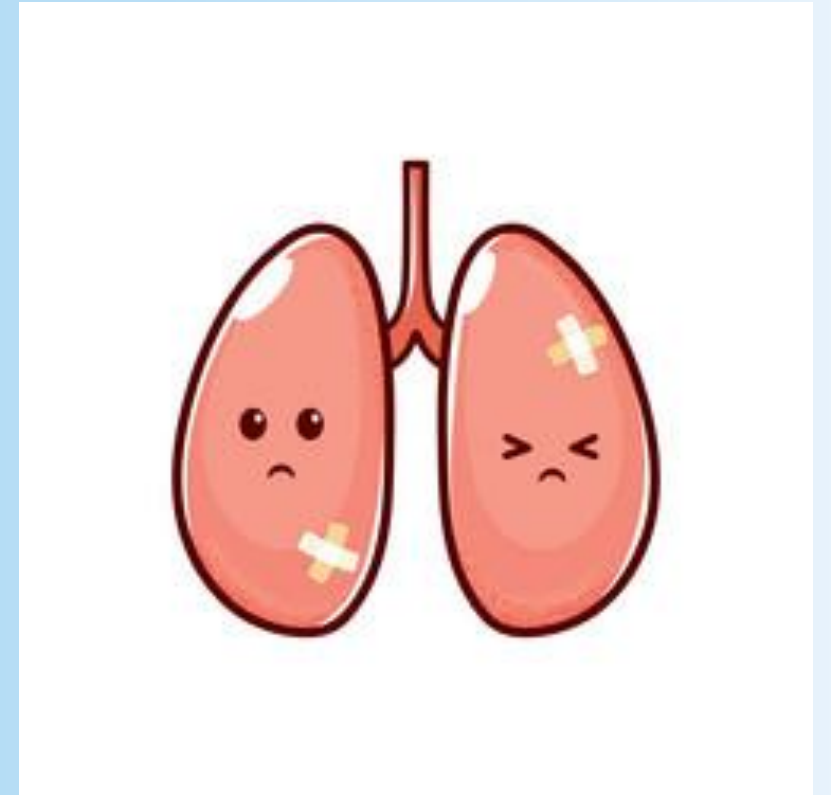


# Acute respiratory disorders

Josefine Holum

# Today's cases at the ER

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





© fot. Karolina Fok / Archiwum SU

# Meet Ms Bloom

Ms Bloom is a 36 year old woman who came into the emergency department with a painful, warm and swollen left leg





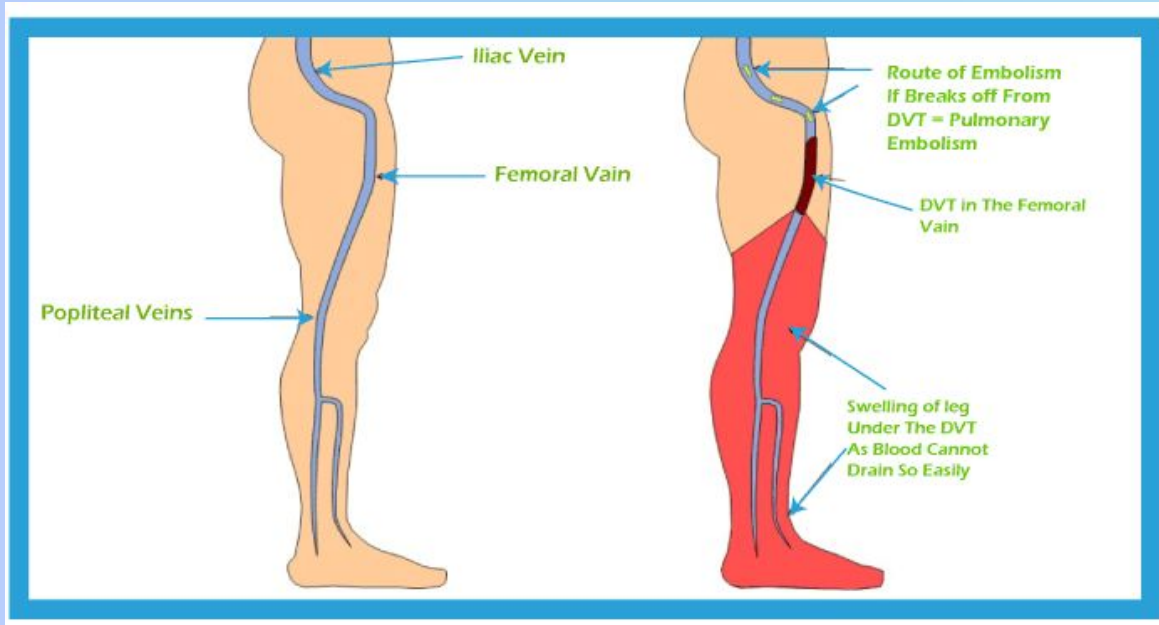
# Ms Bloom

Ms Bloom is a 36 year old woman who came into the emergency department with a painful, warm and swollen left leg

- She recently came back from a trip to Japan
- Denies fever, chill or leg trauma
- She is on an oral contraceptive containing estrogen
- Her BMI is 34
- 20 pack years



# Deep vein thrombosis



## Thrombus

A blood clot that remains at the site it is formed.  
Most common DVT location: deep femoral vein

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

- a) Her BMI
- b) Estrogen containing contraceptive pills
- c) Her age
- d) 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



# SHE

Stasis

Hypercoagulability

Endothelial damage

**Hyper-coagulability**

**Hereditary**

- Factor V Leiden mutation

**Acquired**

- Estrogen therapy
- Pregnancy
- Obesity
- Dehydration

## Virchow triad

**Endothelial damage**

**Dysfunction**

- Age > 60 years
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**Impairment**

- Surgery
- Trauma

**Stasis**

**Immobilization**

- Long flights
- Hospitalization
- Varicose veins

# Deep vein thrombosis

## Pathophysiology

1. Damage to the endothelium

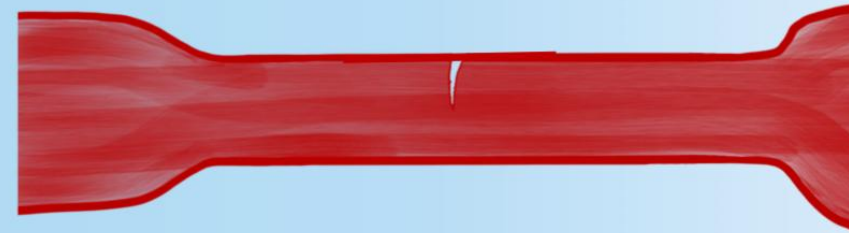
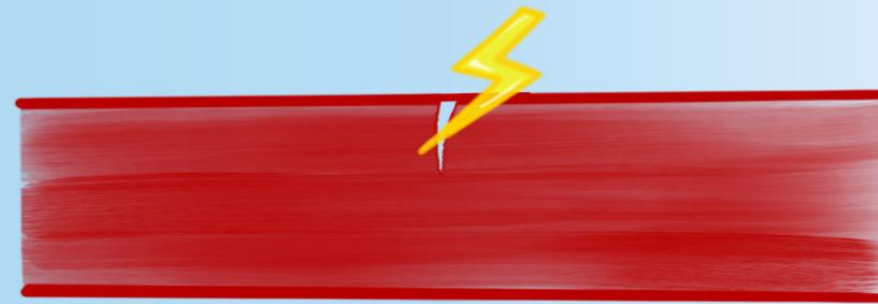
2. Vasoconstriction

3. Primary hemostasis

Formation of a weak platelet plug

4. Secondary hemostasis

Strong fibrin clot



**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
<b>D-dimer (ng/mL)</b>	<b>2557</b>	<b>&lt;500</b>
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
Erythrosedimentation Rate	22	<38

**Negative (<500 ng/mL)**

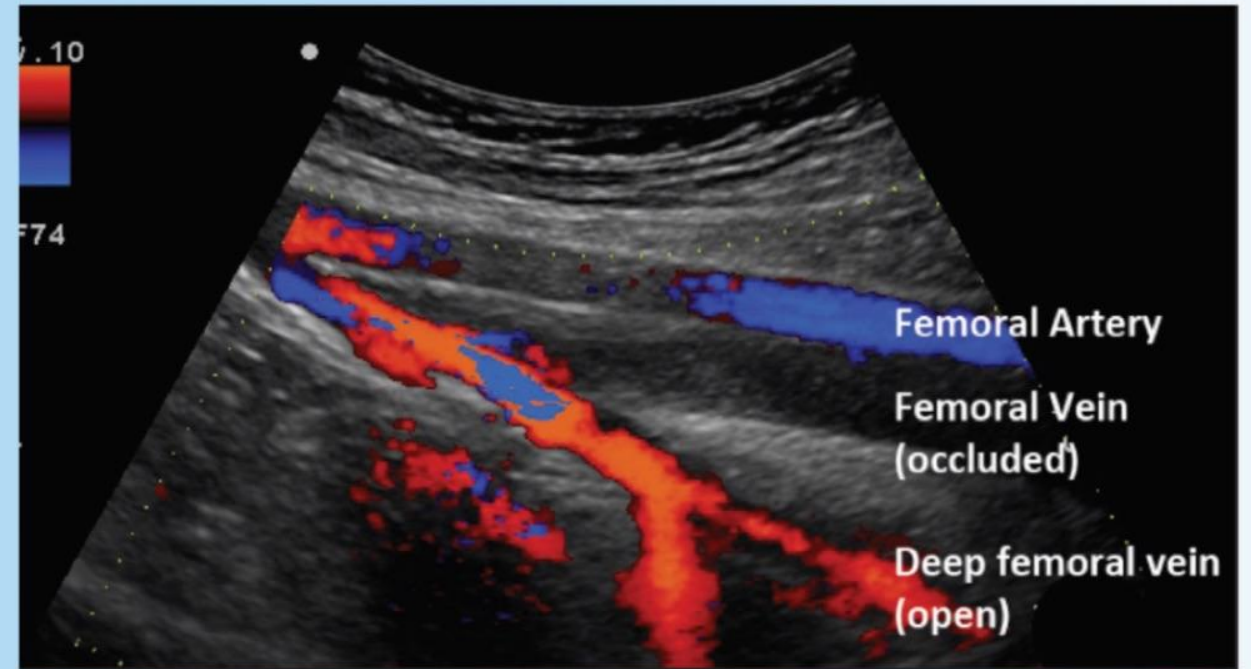
DVT is **ruled out**

**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

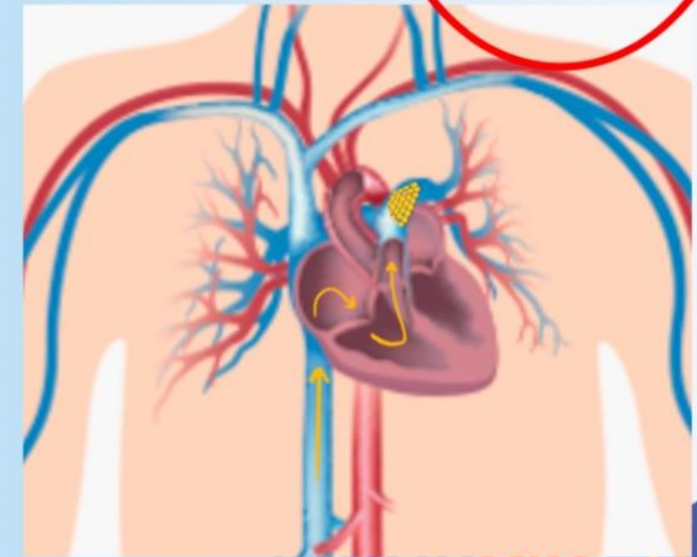
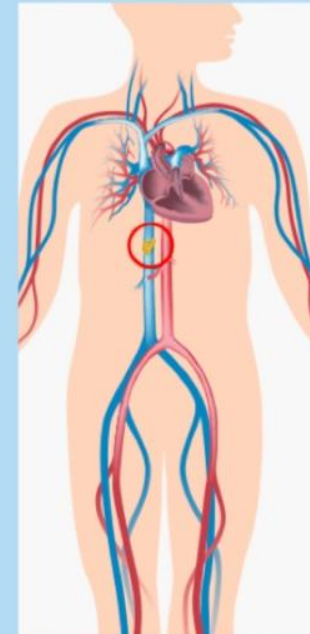
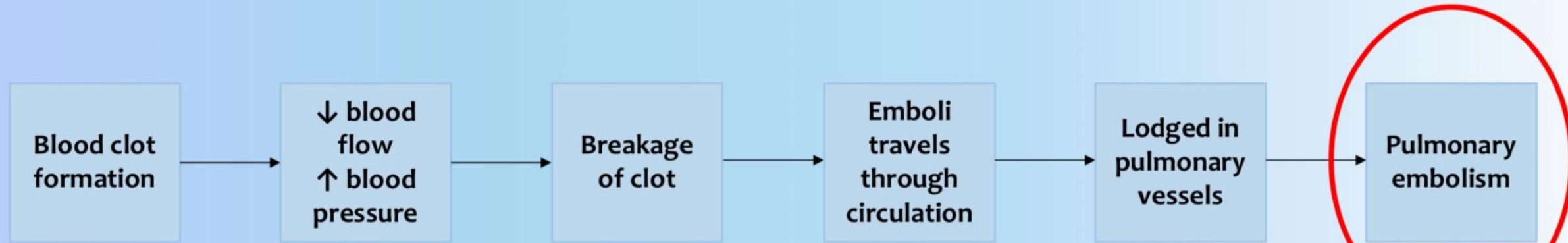
Blood pressure: 130/87 mmHg

Saturation (SpO<sub>2</sub>): 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



# Types of emboli



Fat

Air

Thrombus (blood clot)

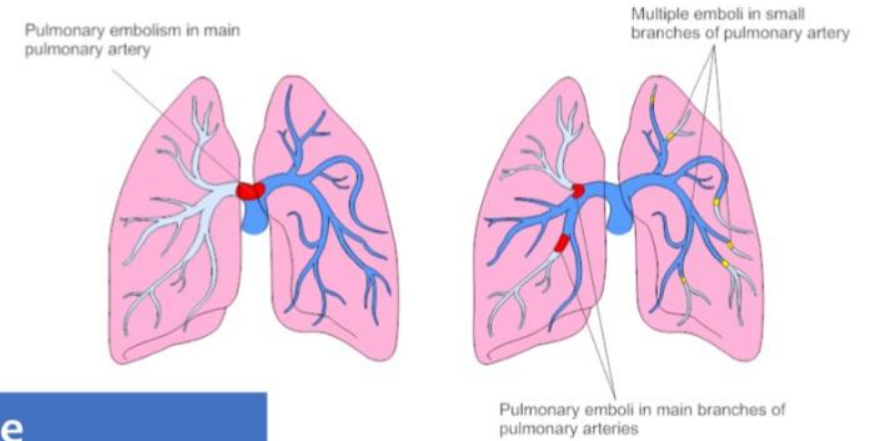
Bacteria

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 do you diagnose Ms Bloom

## Wells criteria for pulmonary embolism

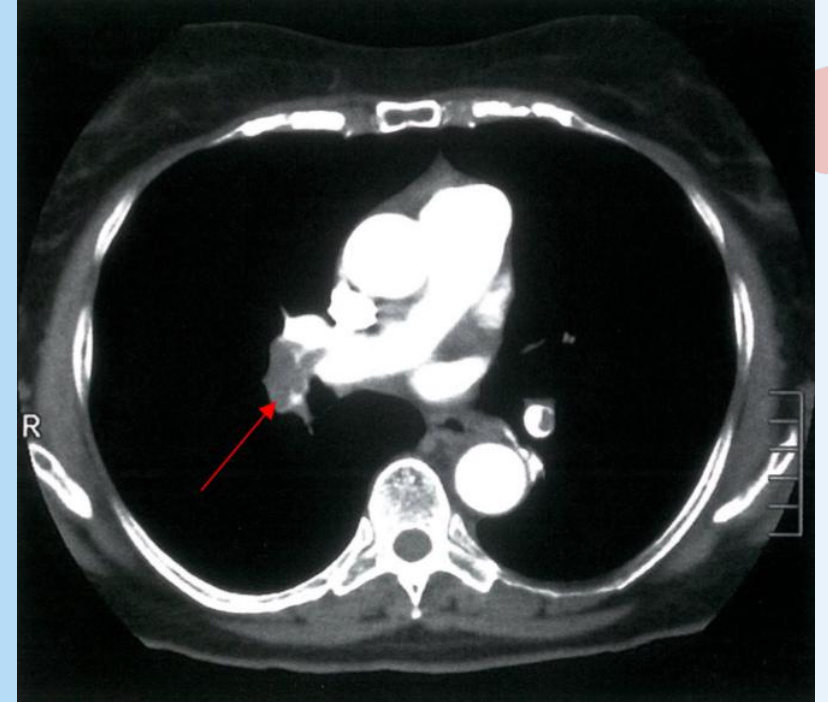
Criteria	Points	
Clinical symptoms of DVT	3	✓
PE more likely than other diagnoses	3	✓
Previous PE/DVT	1.5	
Tachycardia (Heart rate > 100/min)	1.5	✓
Surgery or immobilization in the past 4 weeks	1.5	✓
Hemoptysis	1	
Malignancy 	1	
Original Wells score (clinical probability) <sup>[9]</sup>		
• Total score 0-1: low probability of PE (6%)		
• Total score 2-6: moderate probability of PE (23%)		
• Total score ≥ 7: high probability of PE (49%)		
		<b>Score = 9</b>
Modified Wells score (clinical probability) <sup>[10]</sup>		
• Total score ≤ 4: PE unlikely (8%)		
• Total score > 4: PE likely (34%)		

## Ms Blooms status

- ✓ Diagnosis of DVT
- ✓ Afebrile
- ✓ Chest pain on inspiration
- ✓ Vitals:
  - RR: 26
  - BP: 130/87
  - HR: 110
  - SPO2: 94%

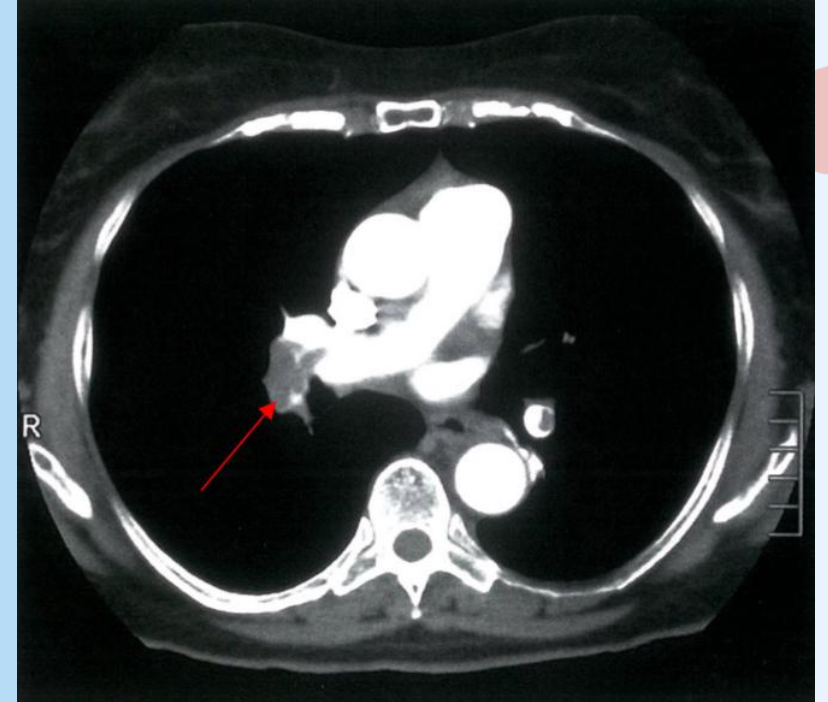
# Diagnostics

- Wells criteria
- D-dimer levels
- Auscultation
- Arterial blood gas
- ECG



# Diagnostics

- Wells criteria
- D-dimer levels
- Auscultation
- Arterial blood gas
- ECG
- ★ CT pulmonary angiogram





# 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 <sub>2</sub>	Temperature
105	110/75 mmHg	22	87%	38.8°C

On auscultation you hear bilateral inspiratory crackles and expiratory wheezes.





# We suspect pneumonia



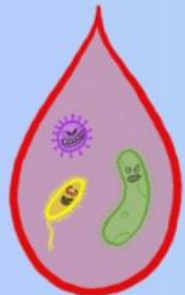
qSOFA:

RR: >22      BP<sub>systolic</sub> < 100 mmHg      Altered mental status

On physical examination you find:

Heart rate	Blood pressure	Resp. rate	SpO <sub>2</sub>	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 <sub>2</sub> :	45 mmHg	(>80 mmHg)
PaCO <sub>2</sub> :	55 mmHg	(35-45 mmHg)
HCO <sub>3</sub> <sup>-</sup> :	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*

<p><b>Definition</b></p>	<p><math>\text{PaO}_2 &lt; 60 \text{ mmHg}</math></p>	<p><math>\text{PaO}_2 &lt; 60 \text{ mmHg}</math>  <math>\text{PaCO}_2 &gt; 45 \text{ mmHg}</math>            ↓  <math>\text{pH} &lt; 7.35</math></p>
<p><b>Pathophysiology</b></p>	<p>Oxygen failure</p>	<p>Ventilation failure            Increased dead space            Increased <math>\text{CO}_2</math> production            Hypoventilation</p>

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:

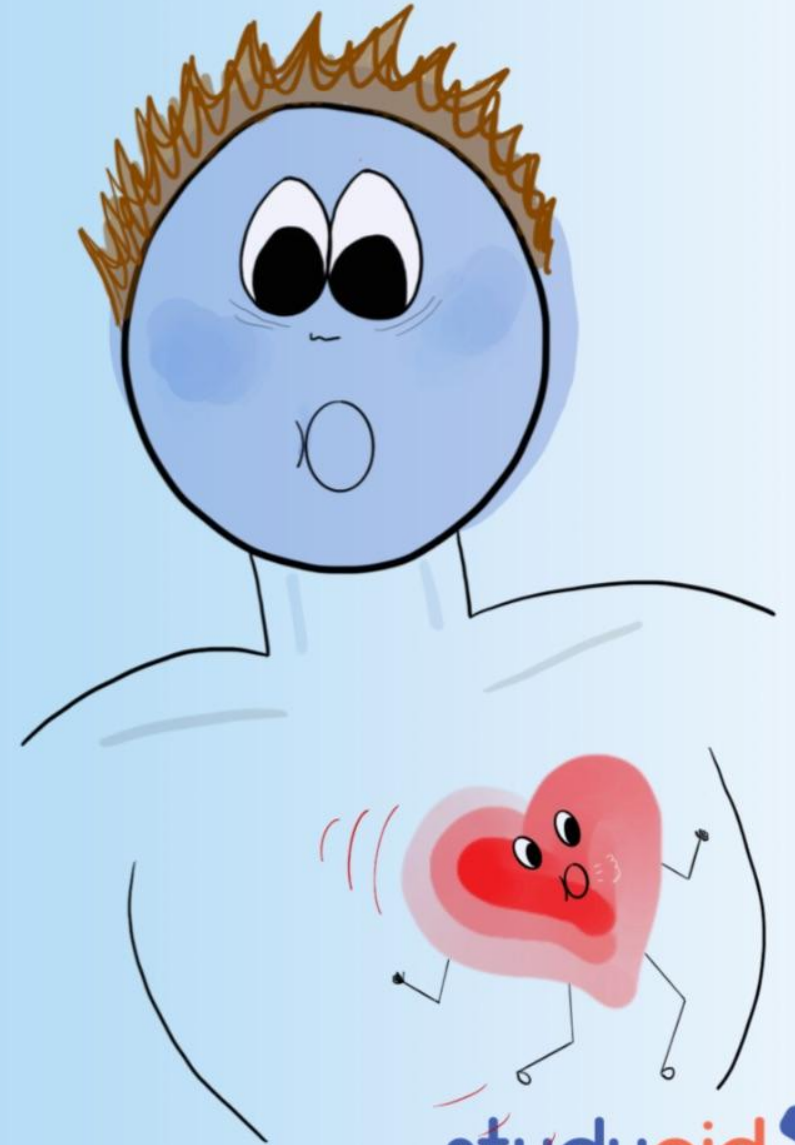
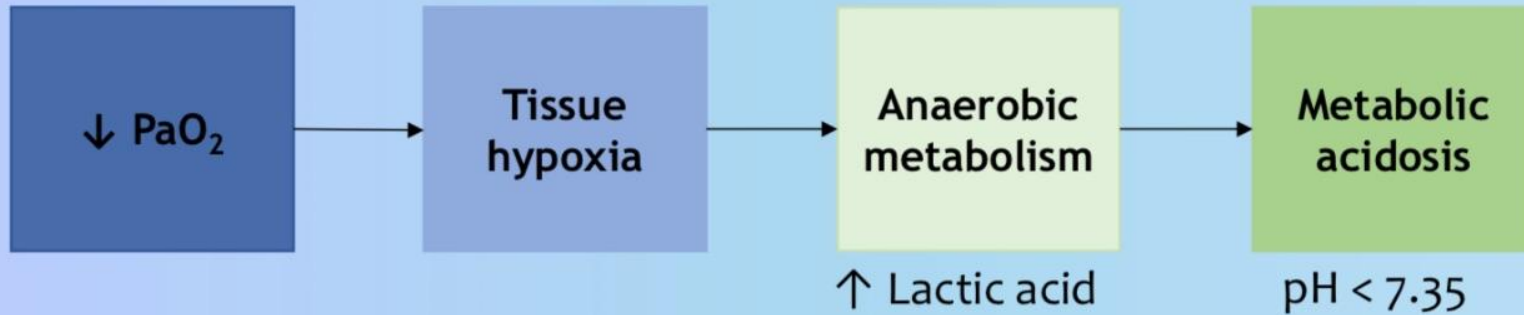
pH:	7.33	(7.35-7.45)
PaO <sub>2</sub> :	45 mmHg	(>80 mmHg)
PaCO <sub>2</sub> :	42 mmHg	(35-45 mmHg)
HCO <sub>3</sub> <sup>-</sup> :	23 mEq/L	(21-27 <u>mEq/L</u> )
Lactic acid:	3.2 mmol/L	(0.5-1.0 mmol/L)





# Clinical presentation

## Respiratory failure type I

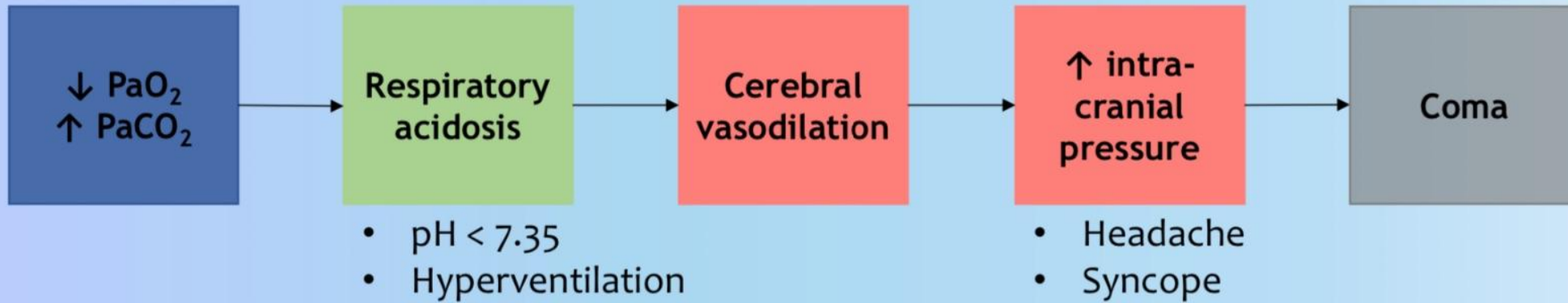


The ABG shows:

pH:	7.33
PaO <sub>2</sub> :	45 mmHg
PaCO <sub>2</sub> :	42 mmHg
HCO <sub>3</sub> <sup>-</sup> :	23 mEq/L
Lactic acid:	3.2 mmol/L

# Clinical presentation

## Respiratory failure type II



Mr. Camel's ABG:

pH:	7.19	(7.35-7.45)
PaO <sub>2</sub> :	45 mmHg	(>80 mmHg)
PaCO <sub>2</sub> :	55 mmHg	(35-45 mmHg)
HCO <sub>3</sub> <sup>-</sup> :	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 <sub>2</sub>	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**

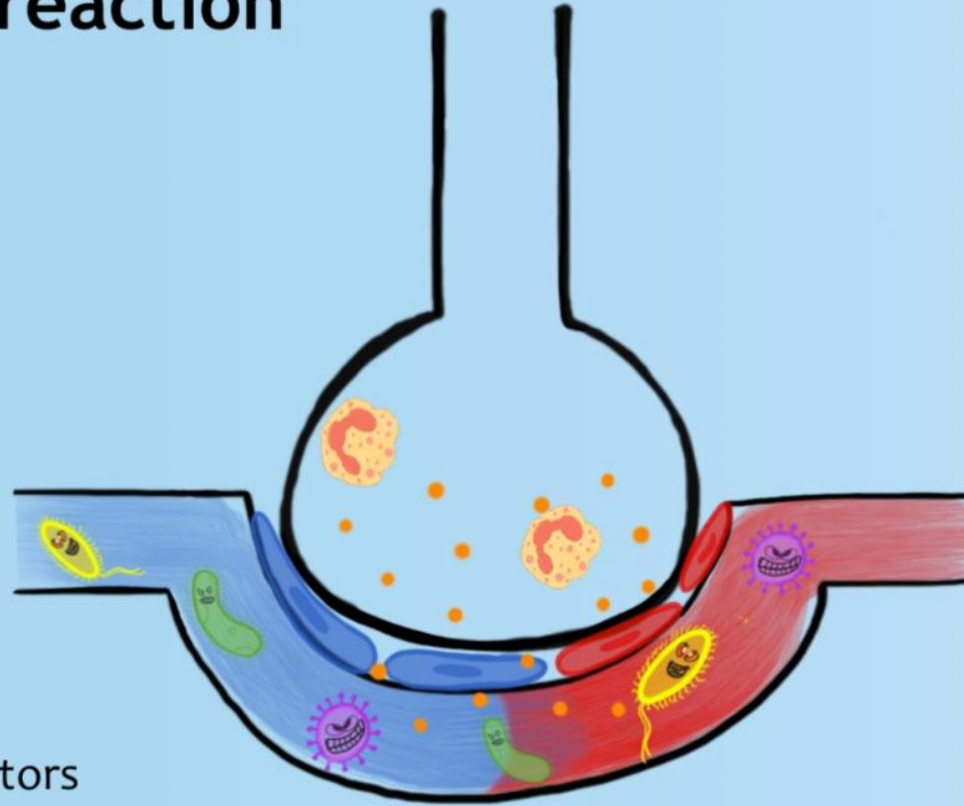
- ✓ Redisposing condition: Pneumonia → sepsis
- ✓ Dyspnea (shallow breathing)
- ✓ Tachypnea (Respiratory rate: 26)
- ✓ Tachycardia (Heart rate: 115 bpm)
- ✓ Cyanosis (blue discoloration around his mouth)

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

# Acute respiratory distress syndrome

## Pathophysiology

### 1. Inflammatory reaction



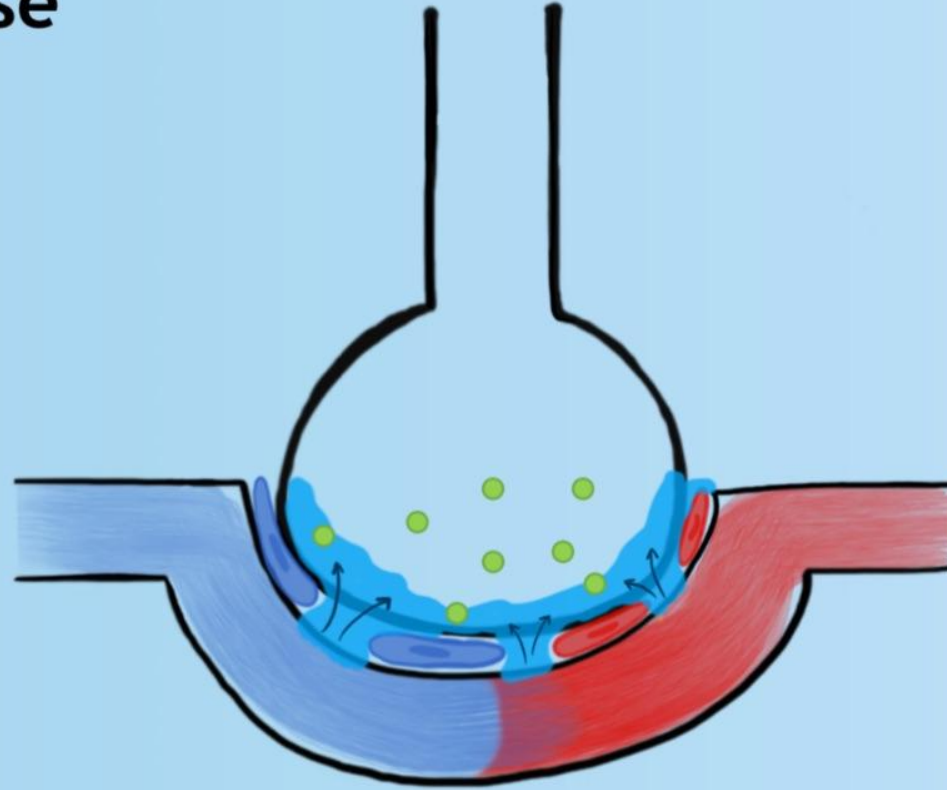
1. Tissue damage
2. Release of inflammatory mediators
3. Neutrophil migration
4. Cytokine release → diffuse alveolar damage



# Acute respiratory distress syndrome

## Pathophysiology

### 2. Exudative phase



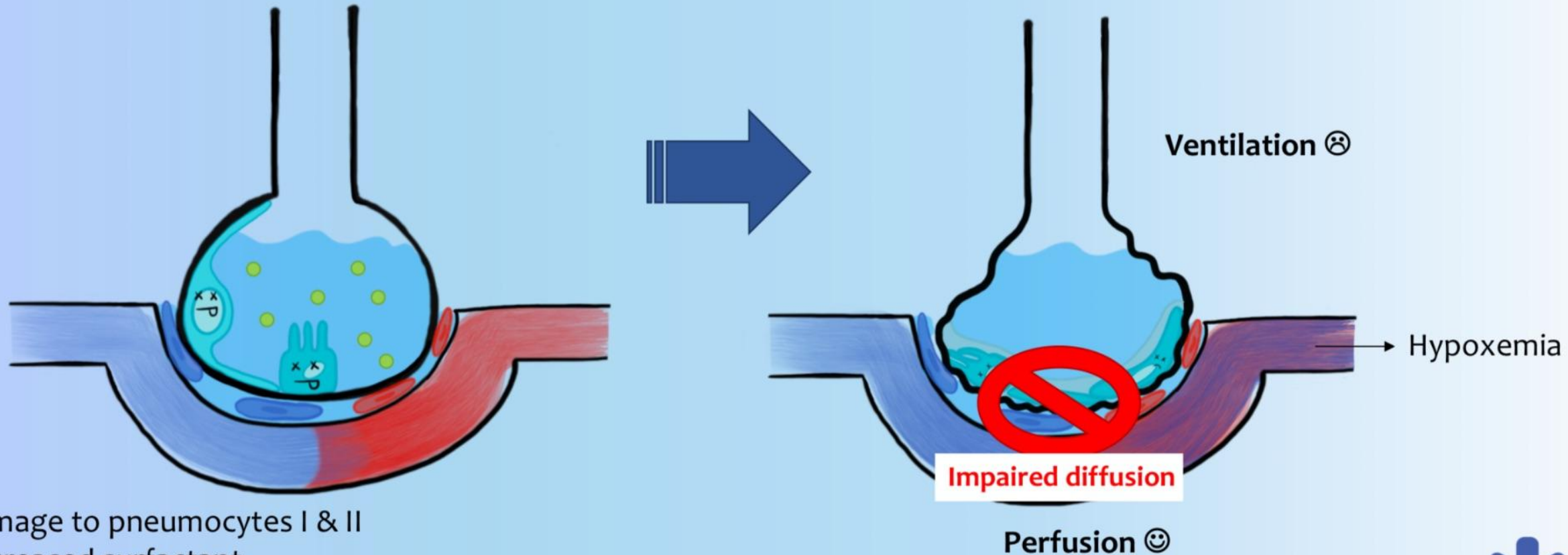
1. Increased vascular permeability: Fluid leakage into the alveoli
2. Protein-rich edema fluid
3. Decreased lung compliance and respiratory distress



# Acute respiratory distress syndrome

## Pathophysiology

### 3. Hyaline membrane formation

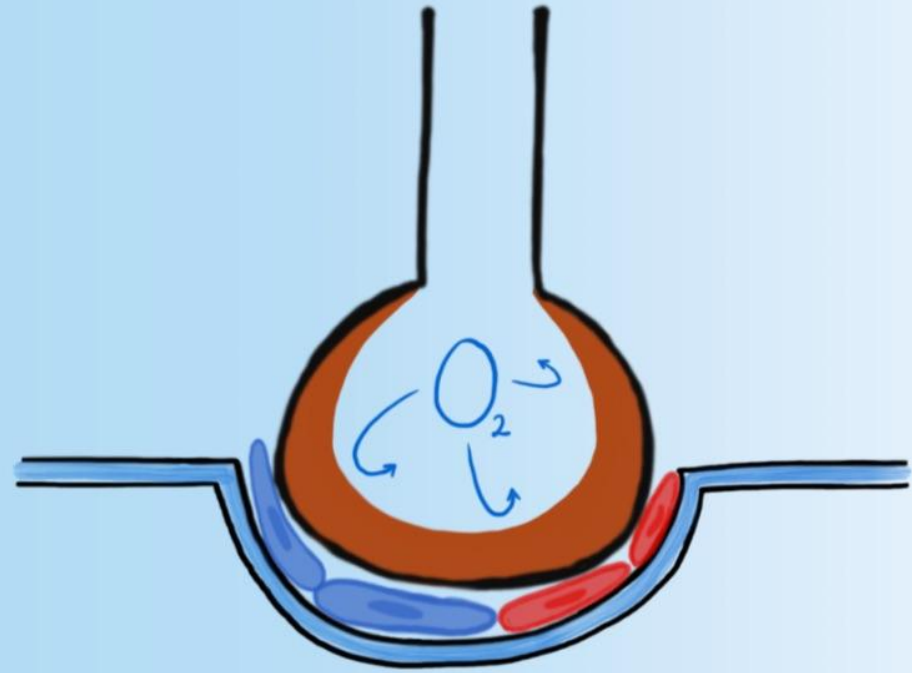
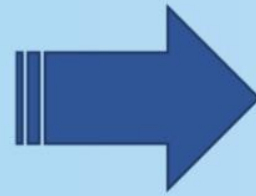
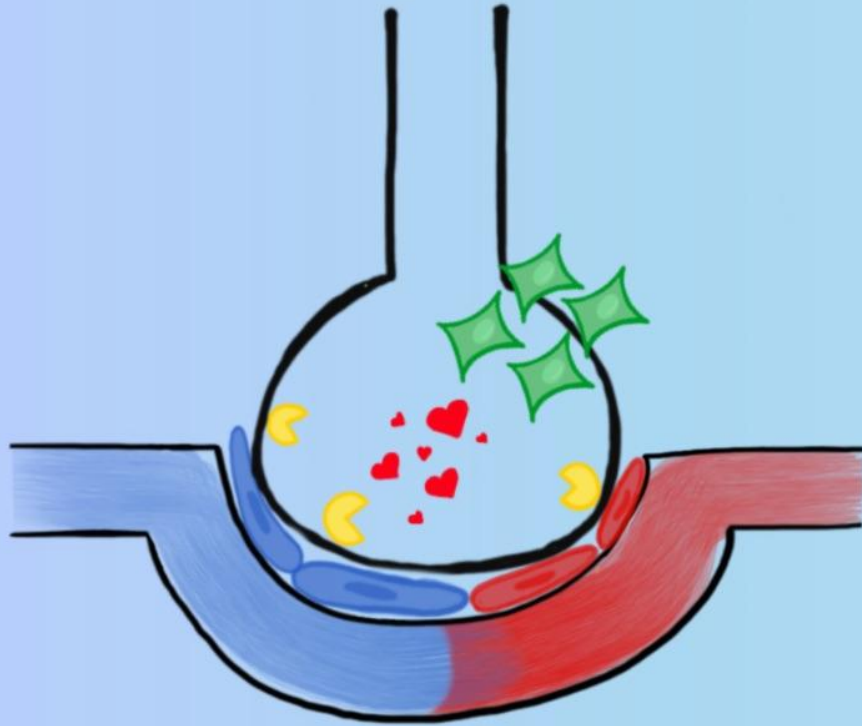


1. Damage to pneumocytes I & II
2. Decreased surfactant
3. Alveolar collapse

# Hyaline membrane formation

## Pathophysiology - complication

### 4. Fibrosis



**Restrictive lung disease:**  
*Progressive interstitial fibrosis*

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

# Acute respiratory distress syndrome

## Etiology

**S**PARTAS

**S**epsis\*

**P**neumonia

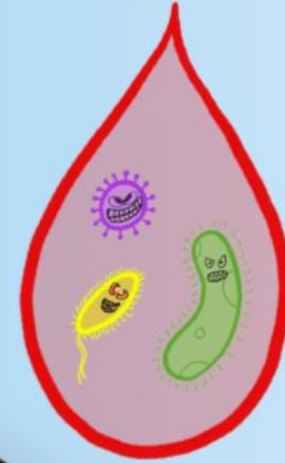
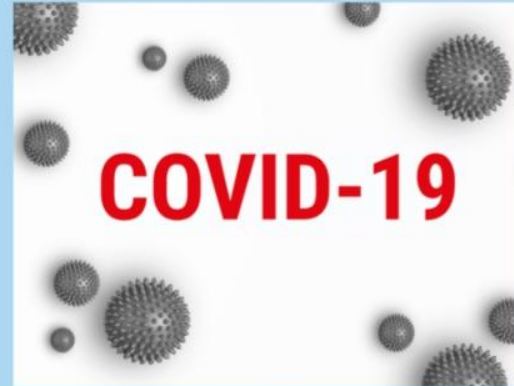
**A**spiration

**u**Remia

**T**rauma

**A**cute pancreatitis

**S**hock

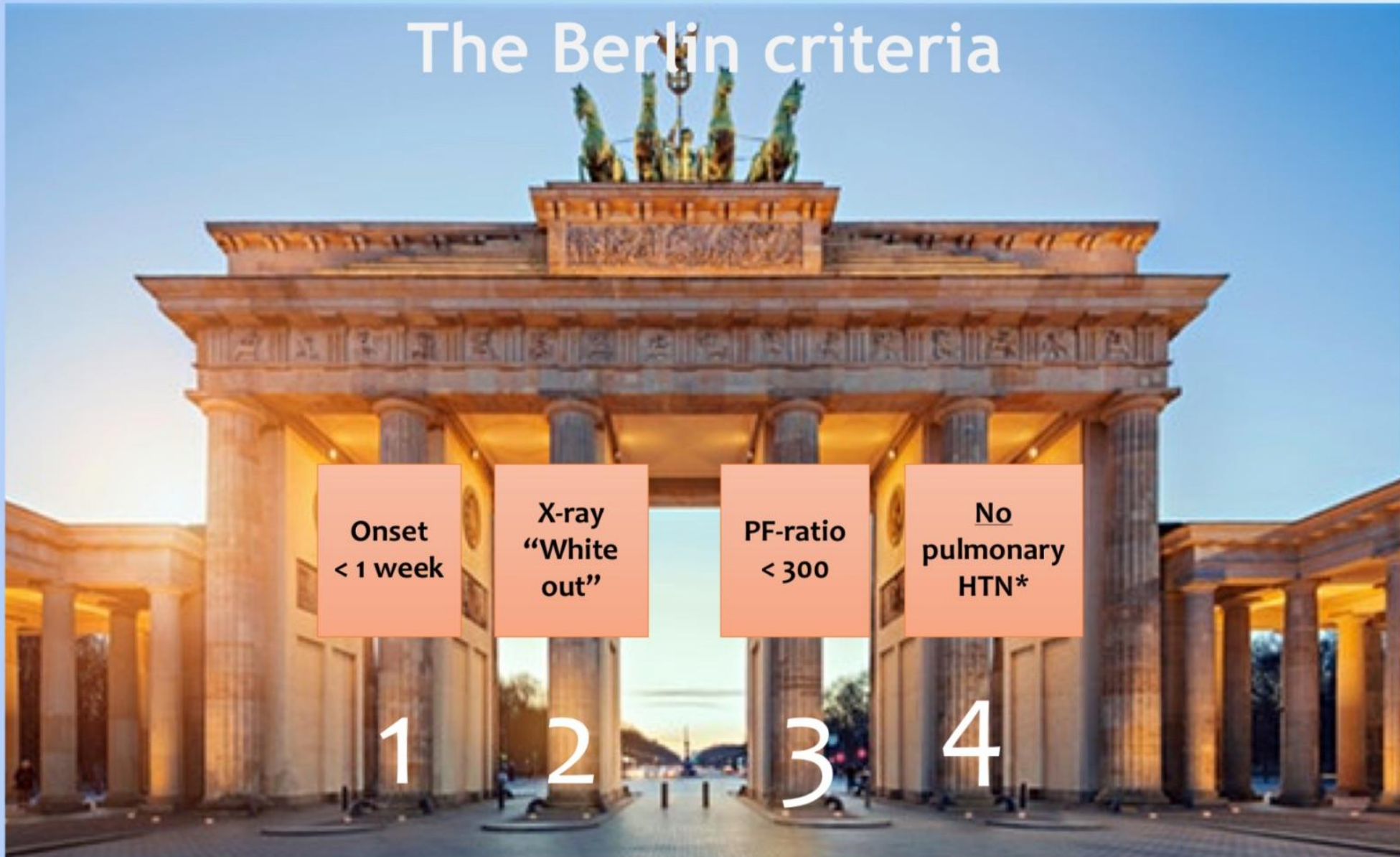


*\*Sepsis is the most common cause of ARDS*



# How do we diagnose Mr Camel?

## The Berlin criteria



\*presence of pulmonary hypertension indicates congestive heart failure



# How do we diagnose Mr Camel

## **A**bnormal chest X-ray

Bilateral lung opacities / white out

## **R**espiratory failure

Onset within 1 week

## **D**ecreased PF ratio

PAO<sub>2</sub>/FIO<sub>2</sub> ratio <300

## **S**ymptoms of respiratory failure

NOT due to HF/fluid overload

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! 😊

