

TVPeru

# Physiological Principles of Shock

Liam Finlay for MESS Intensive Series – 18/8/2020

# Disclaimer

- I am an MD3 student with an interest in intensive care medicine, not a qualified intensivist
- Critical care is a rapidly evolving field. This lecture aims to provide a basic overview/framework but details may change in the future

# What lands someone in the ICU?

- There are multiple reasons why someone may end up in intensive care
  - The main one being – they require care that can't be delivered on the ward
- This care could include
  - Ventilation requirements
  - Vasopressor/inotrope requirements
  - 1:1 nursing
  - Deteriorating patient
  - High risk patient (tied in with 1:1 nursing)
- Admission criteria will vary based on hospital
  - For example, in some hospitals patients may go to a specialty HDU followed a procedure rather than an ICU

# What is Shock?

- Shock is a physiological state where perfusion to end organs is impaired
- It presents as
  - (usually) Hypotension
  - End organ dysfunction
  - Raised lactate
- It can be due to a variety of causes

# Shock - Overview

- SHOCANs
  - Sepsis
  - Haemorrhagic (hypovolaemic)
  - Obstructive
  - Cardiogenic
  - Anaphylactic
  - Neurogenic
- Sepsis and Neurogenic can also be regarded as distributive shock
- We also talk about “warm” and “cold” shock

# How to think about shock

- The heart is a pump which moves fluid through pipes
- We are worried about the pressure inside the pipes
- The pressure can change by
  - Changing the diameter of the pipes
  - Changing the amount of fluid
  - Changing the pump

# Gemma

- You're the intern working in the ED when you're asked to see a Gemma, a 38 year old woman with a history of SLE, in fast track with a sore, swollen leg after recently returning from Europe
- As she walks into the treatment bay she seems unsteady on her feet and becomes short of breath
- You quickly take her vitals as she starts to become confused
  - RR – 35, shallow. SpO2 85%
  - HR – 140. BP – 95/40. Pulse – weak, tachycardic
  - GCS – 10 and falling
- What's your DDx and initial management?

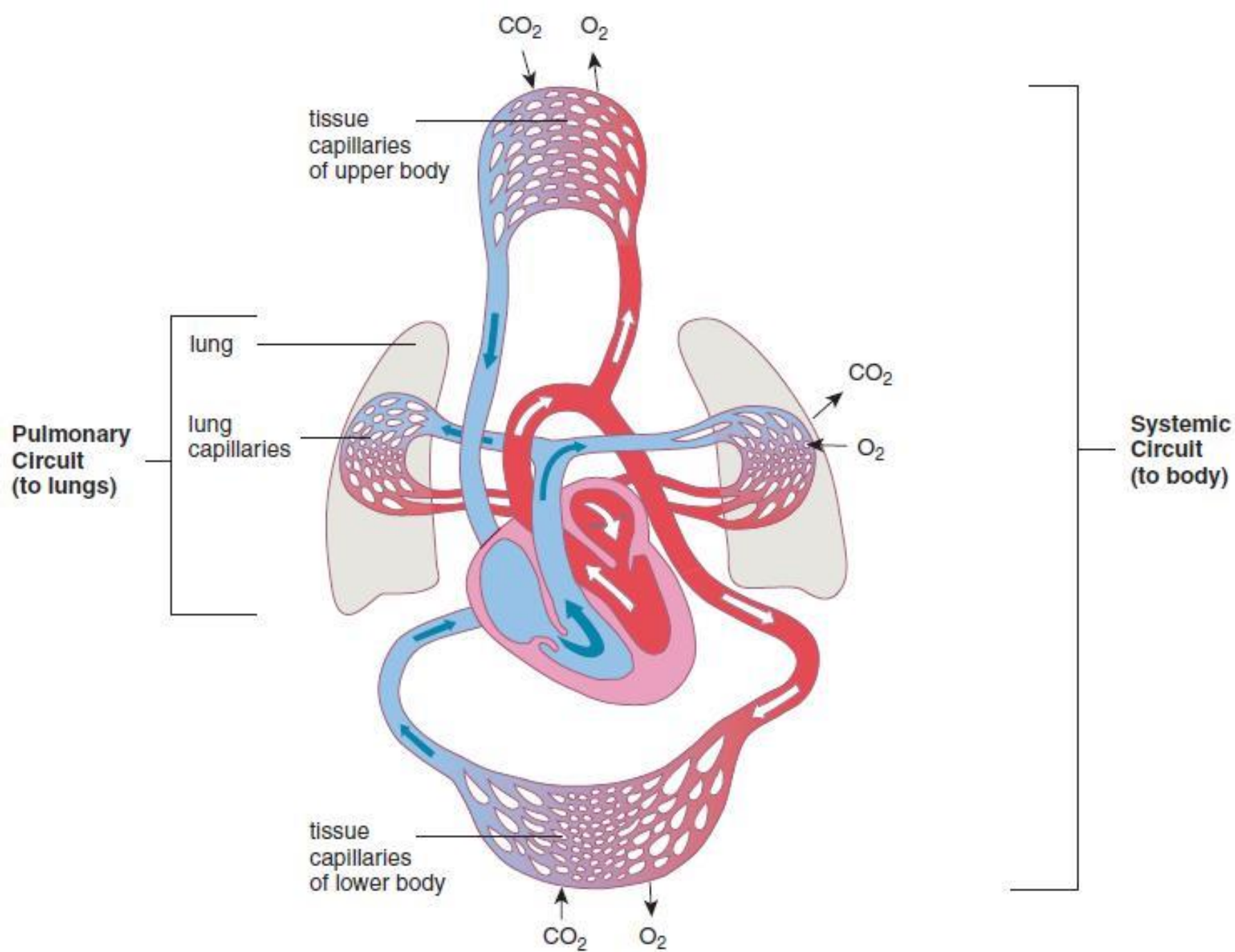
# Gemma

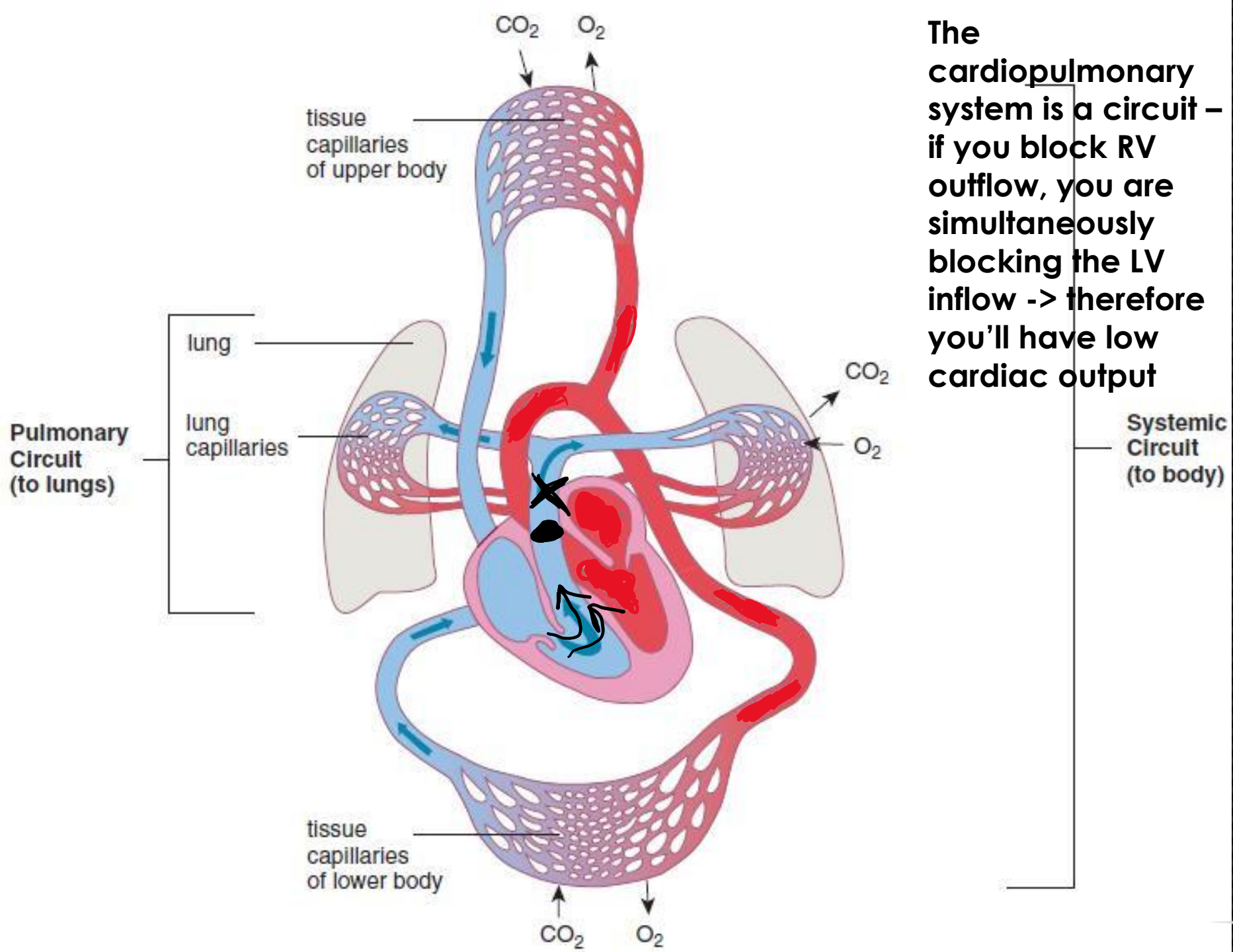
- Diagnosis – PE resulting in obstructive shock
- You're the intern working in the ED when you're asked to see a Gemma, a 38 year old woman with a **history of SLE (risk of antiphospholipid syndrome)**, in fast track with a **sore, swollen leg** after **recently returning from Europe**
  - All DVT RFs
- As she walks into the treatment bay she seems **unsteady on her feet** and becomes **short of breath** and has **altered GCS**
  - Signs of an embolic event resulting in obstructive shock, as evident in her poor cerebral perfusion



# Obstructive

- The pipe has a blockage
  - Massive pulmonary embolism (saddle PE)
  - Cardiac tamponade
  - Tension pneumothorax
- No output -> vasoconstricted, “cold” shock



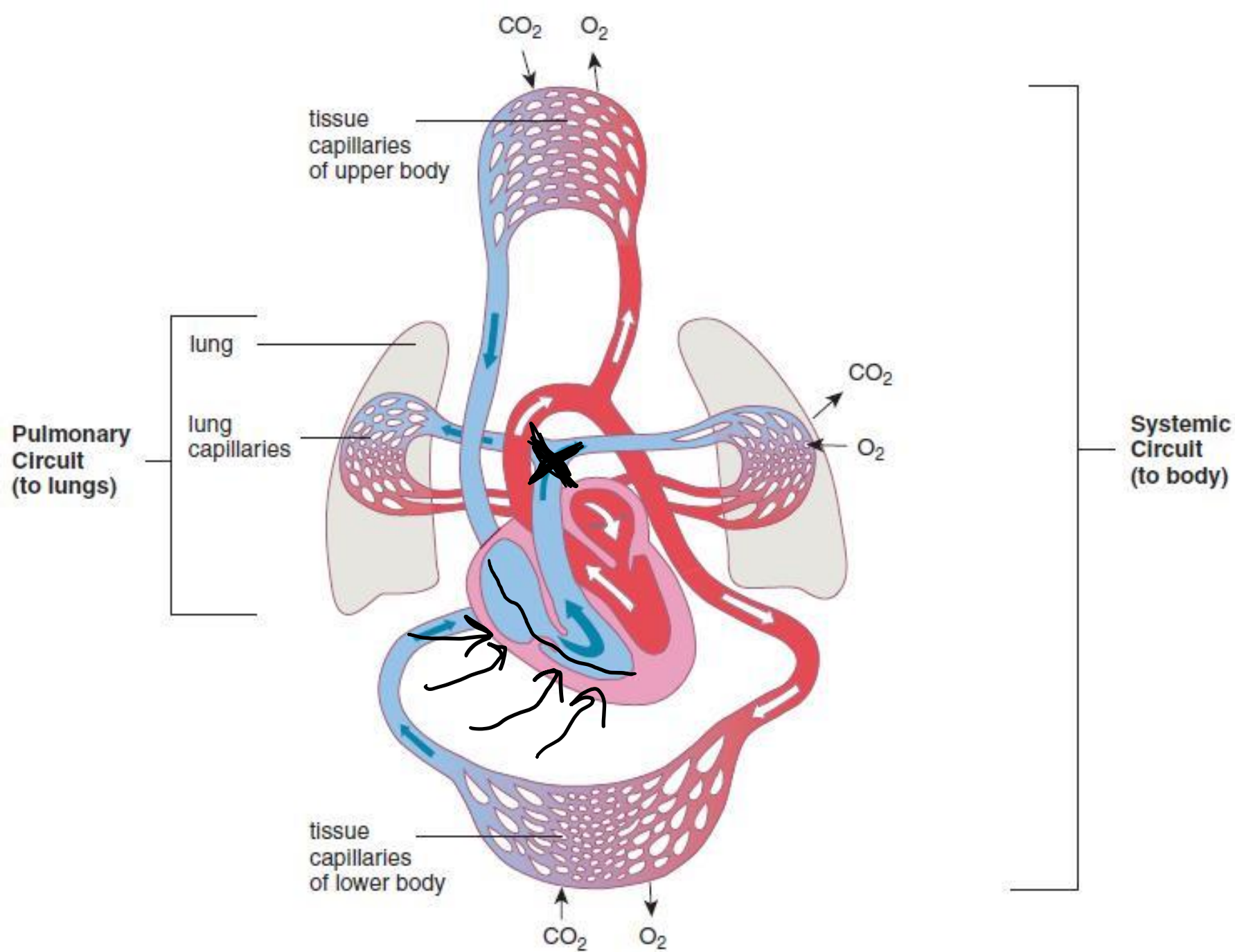


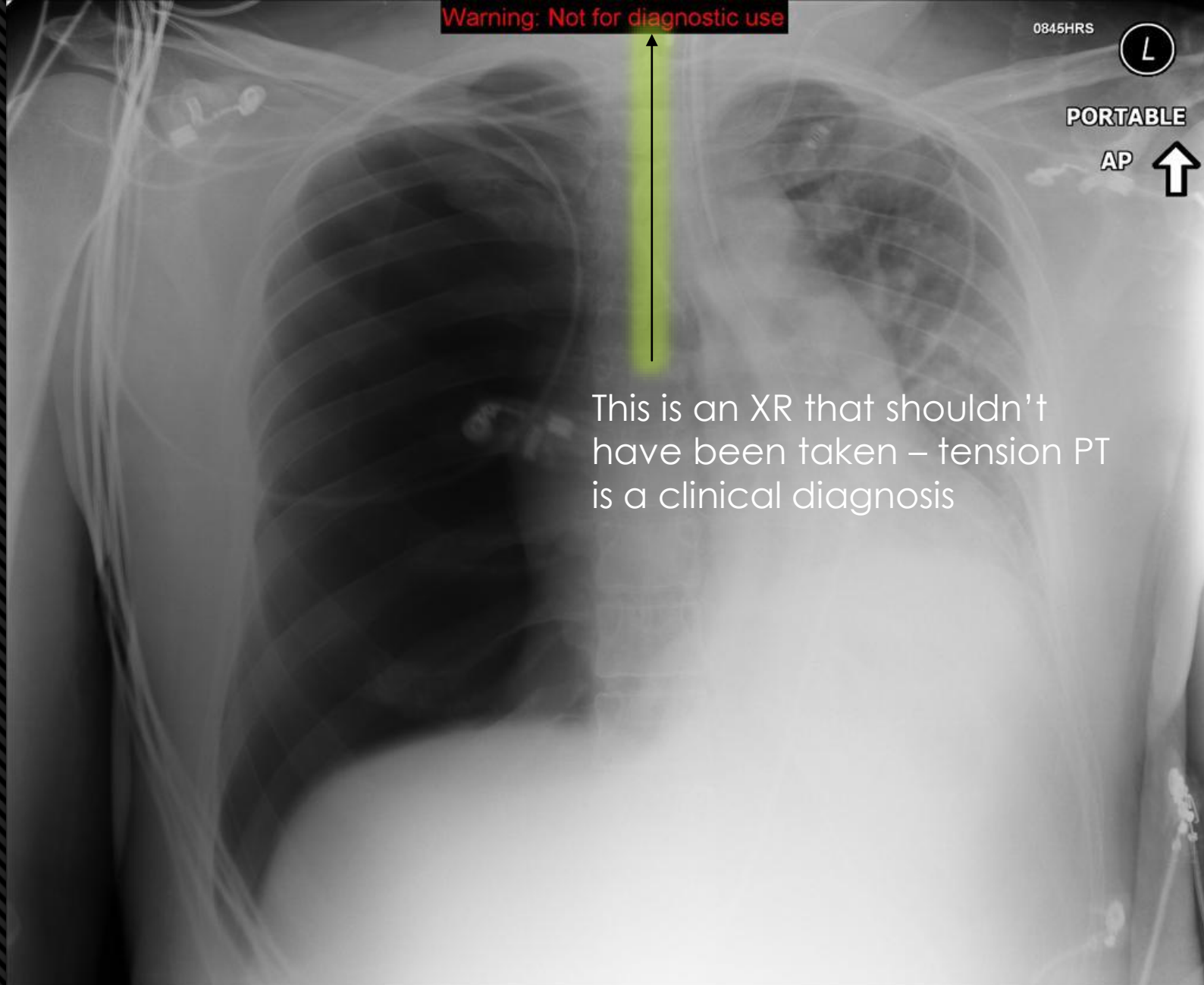


Filling defects showing a saddle embolus blocking the pulmonary trunk

# Tamponade/Tension pneumothorax

- Similar pathophysiology
- Increased pressure surrounding the heart (within the pericardium for tamponade, within the thoracic cavity for TP) results in a **filling defect**
  - Tamponade and pneumothorax are primarily pathologies of **diastole**
- RA and RV collapse due to thinner walls/lower pressures
  - Unable to fill during diastole, therefore nothing to pump out in systole
- Increased thoracic pressure in a TP can also impede venous drainage into the RA





This is an XR that shouldn't have been taken – tension PT is a clinical diagnosis

# Cardinal sign of obstructive shock

- **Raised JVP**
  - Unlike every other type of shock where venous pressures will likely be low, in obstructive shock there will be increased venous pressure resulting in a raised JVP
- PE
  - Signs of DVT/Risk factors
  - Acute onset
- Cardiac tamponade – Beck's Triad
  - Raised JVP
  - Muffled heart sounds
  - Hypotension
- Tension pneumothorax
  - Hyper resonant percussion
  - Absent breath sounds
  - Tracheal deviation



# George - 80

- You're working in a rural GP clinic when you get called to the waiting room to see George
- George is an 80yo smoker with a past history of diabetes, hypertension, previous IHD and 2x PCI stents 8 years ago. He came to the clinic today after waking up more short of breath than usual
- You were called to the waiting room because George seems confused and drowsy. Whilst your clinic manager calls an ambulance, you take some vitals
  - RR – 20, SpO2 94%
  - HR – 100bpm, BP 85/50. Pulse is weak and thready but regular
- What's your DDX and initial investigations/management?

# George - 80

- George is an 80yo smoker with **a past history of diabetes, hypertension, previous IHD and 2x PCI stents 8 years ago (he's an obvious vasculopathy with a high risk of AMI)**. He came to the clinic today after waking up **more short of breath than usual (silent infarct resulting in APO)**
- You were called to the waiting room because George seems **confused and drowsy (poor end organ perfusion)**. Whilst your clinic manager calls an ambulance, you take some vitals
  - RR – 20, SpO2 94%
  - HR – 100bpm, BP 85/50. Pulse is weak and thready but regular
- **He's having an AMI, resulting in cardiogenic shock**

# Cardiogenic

- Failure of the pump
  - Decrease in heart contractility means low output
- “Cold” shock
  - $MAP = CO \times TPR$
- Causes
  - Myocarditis
  - Infarction
  - Cardiomyopathy
  - Sepsis (although that usually causes distributive)
  - Cardiac arrest

# Amelia

- You're the intern on AMU
- Amelia is a 60yo woman with a CAP who has been admitted to AMU for a short course of intravenous antibiotics. She's only just been admitted and you haven't had a chance to meet her yet when the buzzer goes off for her room
- Amelia is short of breath, and her face seems swollen. She's drooling onto the pillow and you can here her wheeze as you enter the room
- As you watch she seems to become more and more drowsy
- You notice a bag with ceftriaxone which has just been started
- What are your DDX and initial investigations/management?

# Amelia

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- Amelia is **short of breath**, and her **face seems swollen**. She's **drooling onto the pillow (implying airway obstruction)** and you can here her **wheeze** as you enter the room
- As you watch she seems to become **more and more drowsy (poor cerebral perfusion)**
- You notice a **bag with ceftriaxone** which has just been started (**in anaphylaxis, you always want to be thinking about what the trigger was so you can remove it**)
- What are your DDX and initial investigations/management?

# Anaphylactic

- Pipes are getting bigger (and leakier) -> “warm” shock
- Fluid in the pipes might not have as much oxygen as it should
- Distinguished from distributive shocks because it also present an airway management issue and has its own distinct management plan (adrenaline)
- Defined as an allergic response affecting 2 or more body systems
  - Angioedema
  - Swelling/tightness in the throat, stridor
  - Dyspnoea, wheezing, cough
  - Vomiting, diarrhoea, abdominal pain
  - Hives, rash
- Treatment – 500mcg adrenaline im (adults). ICU support required for intravascularly administered adrenaline

# Haemorrhagic (hypovolaemic)

- The tubes don't have enough fluid in them
- Kids in particular can be vulnerable to dehydration related hypovolaemic shock
- Management – stop the bleeding, replace the fluid
  - In haemorrhagic shock – replace blood with blood! Replacing with crystalloid increases the risk of dilutional coagulopathy

# Massive Haemorrhage in Trauma

- If you have a trauma patient who is tachycardic and hypotensive, you need to find the bleeding
- On the Floor, plus 4 more
  - Chest
  - Abdomen
  - Pelvis
  - Long bone
- Put a chest drain in, do a FAST/eFAST, apply a pelvic binder, reduce the fracture, **keep the patient warm**



# Maria

- Maria is a 28yo woman, G2P1, who is currently in labour on your delivery ward
- The CTG is beginning to show a worrying trace and you're worried about foetal distress, so you take Maria to theatre for an emergency caesarean. As part of the caesarean, she receives a spinal anaesthetic
- Shortly after administration you notice Maria's blood pressure dropping. Her vitals are
  - RR – 25, SpO2 98% on 4L O2
  - HR 50, BP 85/40
- What is your DDX?

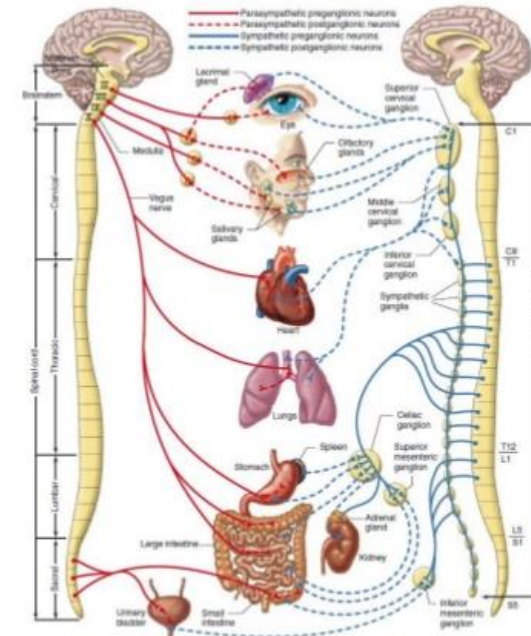
# Maria

- The CTG is beginning to show a worrying trace and you're worried about foetal distress, so you take Maria to theatre for an emergency caesarean. As part of the caesarean, she receives a **spinal anaesthetic**
- Shortly after administration you notice Maria's blood pressure dropping. Her vitals are
  - RR – 25, SpO2 98% on 4L O2
  - **HR 50, BP 85/40**
- Hypotension with bradycardia -> you're thinking about neurogenic shock due to sympathetic blockade

# Distributive

- “warm” shock
- Neurogenic -> Pipes are big
  - Associated with spinal shock/epidural
  - Blockade of the sympathetic trunk results in a loss of tone in vascular beds
  - May require fluid or vasopressors, usually short term

## ANS Physiology and Pharmacology Overview | Review of Autonomic Nervous System



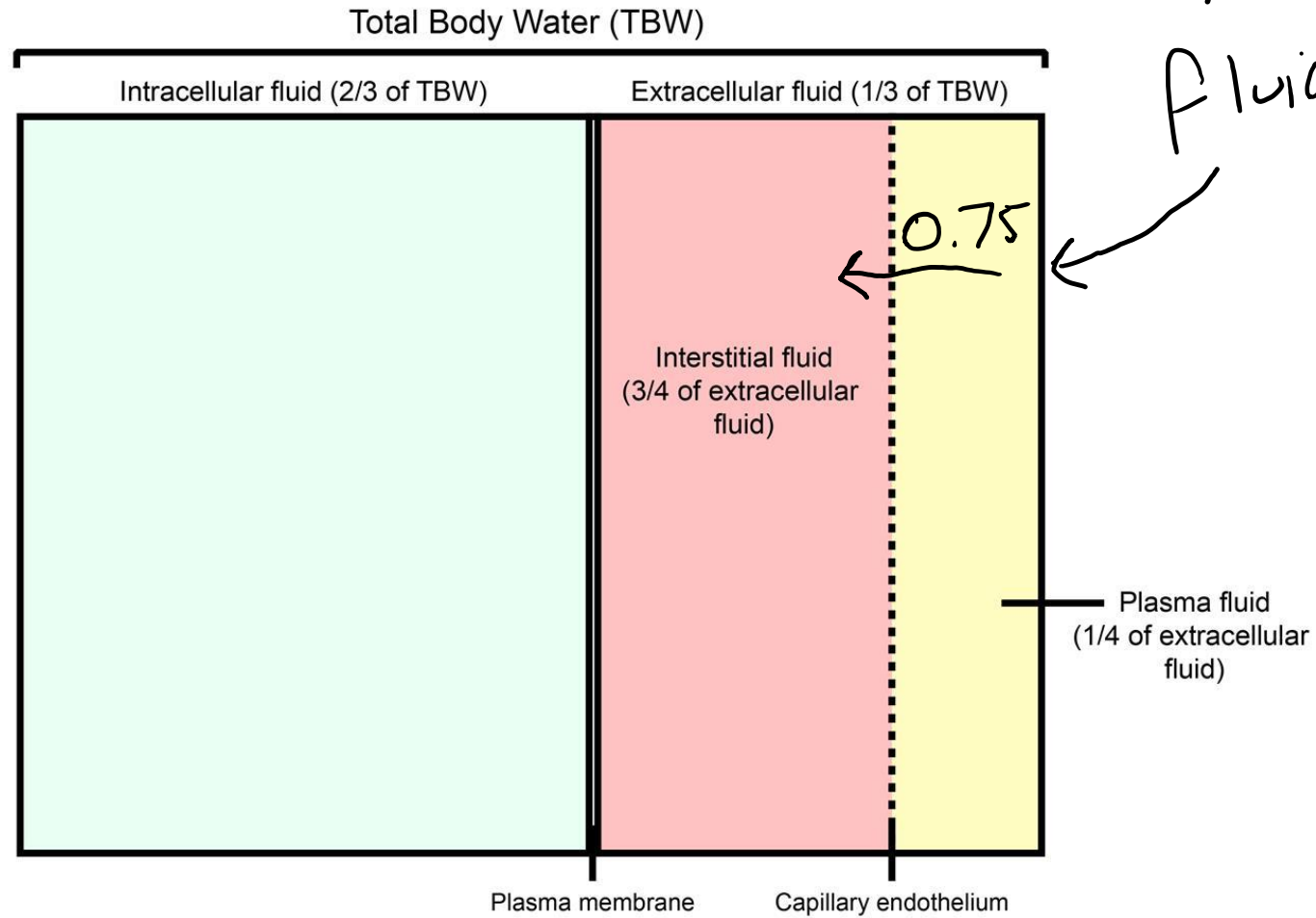
Widmaier, EP. *Vander's human physiology 14th Ed.* New York: McGraw-Hill, 2016.

**Marc Imhotep Cray, M.D.**

# Sepsis

- Pipes are big and leaky
  - Cytokine release results in vasodilation and **increased vasopermeability**
  - This vasopermeability is important -> fluid bolusing does have a role in fluid deplete patients, however third spacing becomes an important issue
- Usually considered a “warm” shock
  - HOWEVER -> geriatric and paediatric population can present peripherally shutdown due to associated dehydration
  - People can transition from a warm to a cold shock

# Body Fluid Compartments



© Lineage

Moises Dominguez  
Moises Dominguez



# Sepsis v Septic Shock

- Sepsis
  - Fever
  - Tachycardia
  - Tachypnoea
  - Hypotension
- Septic shock
  - Evidence of poor end organ perfusion
    - Rising creatinine, urea
    - Confusion/poor GCS
    - Lactate >2

# How do we treat it?

- Find the source
- Remove the source
  - In ICU -> remove all lines and send for culture
- Antibiotics
- Supportive care -> inotropes, vasopressors, fluids, oxygen, ventilator

# Questions?

- Some great questions from the night that weren't captured by the recording
  - What is the difference between Perfusion Pressure and Mean Arterial Pressure?
    - Perfusion pressure refers to the pressure of blood actually getting to the organ to perfuse it
    - PP relies on the central venous pressure as well as the MAP. If the CVP is high, we're going to need a greater MAP to overcome the resistance and perfuse the organ
    - In many ways it's a similar concept to cerebral perfusion pressure,  $CPP = MAP - ICP$ ; however, in other organs it's  $PP = MAP - CVP$
  - What are the vital sign cut-offs for shock?
    - I think this is a hard question to answer because really there isn't one
    - As you saw in neurogenic shock, you can be bradycardic, so HR isn't an accurate vital to solely base your diagnosis of shock
    - Blood pressure also isn't great – you can have normotensive shock
    - There's also so much variation within people. Someone could be used to a BP of 170/100, and when we give them a bunch of antihypertensives their blood pressure might be 130/80, but they might be confused (sign of end organ perfusion), have a raised lactate, and be clinically shocked
    - Your vitals help paint a picture, but you still need the canvas -> you need to interpret your vitals in the context of your patient, what you'd expect to be normal for them, and your clinical assessment





@mess\_education  
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# More info

- <https://messunimelb.org/>
  - Heaps of resources, links, twitter accounts, podcasts, and COVID19 specific resources
- I also like to use
  - <https://emcrit.org/>
  - <https://emcrit.org/ibcc/toc/>
  - <https://emergencymedicinecases.com/>
  - <https://litfl.com/>

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