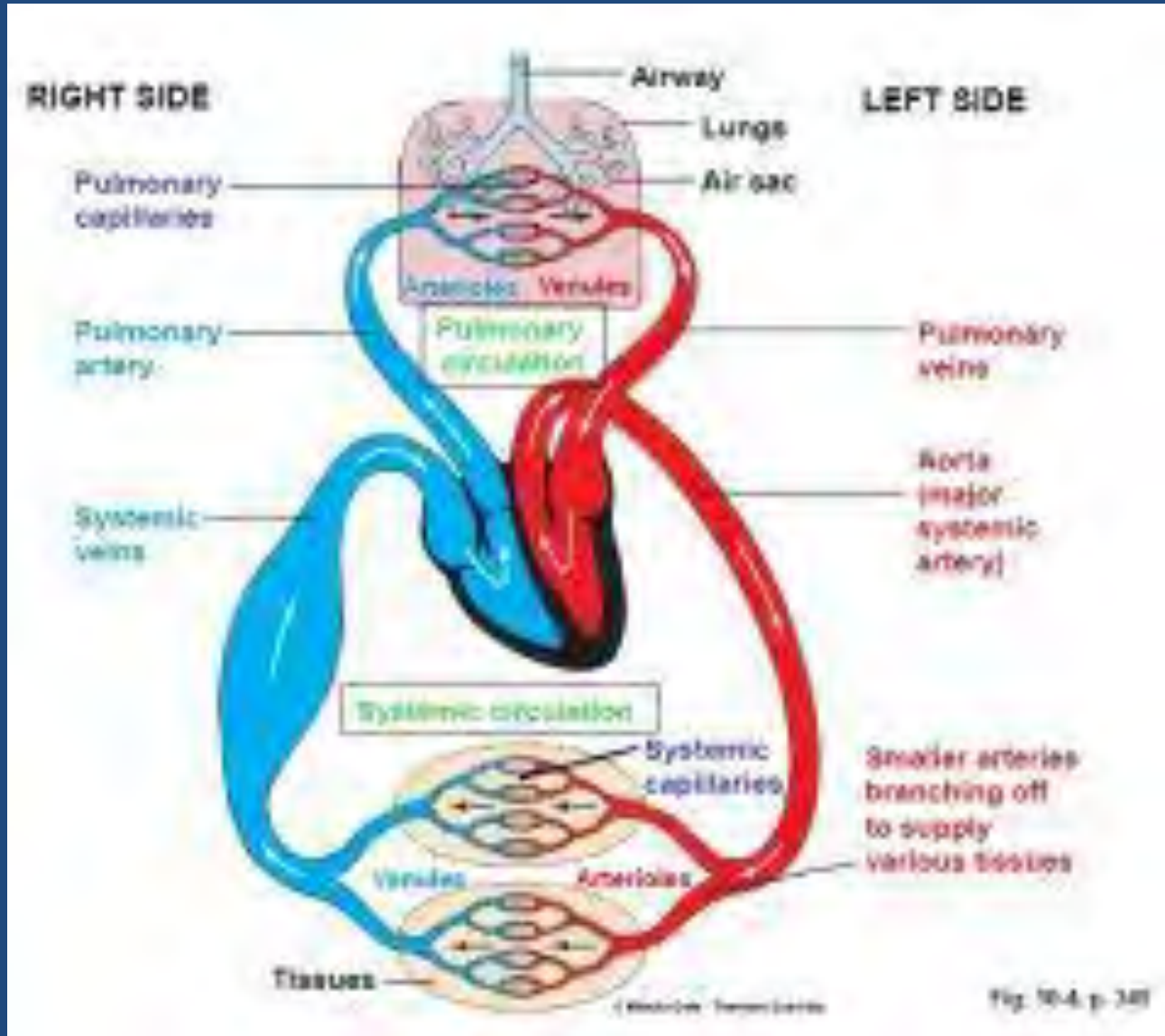
What is evidence?

- Logic vs Science
- Intuition vs counterintuition
- Observation
- Clinical Trial
- Bias
- Metrics

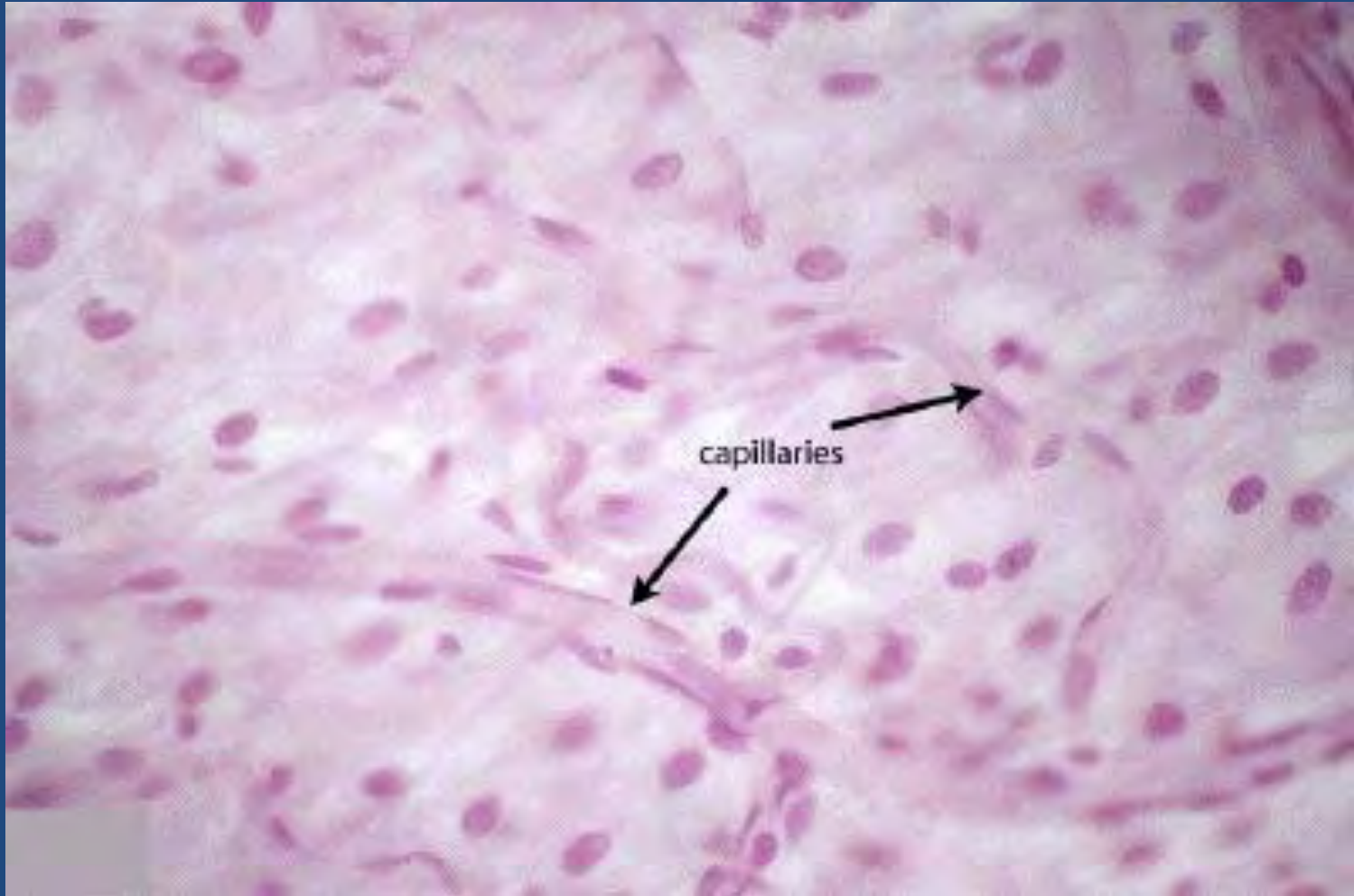
Transudate or Exudate?

- Distinction between TRANSUDATE & EXUDATE
- Medical distinction is through measurement of specific gravity & protein content of extracted fluid
- Capillary permeability \leftrightarrow Protein & Specific Gravity
- Rivalta Test
- Transudates:
 - Low protein content (Less than 2 Grams%)
 - Low specific gravity (Less than 1.012)
 - Caused by disturbances of
 - hydrostatic pressure or
 - colloid osmotic pressure (not by inflammation)

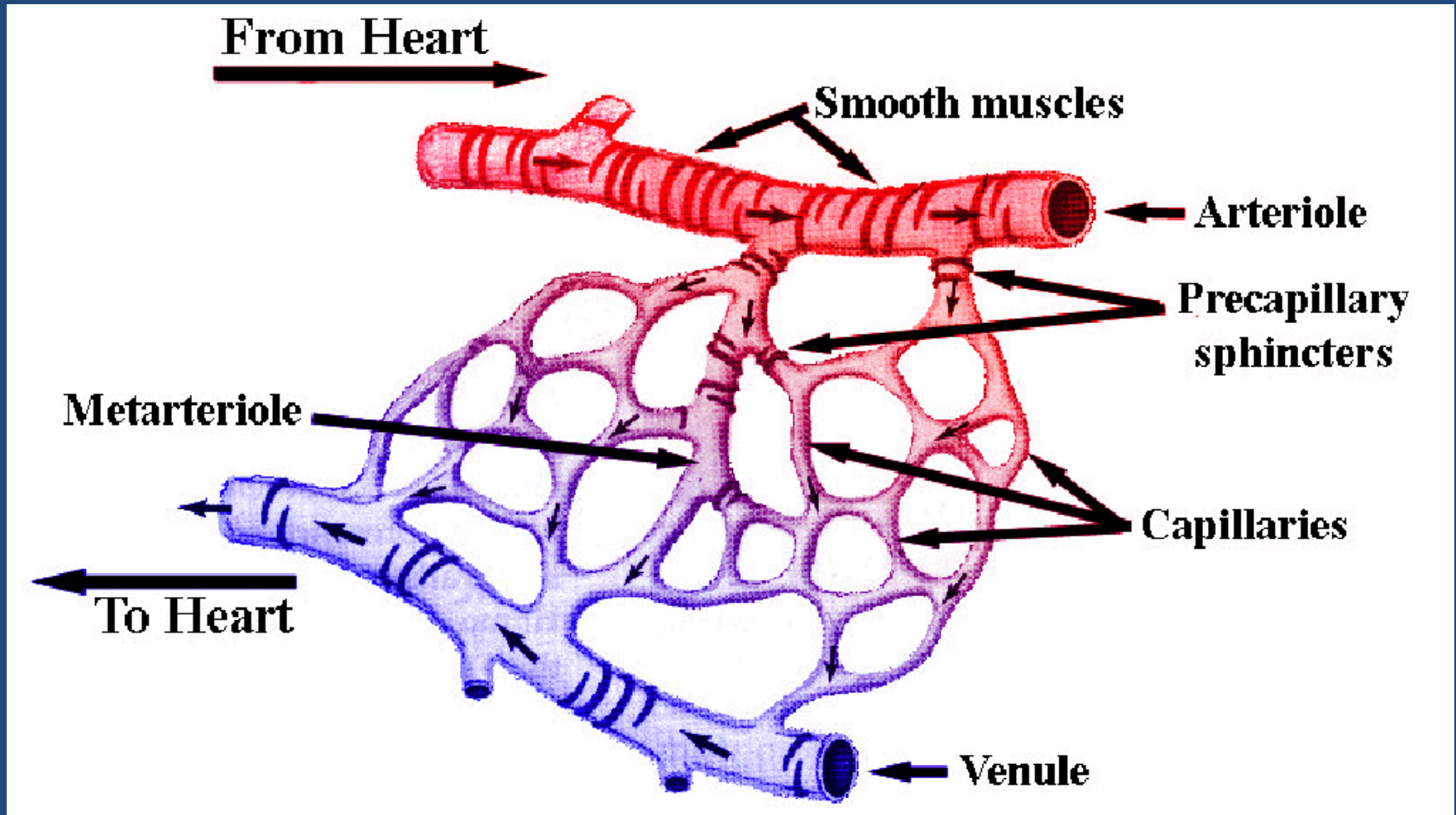
Cardiovascular system



Microcirculation: Photo

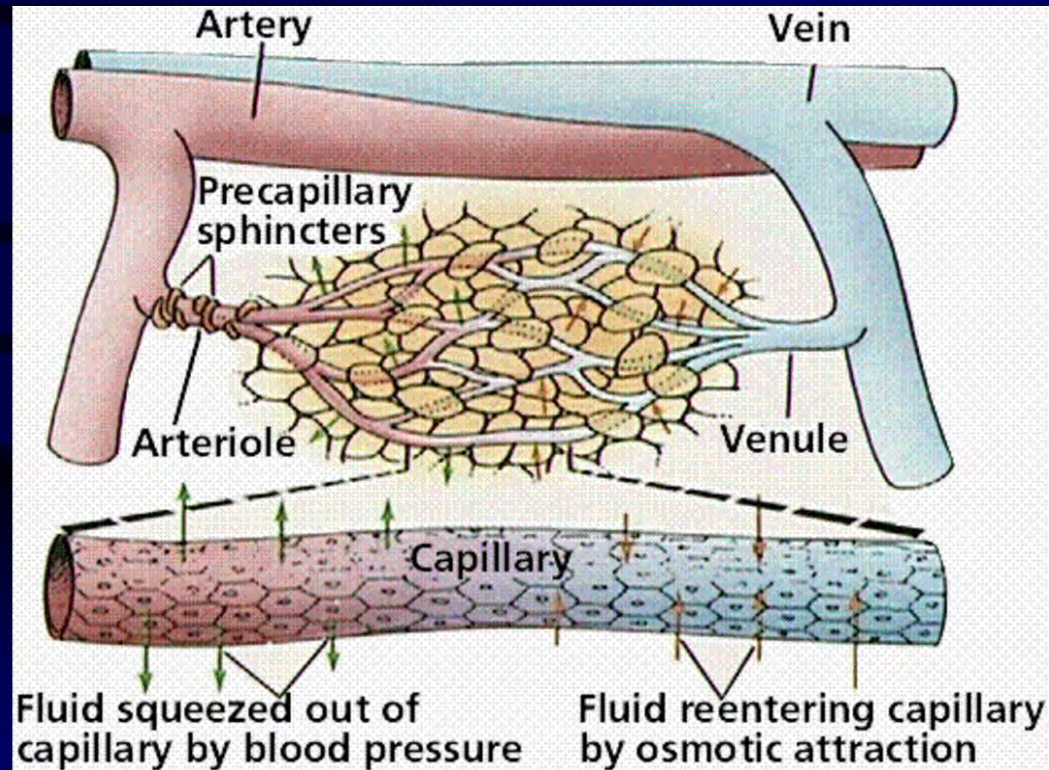


Microcirculation: Smooth Muscle

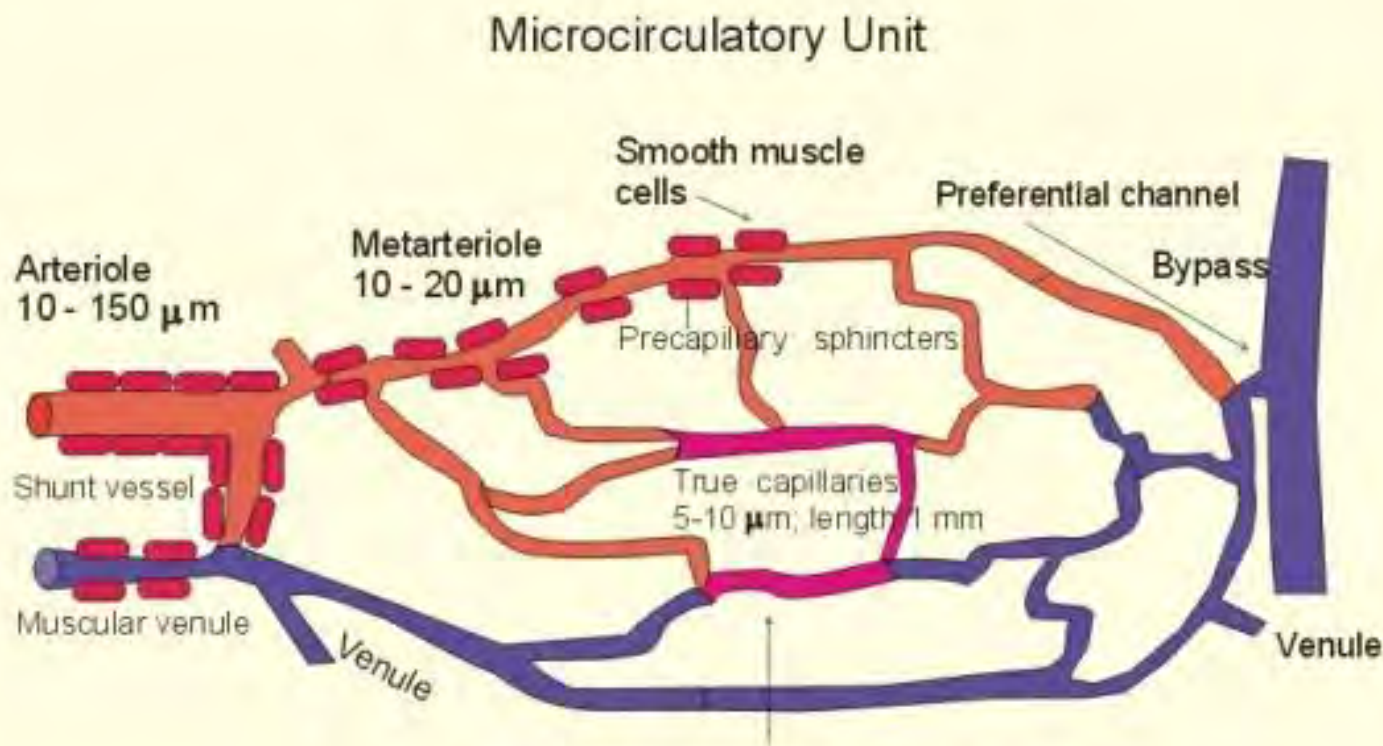


Microcirculation: 3RD Space Equilibrium

Arteries, Arterioles, Veins, Venules, & Capillaries



Microcirculation: Vessel Sizes

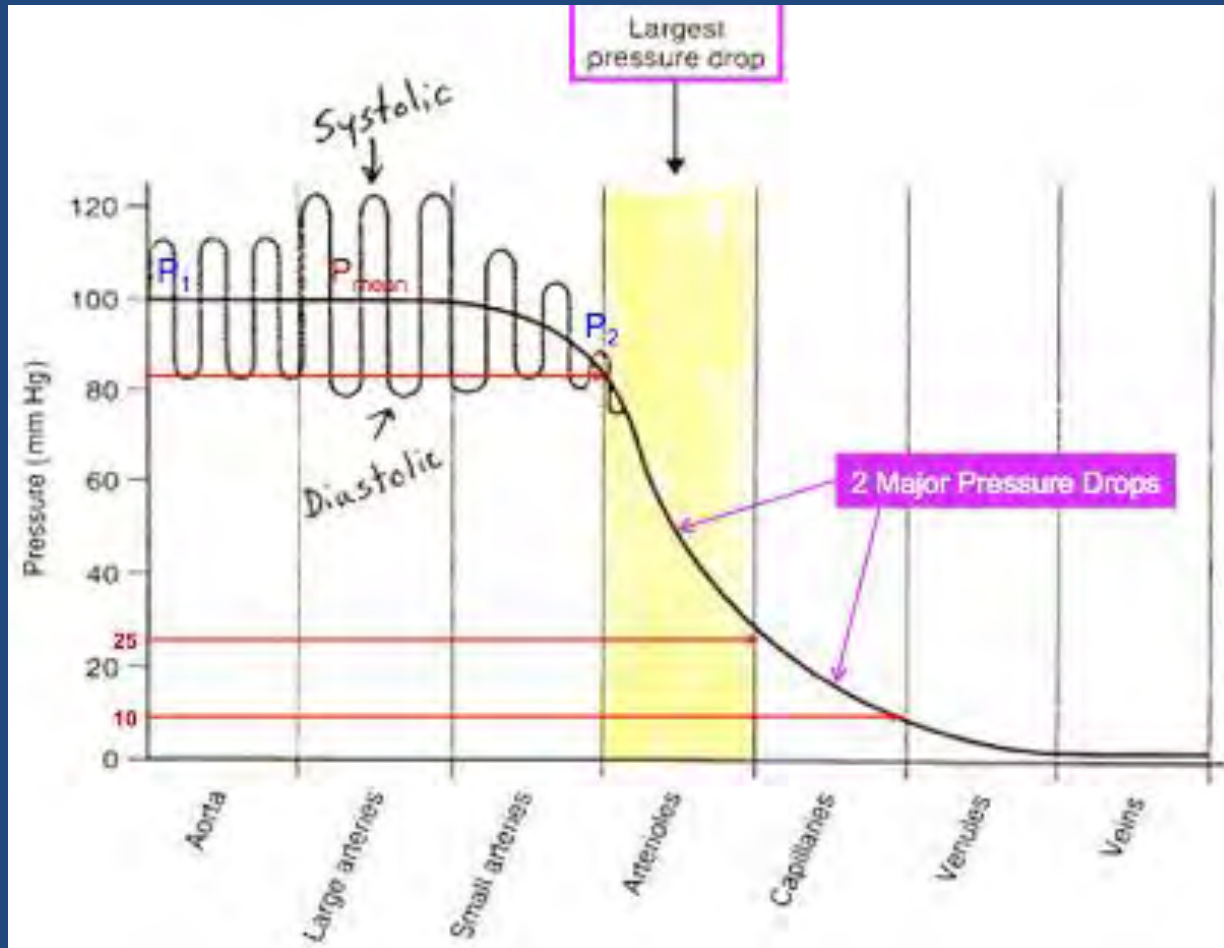


Capillaries pass substances in both directions
Capillary velocity: 1 mm s^{-1}
Capillary intermittence
Chaotic movement of red cells and pulsation

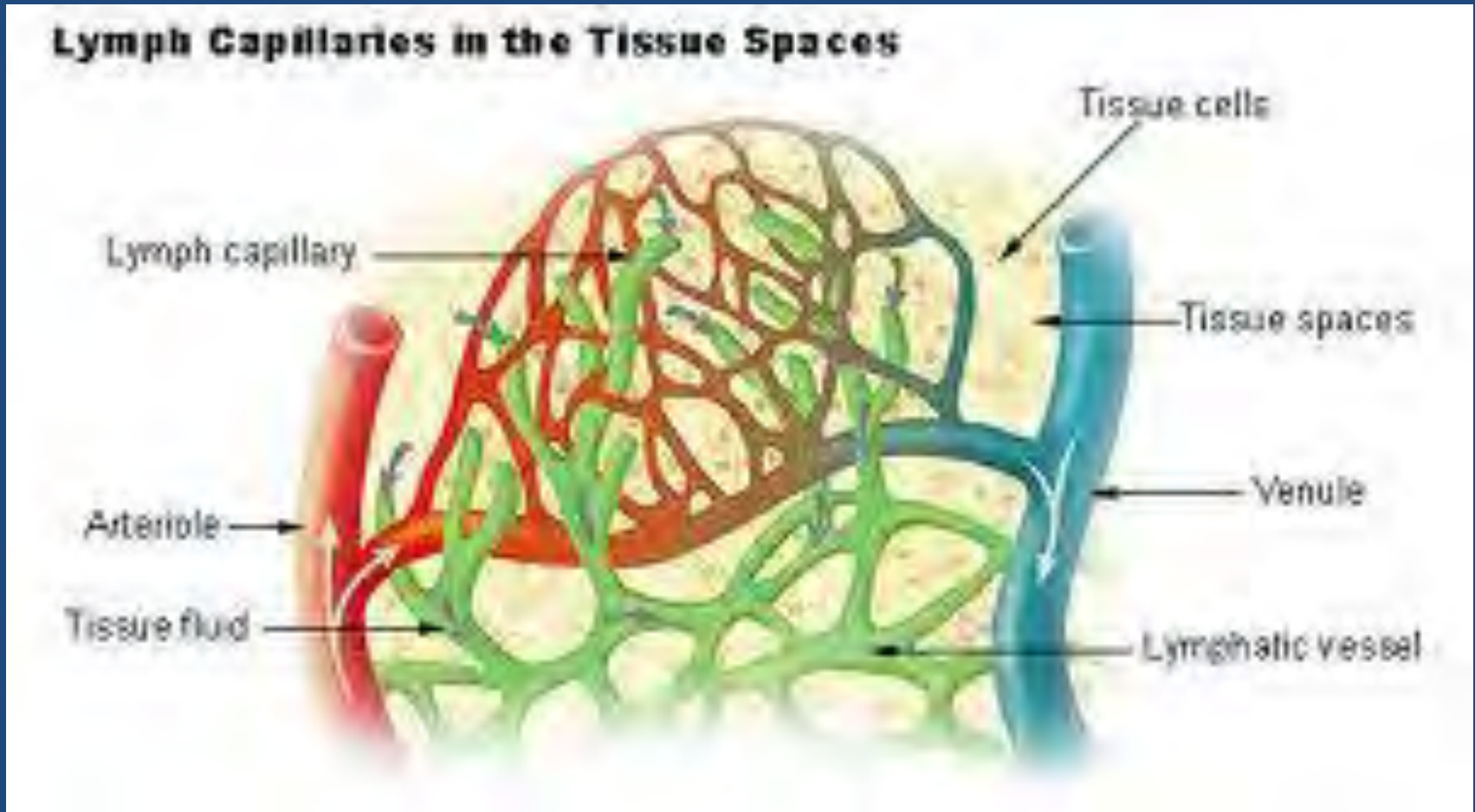
Fig 8-10

KMc

Microcirculation: Pressures



Microcirculation: Lymphatics – Lung?



Pulmonary Edema & Narcan

Adverse Reactions

- Postoperative
- The following adverse events have been associated with the use of Naloxone hydrochloride injection in postoperative patients: hypotension, hypertension, ventricular tachycardia and fibrillation, dyspnea, pulmonary edema, and cardiac arrest. Death, coma, and encephalopathy have been reported as sequelae of these events. Excessive doses of Naloxone in postoperative patients may result in significant reversal of analgesia and may cause agitation.

Opioid Depression

- Abrupt reversal of opioid depression may result in nausea, vomiting, sweating, tachycardia, increased blood pressure, tremulousness, seizures, ventricular tachycardia and fibrillation, pulmonary edema, and cardiac arrest which may result in death.

Summary 1

- **Noncardiogenic Pulmonary Edema = Normal Pulmonary Capillary Pressure Pulmonary Edema**
- **Cardiogenic Pulmonary Edema = High Pulmonary Capillary Pressure Pulmonary Edema**
- Protein & fluid accumulation > interstitium & alveoli
- **Noncardiogenic pulmonary edema can be difficult to distinguish** from cardiogenic pulmonary edema
- A mixed picture can occur.

Summary 2

- The Starling relationship: predicts the net flow of liquid across a membrane.
- In noncardiogenic pulmonary edema, the most common mechanism for a rise in transcapillary filtration is an increase in capillary permeability. (Really? Always?)
- Noncardiogenic pulmonary edema is identified clinically by the presence of radiographic evidence of alveolar fluid accumulation without hemodynamic evidence to suggest a cardiogenic etiology (ie, pulmonary artery wedge pressure ≤ 18 mmHg).

Capillary Leak Syndrome With Pulmonary Edema

Eugene D. Robin, MD; Larry C. Carey, MD; Ake Grenvik, MD; Frederick Glauser, MD; Ralph Gaudio, MD

Arch Intern Med. 1972;130(1):66-71.

doi:10.1001/archinte.1972.03650010054010.

- **ABSTRACT**

In two patients with a diffuse abnormality of capillary permeability possibly related to circulating endotoxin, loss of plasma into the tissues (capillary leak syndrome) produced hypovolemic shock, generalized edema, hemoconcentration, and florid pulmonary edema.

Capillary Leak Syndrome With Pulmonary Edema (Cont.)

Pulmonary edema fluid (PEF) was collected and its chemical composition compared to plasma. A number of solutes including the various plasma proteins were in near chemical equilibrium between plasma and PEF. Intravenous administration of dextran 70 (molecular weight 70,000) and dextran (molecular weight 500,000) (in one patient), led to accumulation of these compounds in PEF at a rate consistent with abnormally high pulmonary capillary permeability. These cases document the development of pulmonary edema secondary to increased pulmonary capillary permeability. Possibly, a number of pulmonary diseases (collectively called adult respiratory distress syndrome) result from increased pulmonary capillary permeability, increased alveolar epithelial permeability, or abnormalities of pulmonary interstitial solute removal.

Cochrane Reviews

- Cochrane Link
 - www.cochrane.org
- Heart Failure Link
 - <http://summaries.cochrane.org/search/site/heart%20failure%20treatment>
- ARDS Link
 - <http://summaries.cochrane.org/search/site/Treatment%20of%20ARDS>