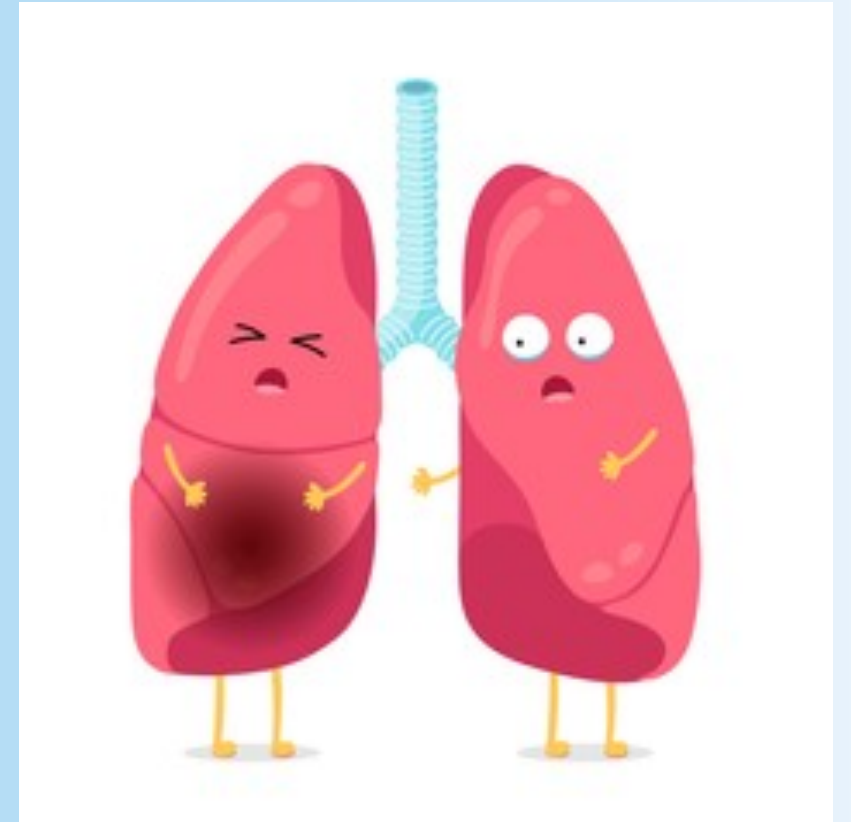


Acute respiratory disorders

Alexandra K Vedeler

Today's case studies at the ER

- Deep vein thrombosis
- Pulmonary embolism
- Respiratory failure type 1 and 2
- Acute respiratory distress syndrome



Let's take a trip to the ER



Meet Ms Bloom

Ms. Bloom is a 36 year old women who came to the emergency department presenting with a painful, warm, and swollen left leg.

Before you start to examine her you have learned that it is always important to take a thorough history.

What would you like to ask Ms Bloom?



Meet Ms Bloom



Ms. Bloom is a 36 year old women who came to the emergency department presenting with a painful, warm, and swollen left leg.

She reports that she recently came back from a business trip in Japan.

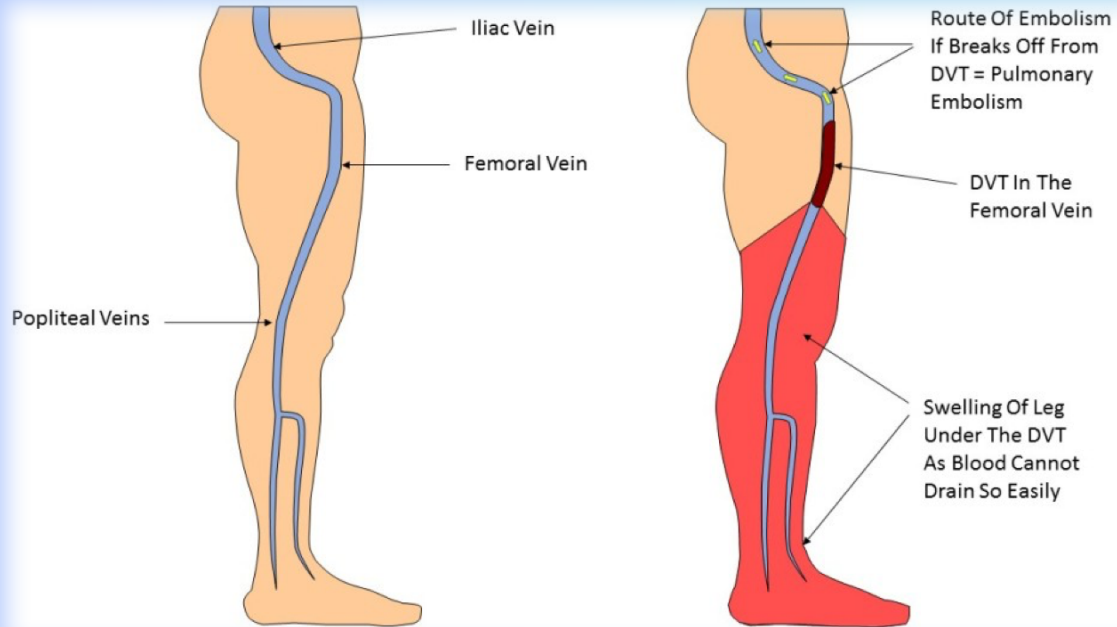
She denies any fever, chills, or history of trauma to her leg.

She takes estrogen containing birth control pills. She is obese with a BMI of 34 and she has a smoking history of 20 pack-years.

She denies having similar episodes in the past. Remainder of the physical exam is unremarkable.



Deep Vein Thrombosis



Thrombus

A *blood clot* that remains at the site it is formed, in this case in deep veins.

Most common location: Femoral vein



Wait! This Swollen Right Arm May Not be Muscles? DVT? I'm Too Young for a DVT!

Which of the following is NOT a risk factor of deep vein thrombosis?

1. Her BMI
2. Estrogen containing contraceptive pills
3. Her age
4. Recent flight history

Hyper-coagulability

Hereditary

- Factor V Leiden mutation

Acquired

- Estrogen therapy
- Pregnancy
- Obesity
- Dehydration

Virchow triad

Endothelial damage

Dysfunction

- Age > 60 years
- Hypertension
- Smoking

Impairment

- Surgery
- Trauma

Stasis

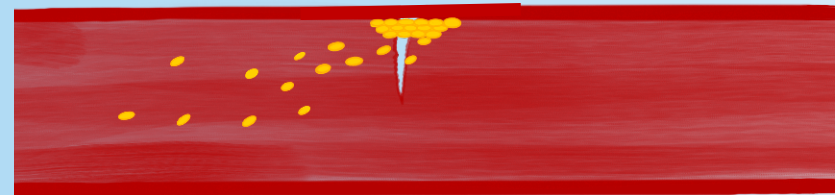
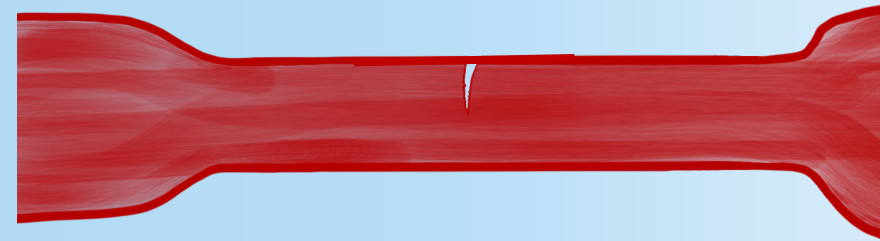
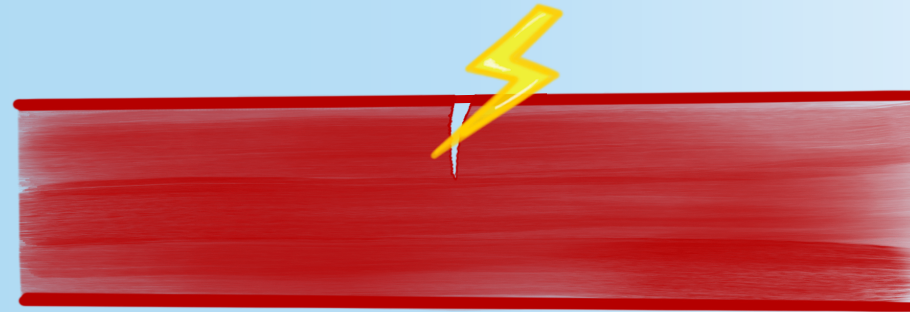
Immobilization

- Long flights
- Hospitalization
- Varicose veins

Deep vein thrombosis

Pathophysiology

1. Damage to the endothelium
2. Vasoconstriction
3. Primary hemostasis
4. Secondary hemostasis



**You take a blood test from Ms Bloom.
What would strengthen your suspicion of a DVT?**

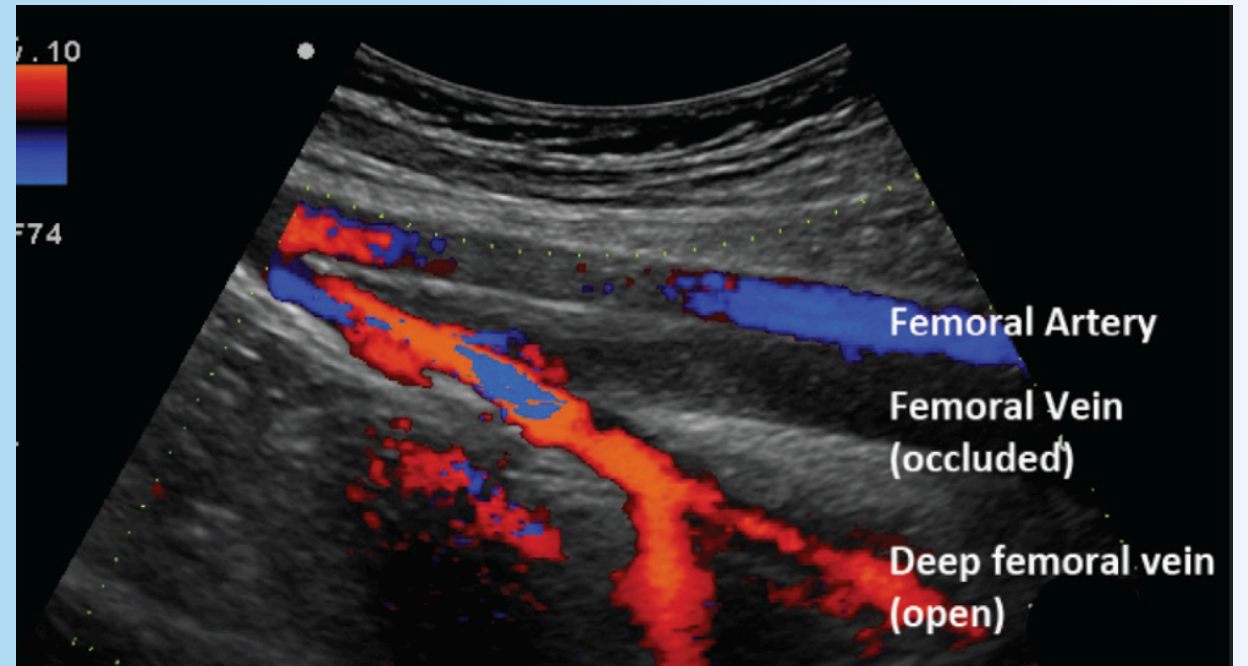
- a. Elevated troponin
- b. Elevated D-dimer
- c. Elevated lactate
- d. Elevated creatinine



	Test result	Reference range
Prothrombin time (INR)	1.09	0.83-1.11
Activated partial thromboplastin time (ratio)	1.10	0.85-1.17
Fibrinogen (mg/dL)	374	150-400
D-dimer (ng/mL)	2557	<500
Hemoglobin (g/dL)	12.0	12.0-16.0
Hematocrit	0.35	0.35-0.45
Red blood cell count (x12/L)	4.27	3.80-5.10
White blood cell count (x12/L)	9.88	4.30-10.0
Platelets (x12/L)	395	150-400
Alanine aminotransferase (IU/L)	28	6-40
Lipase (IU/L)	30	13-60
Pancreatic amylase (IU/L)	37	28-100
Total bilirubin (mg/dL)	0.40	0.20-1.10
Creatinine (mg/dL)	0.64	0.50-1.20
Urea nitrogen (mg/dL)	8.6	8.0-22.0
Glucose (mg/dL)	106	60-110
Albumin (g/L)	38	32-50
Erythro sedimentation Rate	22	<38

Negative (<500 ng/mL)	DVT is ruled out
Positive (>500 ng/mL)	Possible DVT – more investigations are needed

Venous ultrasound with doppler



You confirm the diagnosis of a deep vein thrombosis ✓



Suddenly Ms Bloom starts hyperventilating and complains of chest pain worsening on deep inspiration. The nurse takes her vitals:

Respiratory rate: 26

Heart rate: 110bpm

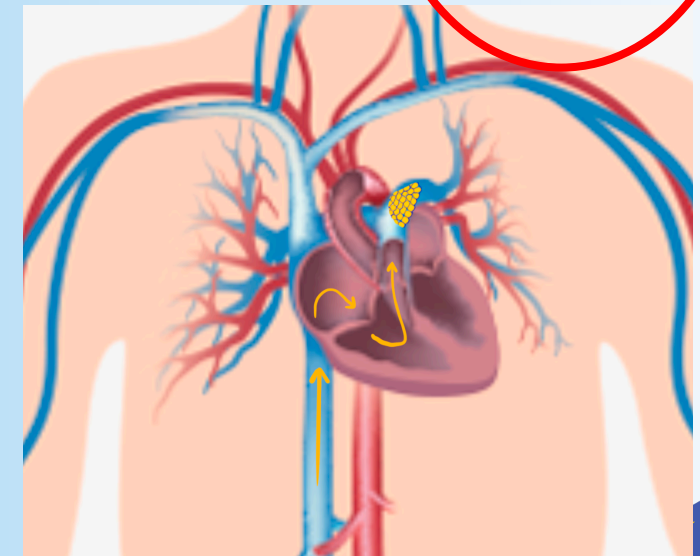
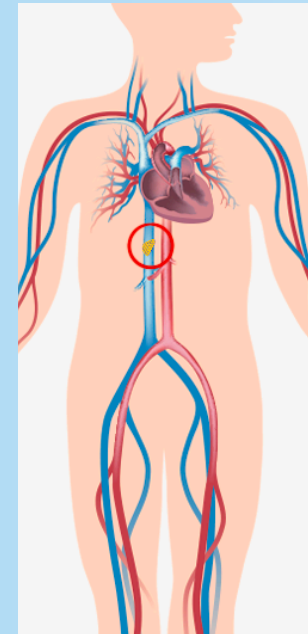
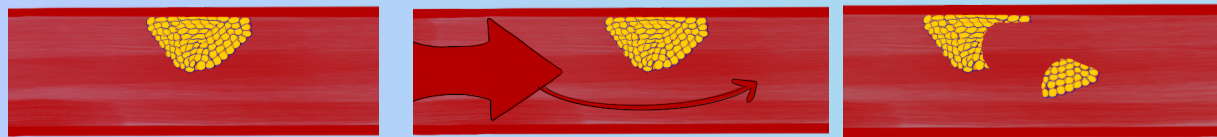
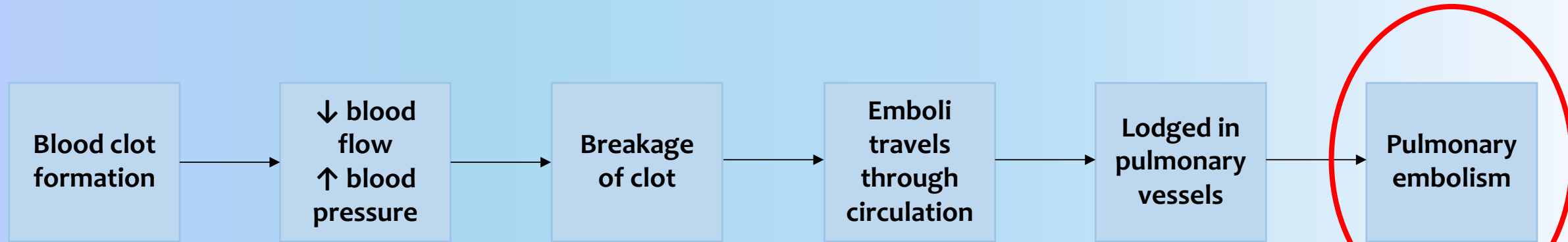
Blood pressure: 130/87 mmHg

Saturation (SpO₂): 94%

What do you now suspect is causing Ms Bloom's symptoms?

From DVT to pulmonary embolism

> 95% of pulmonary embolisms are caused by a DVT

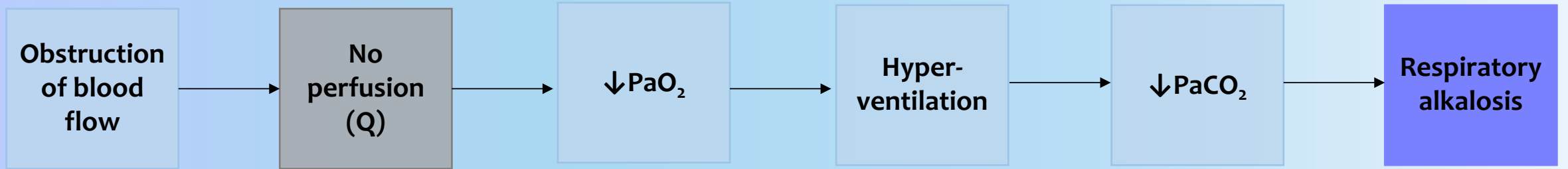


Embolism

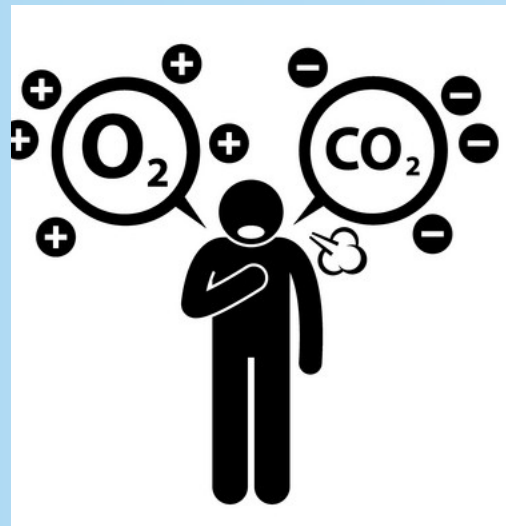
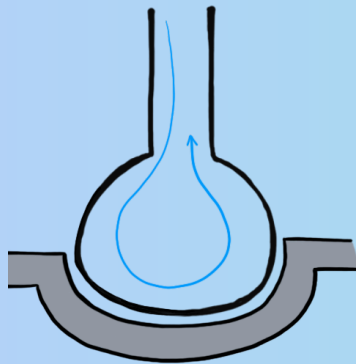
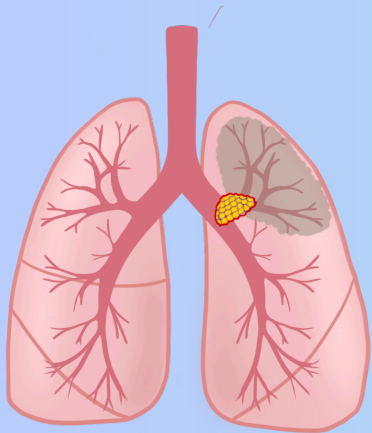
A *clot* that has traveled from its point of origin to a different part of the body

What is causing Ms Bloom to hyperventilate?

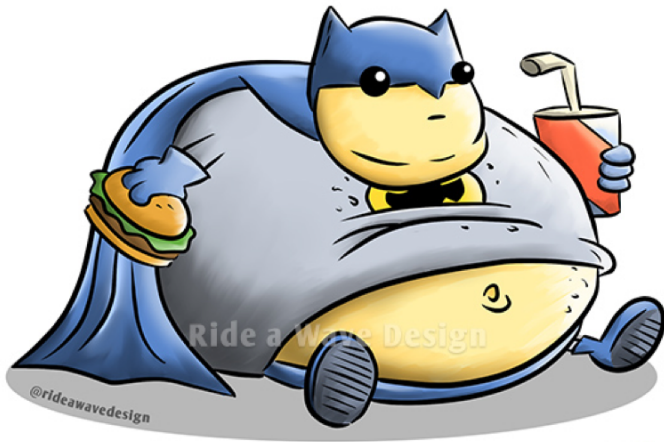
V/Q mismatch



pH > 7.45
PaCO₂ < 35 mmHg



Types of emboli



FAT BAT

Fat

Air

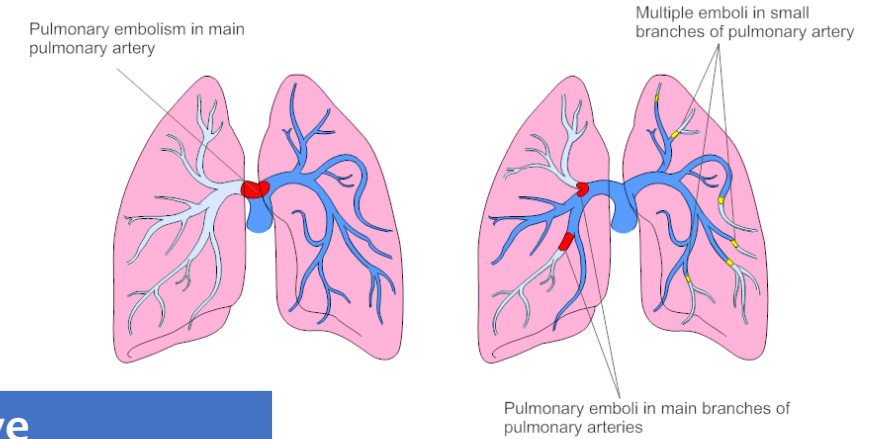
Thrombus (blood clot)

Bacteria

Amniotic fluid

Tumor

Severity!



	Small	Medium	Massive
Recognition	Often unrecognized	Sudden	Sudden
Symptoms	Dyspnea on exercise	Pleuritic chest pain Dyspnea Fever Hemoptysis	Shock – hemodynamic collapse Central chest pain Syncope Tachypnea
Signs	Pulmonary hypertension Right ventricular hypertrophy	Tachycardia Pleural friction rub may be present	Weak pulse Hypotension Death

How to diagnose Ms Bloom?



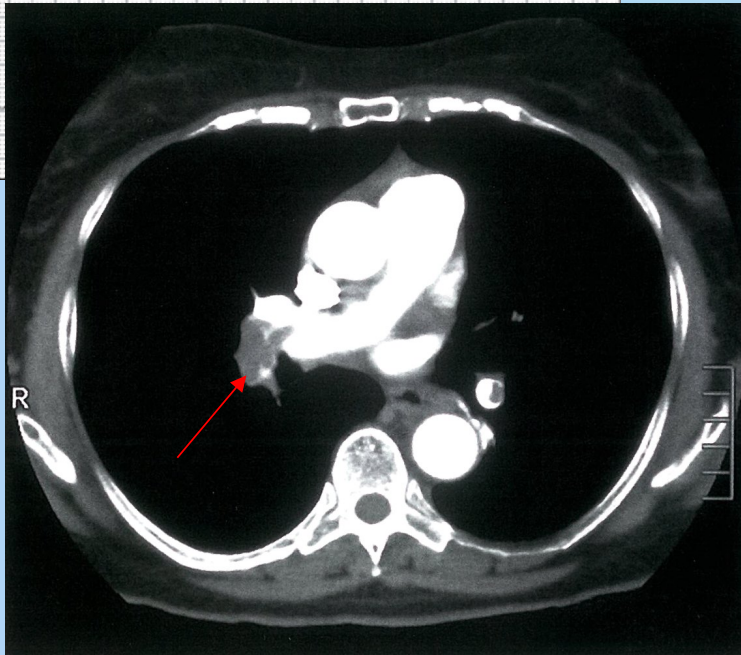
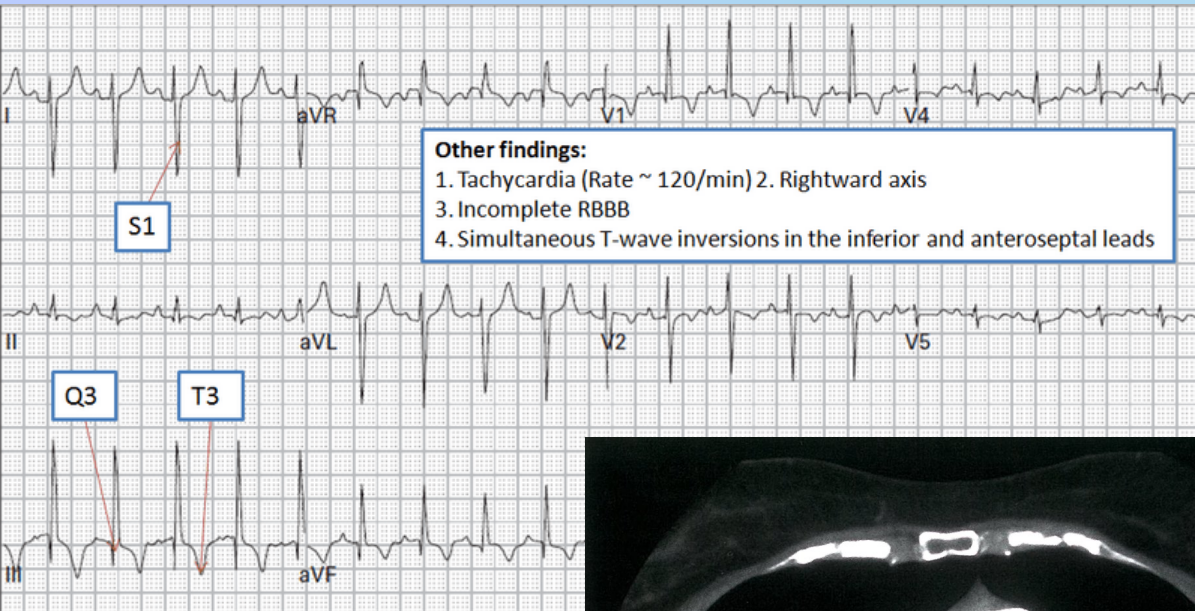
Wells criteria for pulmonary embolism

Criteria	Points
Clinical symptoms of <u>DVT</u>	3 ✓
PE more likely than other diagnoses	3 ✓
Previous PE/ <u>DVT</u>	1.5
Tachycardia (Heart rate > 100/min)	1.5 ✓
Surgery or immobilization in the past 4 weeks	1.5 ✓
Hemoptysis	1
Malignancy ☰	1
Original Wells score (clinical probability) ^[9] <ul style="list-style-type: none">• Total score 0–1: low probability of PE (6%)• Total score 2–6: moderate probability of PE (23%)• Total score ≥ 7: high probability of PE (49%)	Score = 9
Modified Wells score (clinical probability) ^[10] <ul style="list-style-type: none">• Total score < 4: PE unlikely (8%)• Total score > 4: PE likely (34%)	

Ms Flight's status

- ✓ Diagnosis of DVT
- ✓ Afebrile
- ✓ Chest pain on inspiration
- ✓ Vitals:
 - Respiratory rate: 26
 - Blood pressure: 130/87
 - Heart rate: 110
 - Saturation (SpO₂): 94%

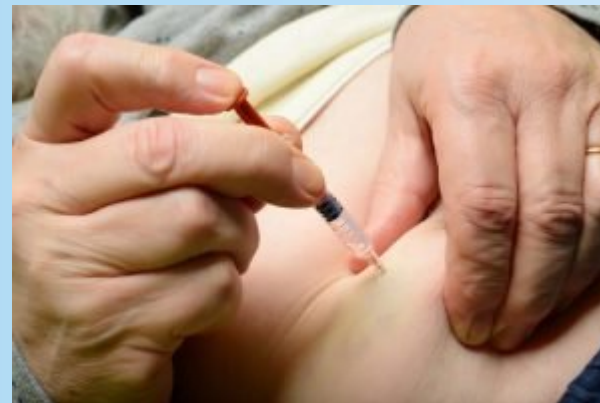
Diagnostics



- Wells criteria
- D-dimer levels
- Auscultation
- Arterial blood gas (ABG)
- ECG
- ★ CT pulmonary angiogram
 - Gold standard

Prevention!

- ✓ Mobilization
- ✓ Life-style changes
- ✓ Compression therapy
- ✓ Anticoagulant prophylaxis
 - Low molecular weight heparin



A new patient arrives at the ER



Meet Mr. Camel

Mr. Camel is a 68 year old man previously diagnosed with grade 3 COPD and a history of 40 pack-years.

He presents to the emergency department with a 4-day history of worsening dyspnea, chest pain, and a productive cough.

On physical examination you find:

Heart rate	Blood pressure	Resp. rate	SpO ₂	Temperature
105	110/75 mmHg	22	87%	38.8°C

On auscultation you hear bilateral inspiratory crackles and expiratory wheezes.



We suspect pneumonia



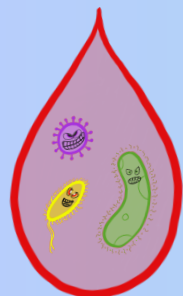
qSOFA:

RR: >22 BP_{systolic} < 100 mmHg Altered mental status

On physical examination you find:

Heart rate	Blood pressure	Resp. rate	SpO ₂	Temperature
105	110/75 mmHg	22	87%	38.8°C

On auscultation you hear bilateral inspiratory crackles and expiratory wheezes.



You take a blood culture that is positive for *Streptococcus Pneumoniae*
Confirming a bacterial pneumonia

You decide to perform an arterial blood gas:



pH:	7.19	(7.35-7.45)
PaO ₂ :	45 mmHg	(>80 mmHg)
PaCO ₂ :	55 mmHg	(35-45 mmHg)
HCO ₃ ⁻ :	29 mEq/L	(21-27 mEq/L)



Respiratory failure is a syndrome of inadequate gas exchange due to dysfunction of one or more essential components of the respiratory system

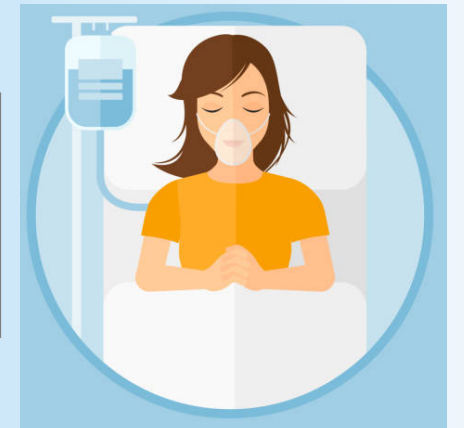
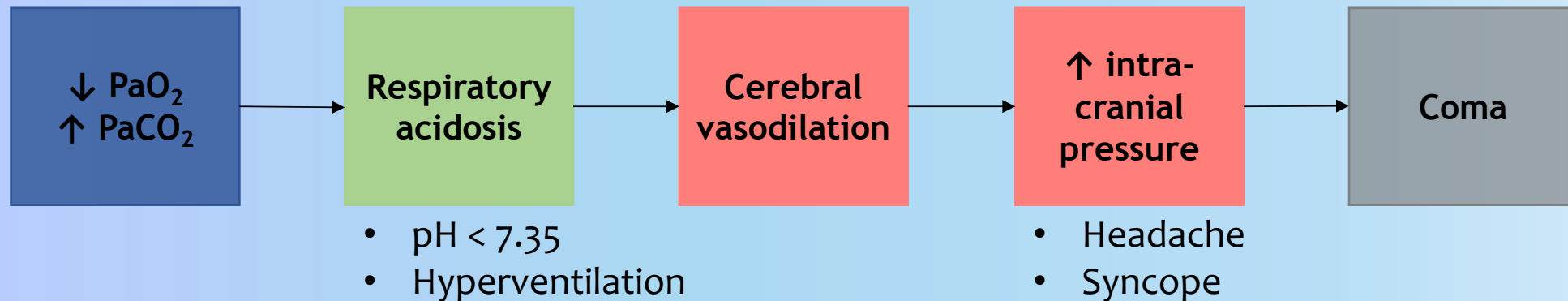
Respiratory Failure Type I
Hypoxemic respiratory failure

Respiratory Failure Type II
Hypercapnic respiratory failure

Definition	PaO ₂ < 60 mmHg	PaO ₂ < 60 mmHg PaCO ₂ > 45 mmHg ↓ pH < 7.35
Pathophysiology	Oxygen failure	Ventilation failure Increased dead space Increased CO ₂ production Hypoventilation

Clinical presentation

Respiratory failure type II



Mr. Camel's ABG:

pH:	7.19	(7.35-7.45)
PaO ₂ :	45 mmHg	(>80 mmHg)
PaCO ₂ :	55 mmHg	(35-45 mmHg)
HCO ₃ ⁻ :	29 mEq/L	(21-27 mEq/L)

The ER is busy today and the attending asks you to run a blood gas on a new patient is having difficulties breathing:

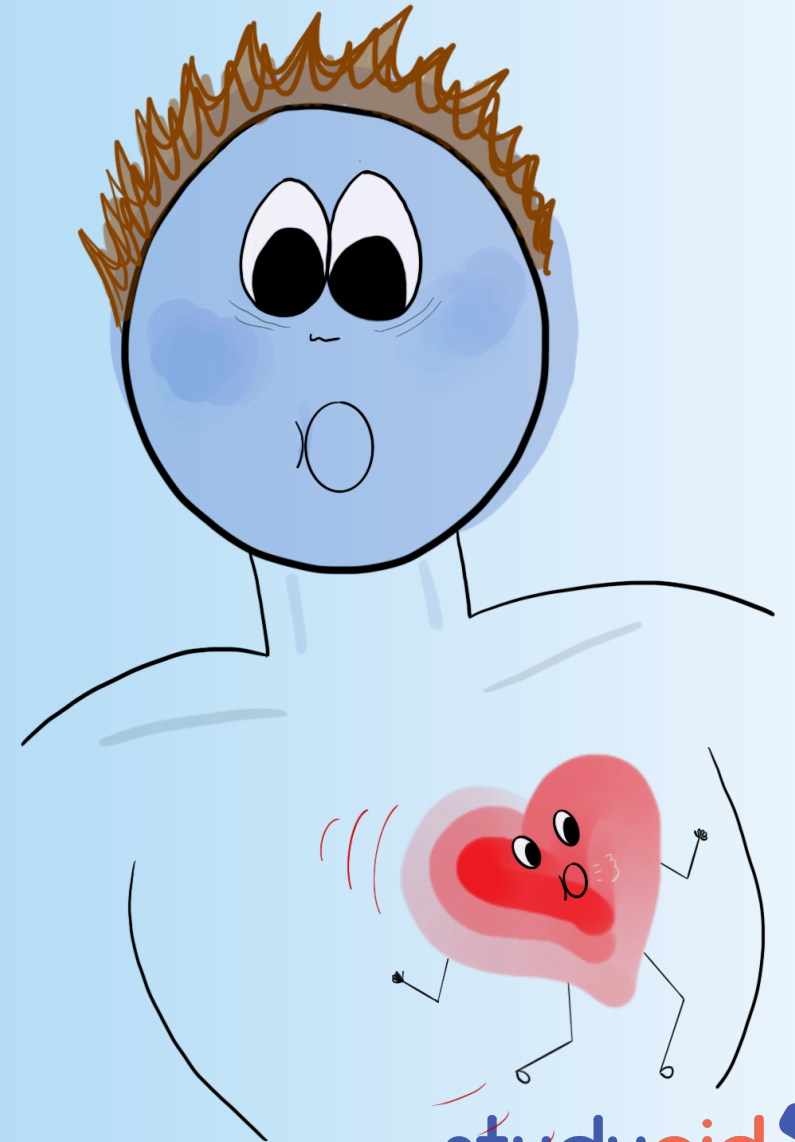
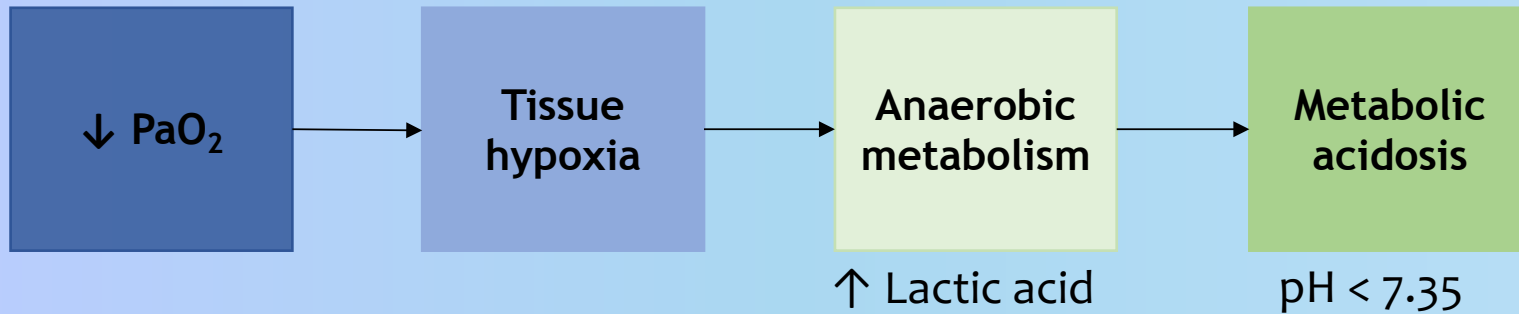
The ABG shows:

pH:	7.33	(7.35-7.45)
PaO ₂ :	45 mmHg	(>80 mmHg)
PaCO ₂ :	42 mmHg	(35-45 mmHg)
HCO ₃ ⁻ :	23 mEq/L	(21-27 <u>mEq/L</u>)
Lactic acid:	3.2 mmol/L	(0.5-1.0 mmol/L)



Clinical presentation

Respiratory failure type I



The ABG shows:

pH:	7.33
PaO ₂ :	45 mmHg
PaCO ₂ :	42 mmHg
HCO ₃ ⁻ :	23 mEq/L
Lactic acid:	3.2 mmol/L

Respiratory failure type I and II

	Acute	Chronic
Onset	minutes – hours	Days-weeks
pH value	< 7.2 (decreases rapidly)	slight decrease (↑ HCO ₃)
Example	Pneumonia	COPD

How would you classify Mr Camel's respiratory failure?

- a. Respiratory failure type 1
- b. Acute respiratory failure type 2
- c. Chronic respiratory failure type 2
- d. Acute on chronic respiratory failure type 2

	ABG	
pH:	7.19	(7.35-7.45)
PaO ₂ :	45 mmHg	(>80 mmHg)
PaCO ₂ :	55 mmHg	(35-45 mmHg)
HCO ₃ ⁻ :	29 mEq/L	(21-27 mEq/L)

The nurse comes running!



Mr. Camel's condition is deteriorating, his vitals now show:

Heart rate	Blood pressure	Resp. rate	SpO ₂	Temperature
115	98/64 mmHg	26	84%	39.0°C

You notice that his mouth is turning slightly blue and he is becoming more drowsy.



He is presenting with all the clinical features of **Acute Respiratory Distress Syndrome**

- ✓ Redisposing condition: Pneumonia → sepsis
- ✓ Dyspnea (shallow breathing)
- ✓ Tachypnea (Respiratory rate: 26)
- ✓ Tachycardia (Heart rate: 115 bpm)
- ✓ Cyanosis (blue discoloration around his mouth)

Heart rate	Blood pressure	Resp. rate	SpO ₂	Temperature
115	98/64 mmHg	26	84%	39.0°C

Acute respiratory distress syndrome

Etiology

SPARTAS

Sepsis*

Pneumonia

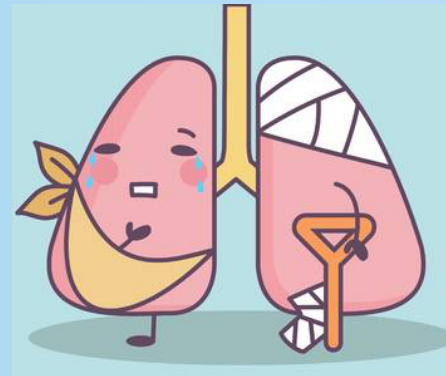
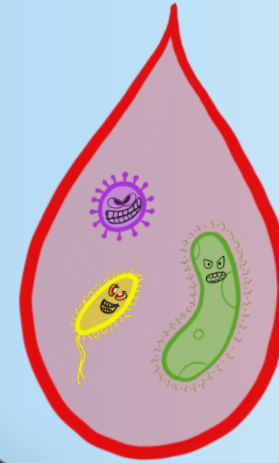
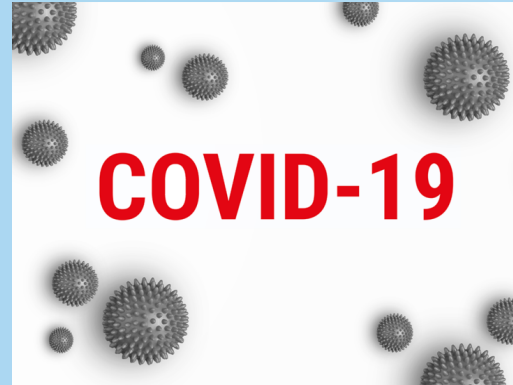
Aspiration

uRemia

Trauma

Acute pancreatitis

Shock

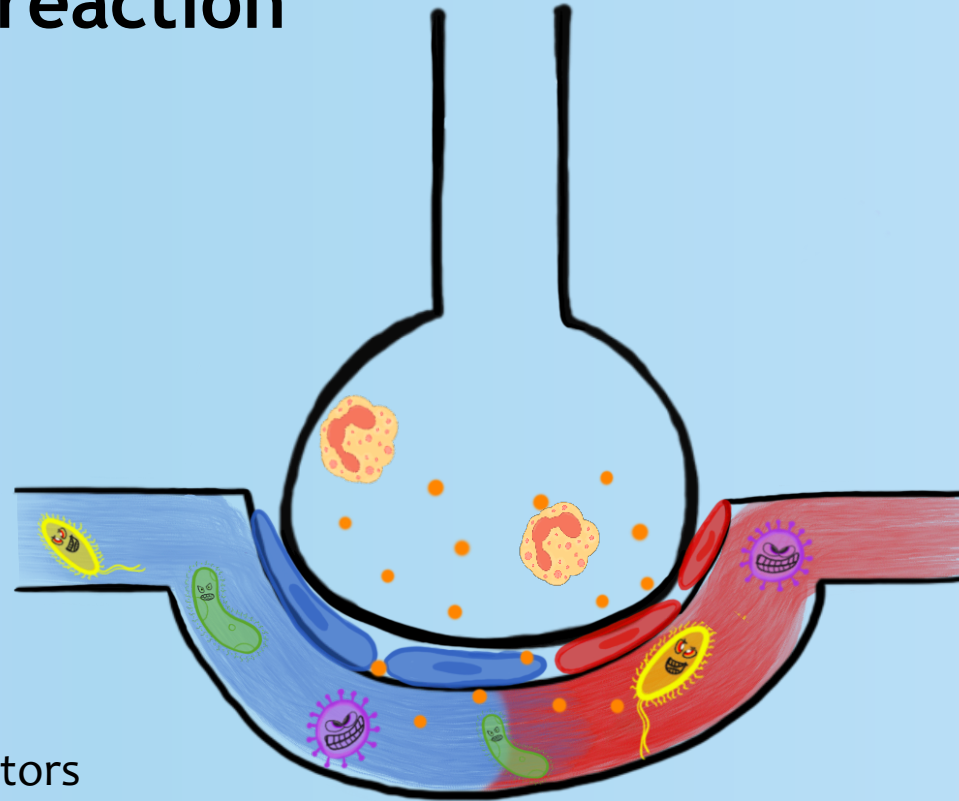


**Sepsis is the most common cause of ARDS*

Acute respiratory distress syndrome

Pathophysiology

1. Inflammatory reaction

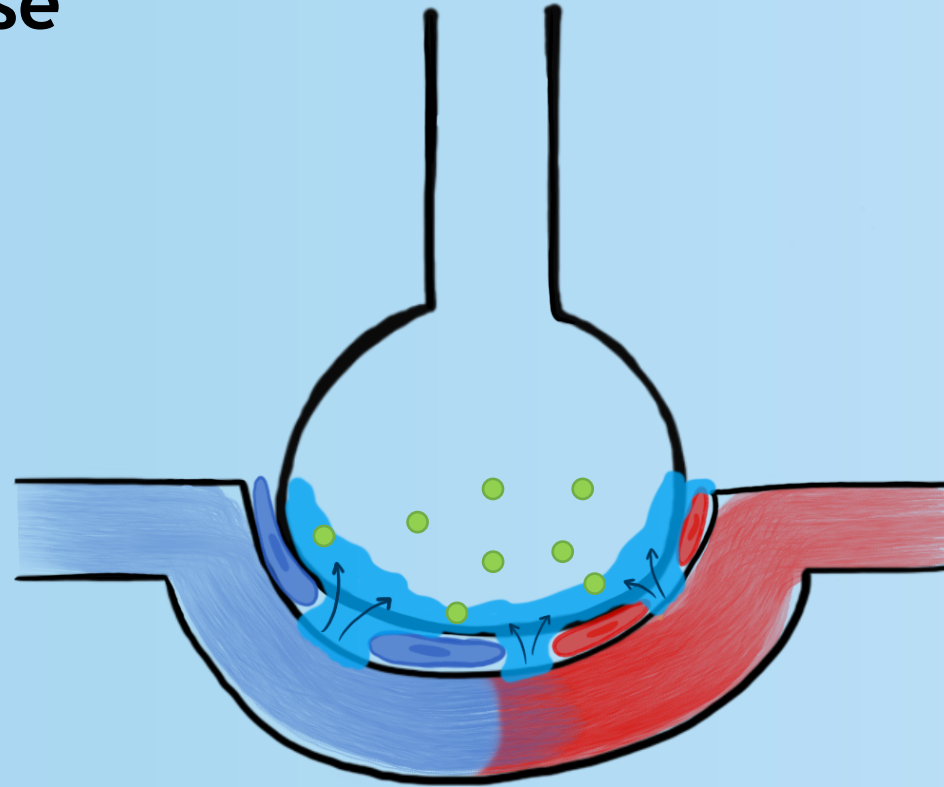


1. Tissue damage
2. Release of inflammatory mediators
3. Neutrophil migration
4. Cytokine release → diffuse alveolar damage

Acute respiratory distress syndrome

Pathophysiology

2. Exudative phase

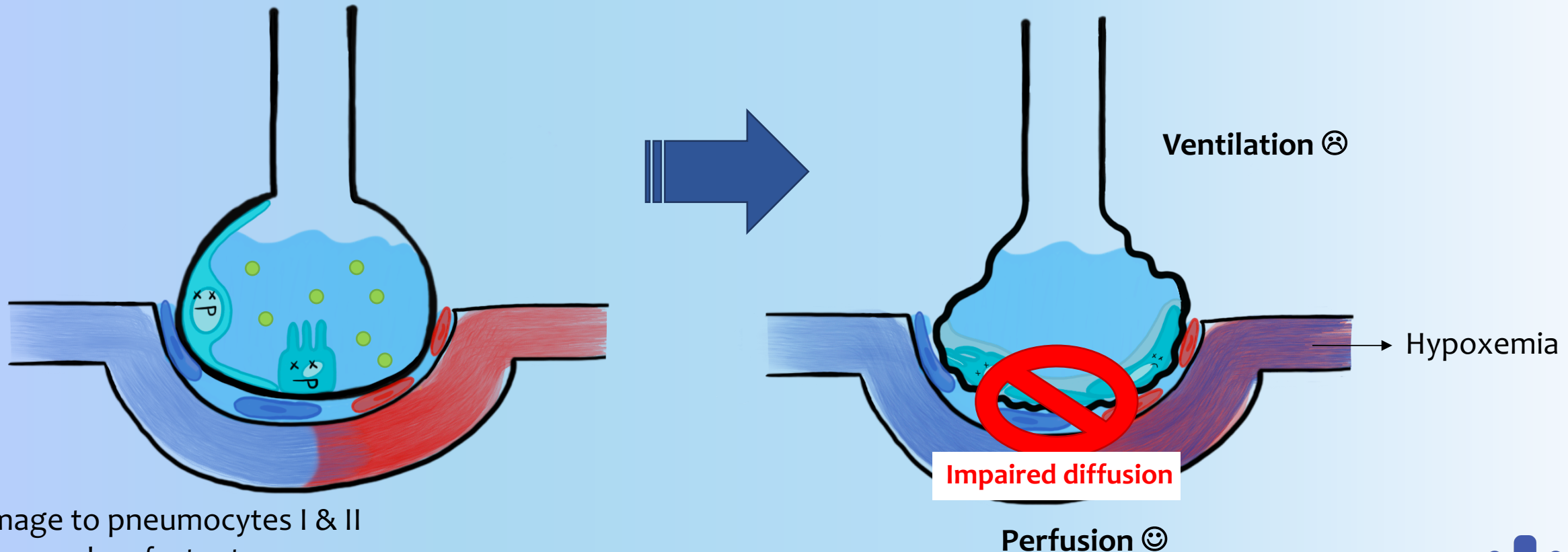


1. Increased vascular permeability: Fluid leakage into the alveoli
2. Protein-rich edema fluid
3. Decreased lung compliance and respiratory distress

Acute respiratory distress syndrome

Pathophysiology

3. Hyaline membrane formation

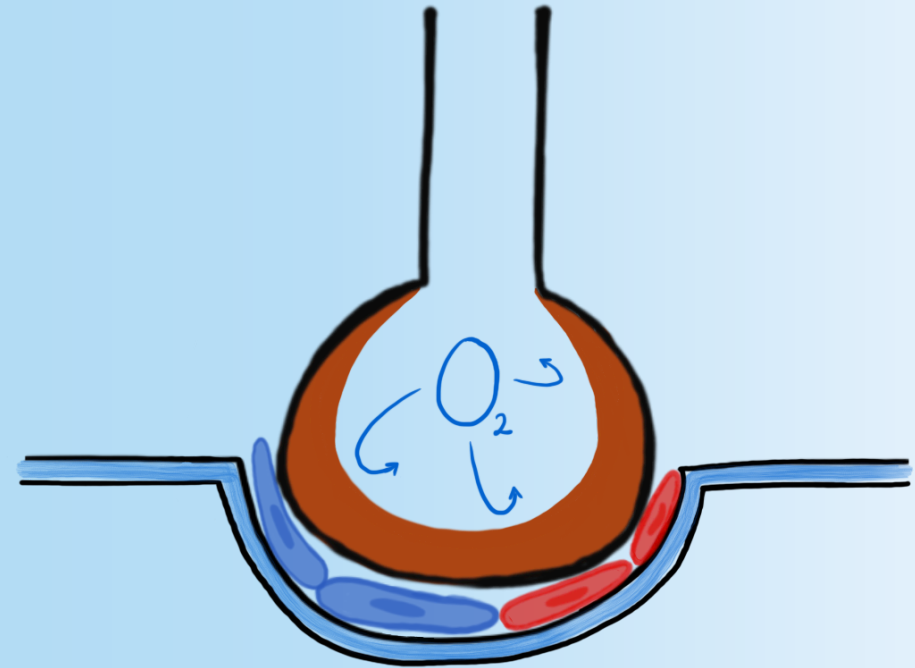
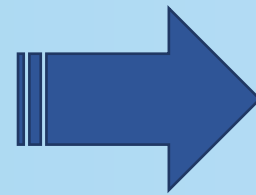
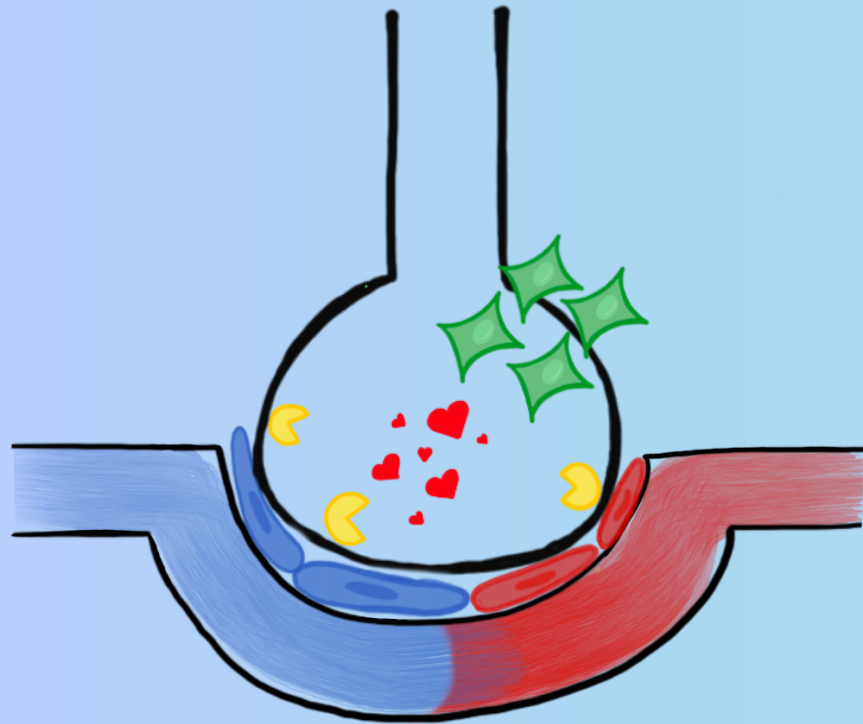


1. Damage to pneumocytes I & II
2. Decreased surfactant
3. Alveolar collapse

Hyaline membrane formation

Pathophysiology - complication

4. Fibrosis

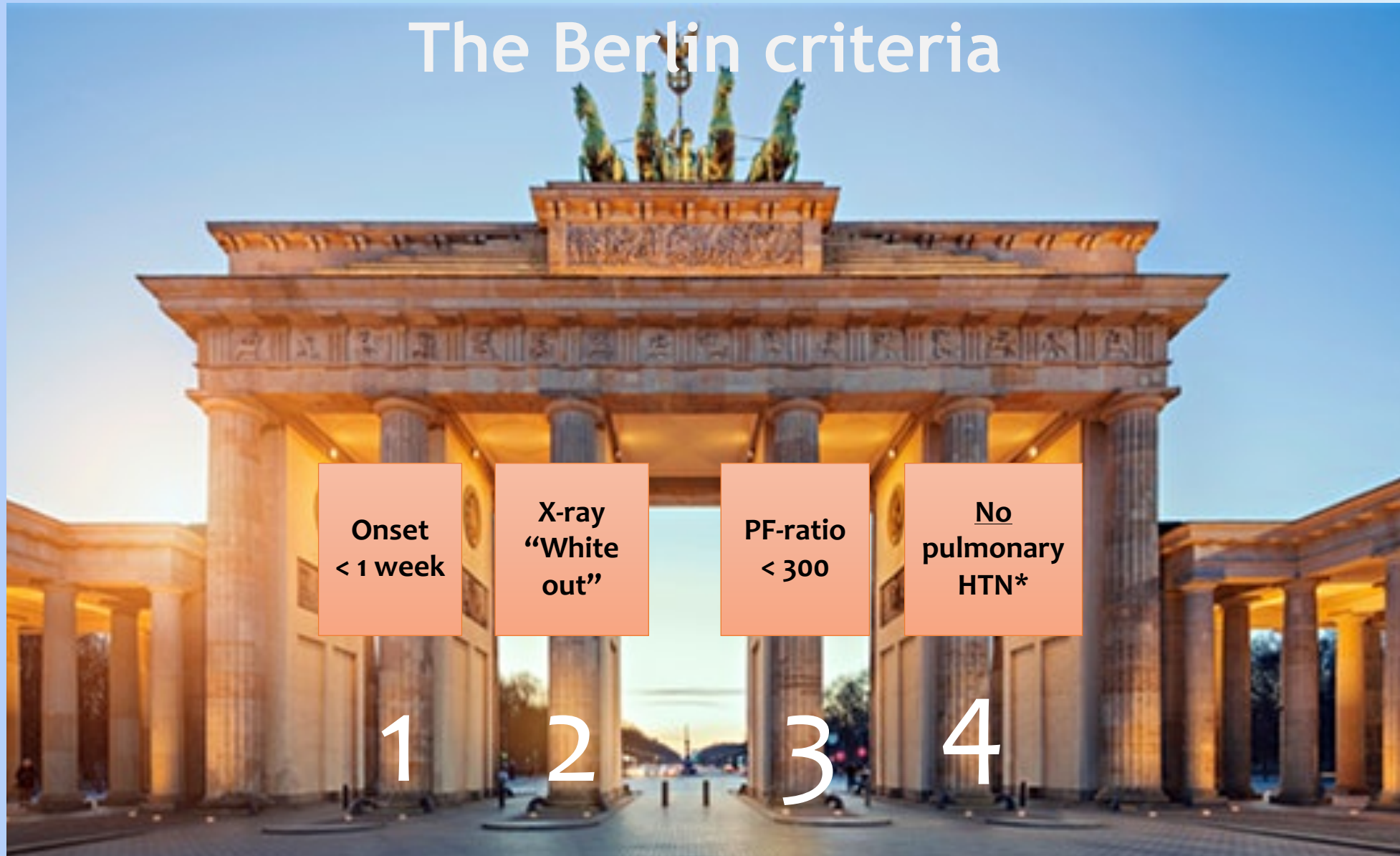


Restrictive lung disease:
Progressive interstitial fibrosis

1. Macrophage migration
2. Fibroblast proliferation
3. Collagen deposition

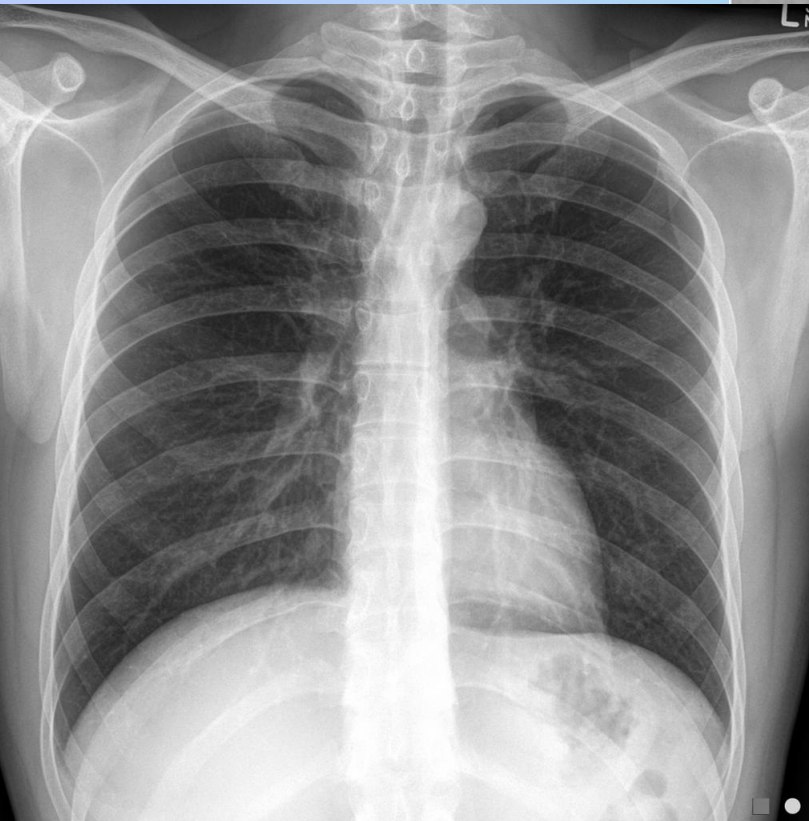
How do we diagnose Mr Camel?

The Berlin criteria



*presence of pulmonary hypertension indicates congestive heart failure

You receive Mr Camel's chest x-ray:



You successfully diagnosed Mr Camel with acute respiratory distress syndrome



He was sent to the intensive care unit where he was treated with

- Mechanical ventilation
- Broad spectrum antibiotics
- Fluid management
- Diuretics

Good luck! 😊

