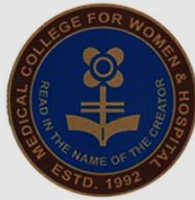


# HAEMODYNAMIC DISORDERS, THROMBOEMBOLIC DISEASE and SHOCK

## TOPIC 3 EMBOLISM

**Professor Tamanna Choudhury**  
**HOD, Pathology**  
**MCWH**





## **References:**

- **Robbins & Cotran Pathologic Basis of Disease- 9<sup>th</sup> edition**
- **Walter & Israel GENERAL PATHOLOGY 7<sup>th</sup> edition**
- **Davidson's Principles and Practice of Medicine-23<sup>rd</sup> edition**
- **IMAGES- Above mentioned books & internet**



# EMBOLUS

## *Definition*

*An embolus is a detached intravascular solid, liquid or gaseous mass that is carried by the blood from its point of origin to a distant site, where it often causes tissue dysfunction or infarction*

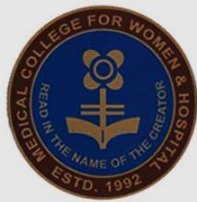


# EMBOLUS- definition

## key points

- 1. detached intravascular***
- 2. solid, liquid or gaseous mass***
- 3. carried by the blood to a distant site from its point of origin***
- 4. often causes tissue dysfunction or infarction***





# EMBOLUS

The vast majority of emboli are **dislodged thrombi** hence the term ***thromboembolism***



# EMBOLUS

Types: (based on composition)

(1) Thrombi & Clot- **majority**

(2) Gas - Air & N<sub>2</sub>

(3) Fat

(4) Tumour

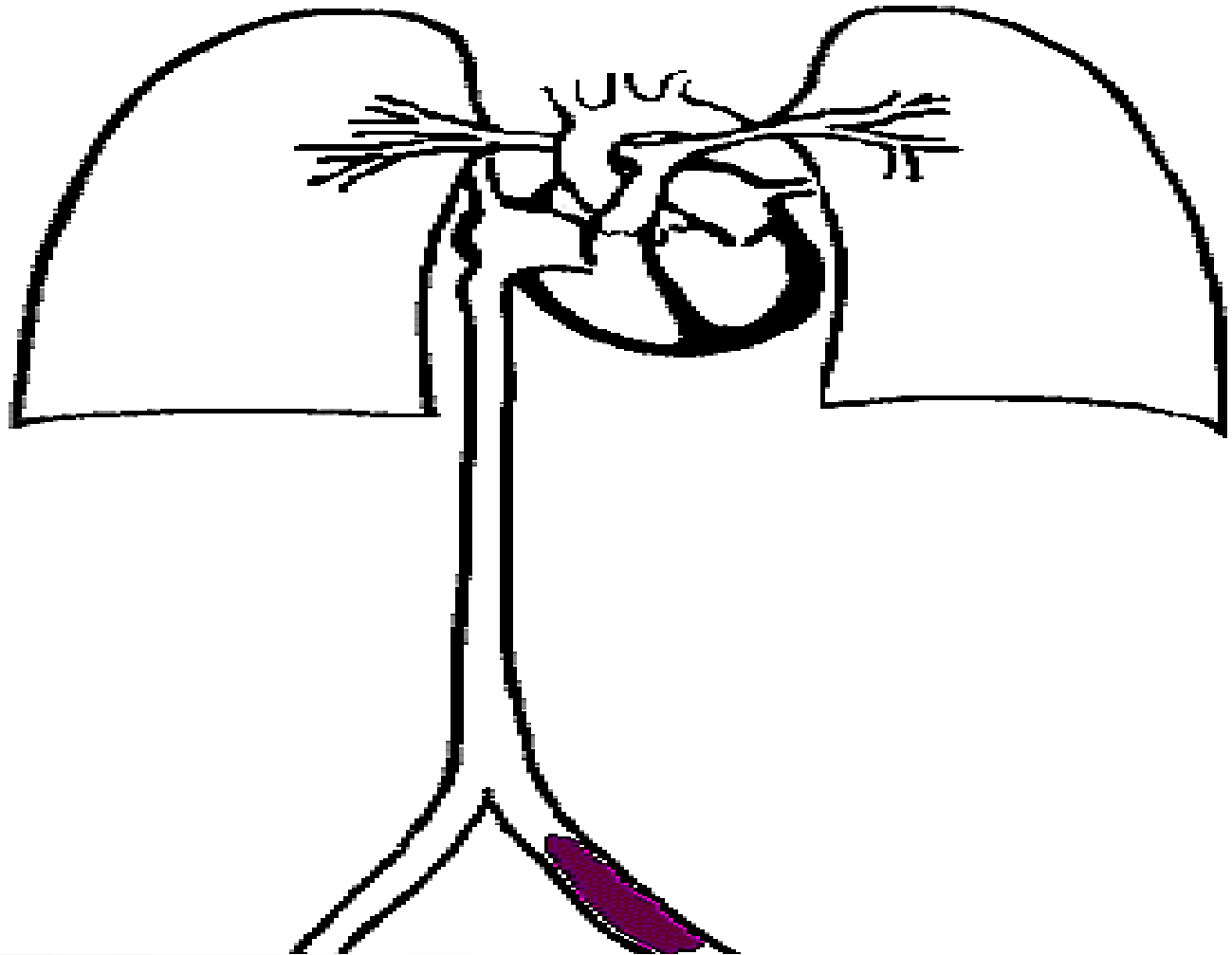
(5) Misc -foreign bodies,  
parasites,  
RBC aggregates,  
fragments of bone or bone marrow,  
atheromatous debris (cholesterol  
emboli),  
amniotic fluid etc.



# EMBOLISM

- Pulmonary
- Systemic

# PULMONARY EMBOLISM

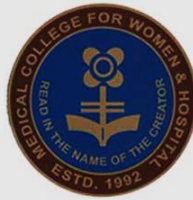






# PULMONARY EMBOLISM (PE)

- Most common form of thromboembolic disease
- Pulmonary emboli originate from **deep venous thromboses (DVT)**



# PULMONARY EMBOLISM

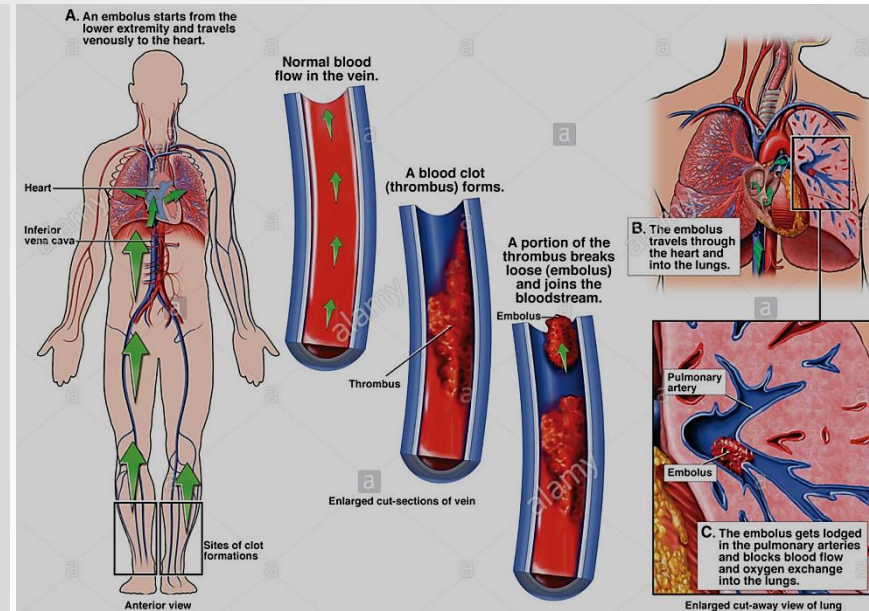
## *Sources*

- More than **95%** of all pulmonary emboli arise in thrombi within **deep veins of lower legs (DVT) - popliteal, femoral & iliac veins**
- Uncommon sources are superficial veins of the legs, veins of the calf muscles, pelvic veins



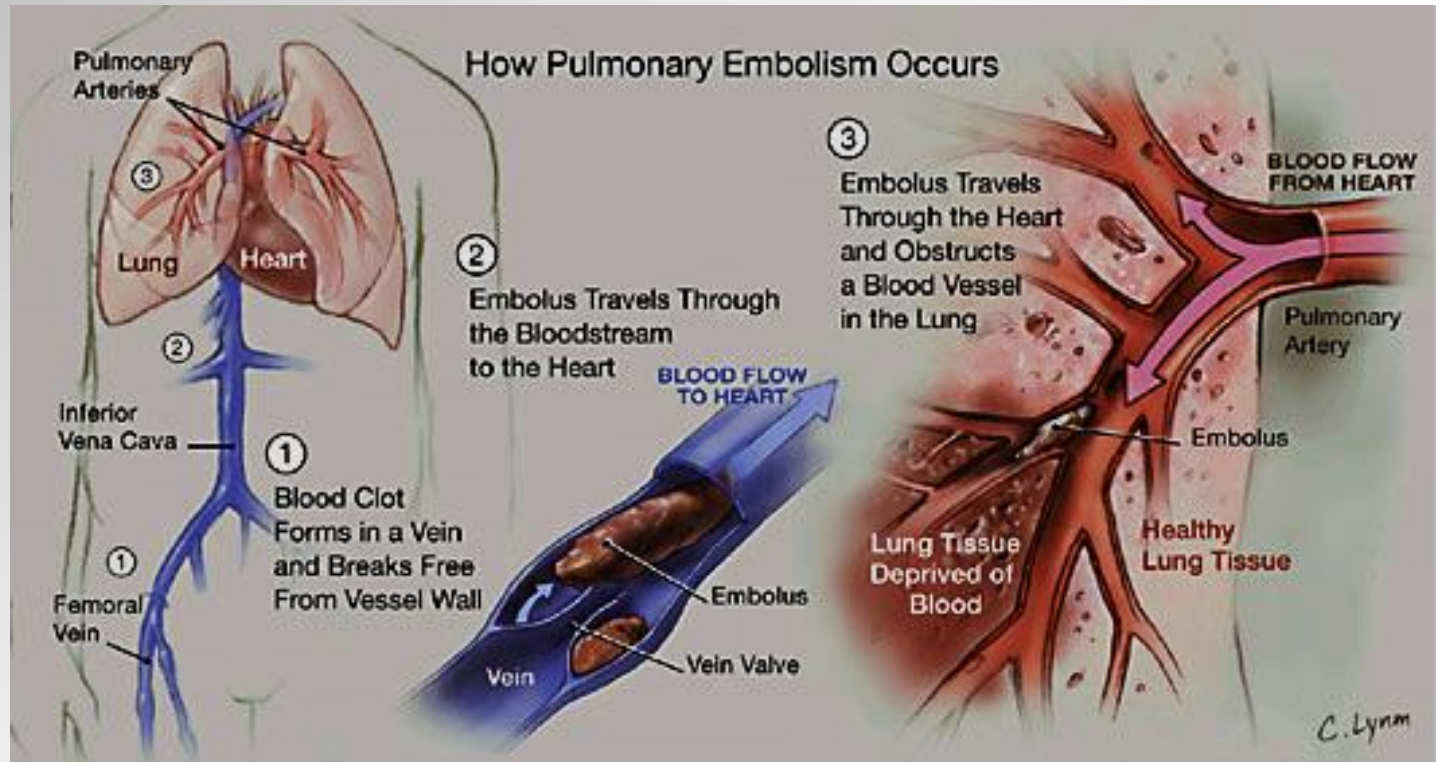
# PULMONARY EMBOLISM

Fragmented thrombi from DVTs are carried through progressively larger veins to the **right heart** from there finally into **pulmonary arterial vasculature**





# PULMONARY EMBOLISM





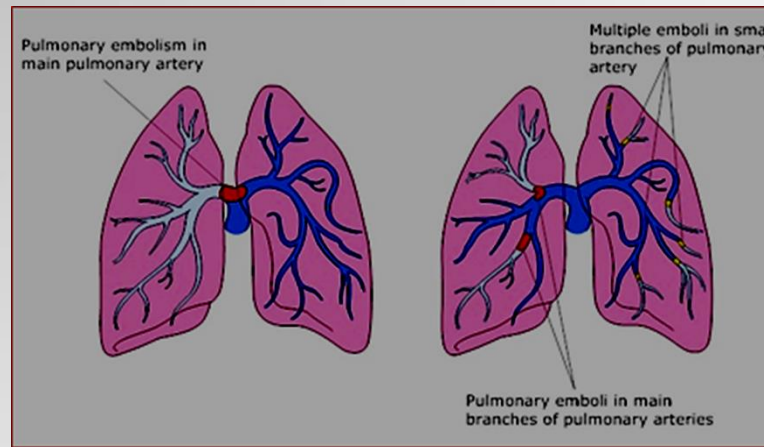


# PULMONARY EMBOLUS

Depending upon the size

- Occlude **main pulmonary** artery
- Impact across the **bifurcation** (**saddle embolus**)
- Pass into **smaller branching** arteries
- Shower of small emboli occurring sequentially/  
simultaneously from a single large mass

# Embolus in a pulmonary artery branch



## Saddle embolus

**The patient who has had one PE is at high risk of more**

Tamanna Choudhury



# PULMONARY EMBOLUS

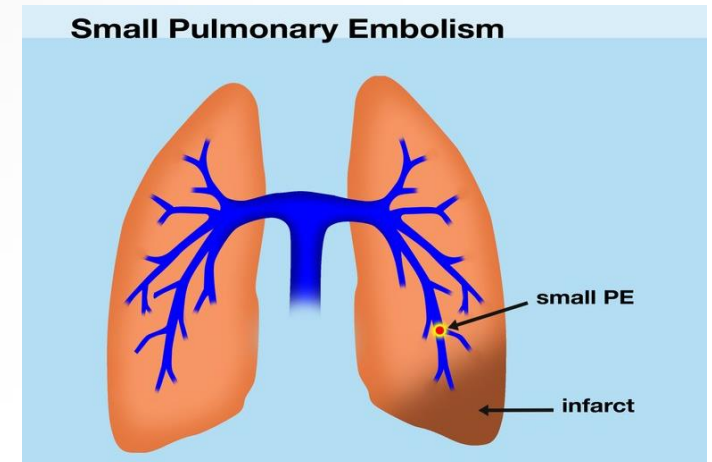
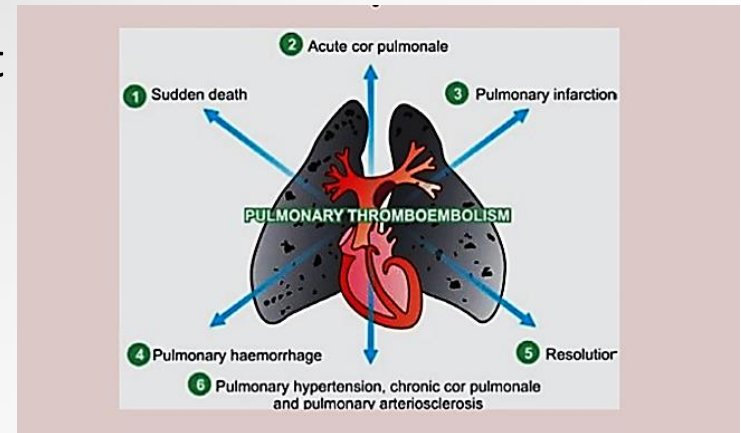


**This pulmonary thromboembolus is occluding the main pulmonary artery. Persons who are immobilized for weeks are at greatest risk. The patient can experience sudden onset of shortness of breath. Death may occur within minutes.**

# PULMONARY EMBOLUS

## Functional consequences

- 60%-80% are **clinically silent**
- **Sudden death**, right sided heart failure (cor pulmonale) occurs **when 60% or more** of the pulmonary circulation is obstructed with emboli
- PE in **medium** sized arteries cause **pulmonary haemorrhage**
- PE in **small end arteriolar** vessels cause haemorrhage or **infarction**
- Multiple emboli over time can cause **pulmonary hypertension and RVF**

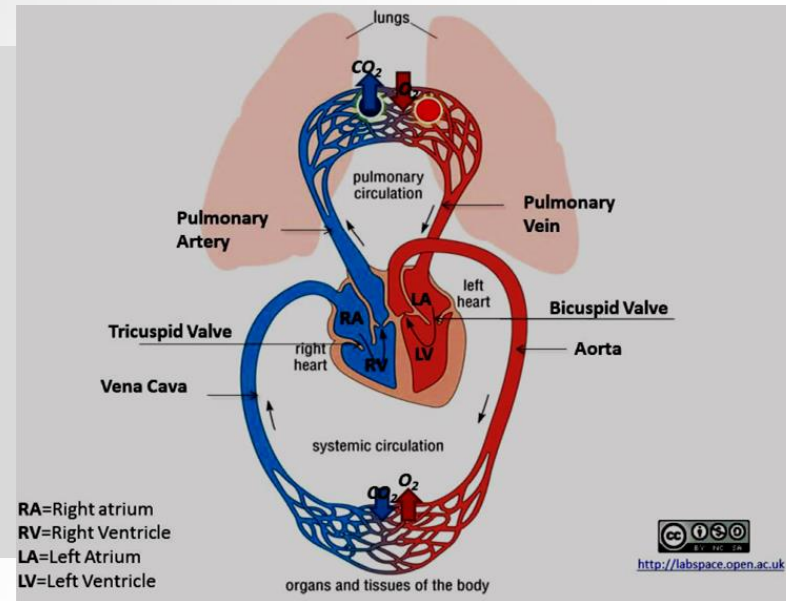




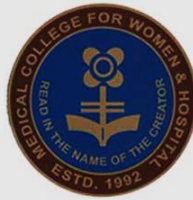


# Paradoxical embolism

A venous embolus may pass through **interatrial/**  
**interventricular defects** and  
gain access into the systemic  
arterial circulation



**Pulmonary and Systemic  
circulation**

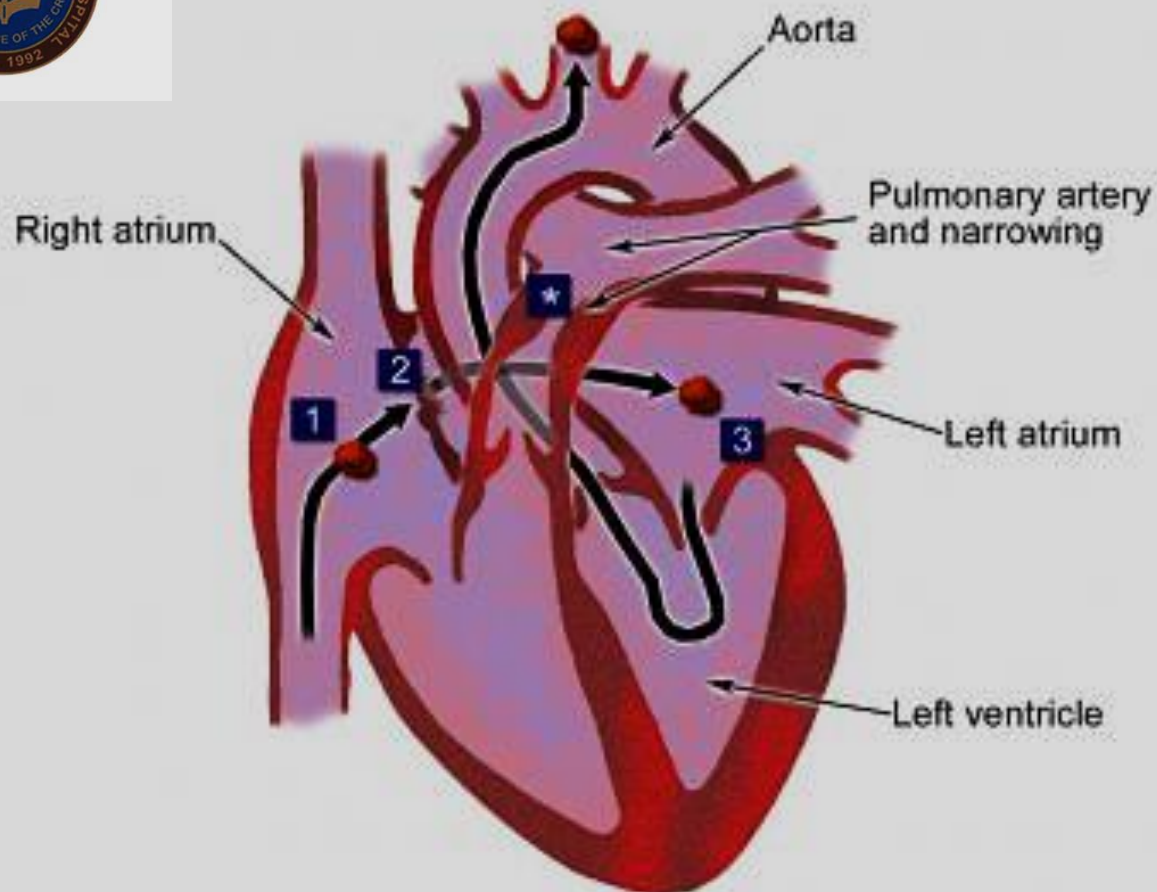


# Paradox

A situation or statement that seems impossible  
*or*  
is difficult to understand  
*because*  
it contains two opposite facts or characteristics

**Example: You can save money by spending it.**

## Paradoxical embolism



1. Embolus (blood clot) from a vein in leg or pelvis enters right atrium.
  2. Embolus passes through defect in septum between right and left atria, and enters left atrium.
  3. Embolus enters left ventricle, and is then pumped into the aorta and thence into the brain, causing a stroke.
- \* Narrowing of the pulmonary artery causes increased pressure differential between right and left side of heart, expediting passage of embolus from right to left atrium.





# SYSTEMIC EMBOLISM

Emboli that travel through **arterial circulation**

- About **80%** - arise from **intracardiac mural thrombi**

Aortic aneurysms, atherosclerotic plaques, vegetations

- About **10-15%** - the source is **unknown**





# SYSTEMIC EMBOLISM

- **Venous emboli** – vast majority lodge in the lung
- **Arterial emboli** – point of arrest depends on the source and the blood flow in the downstream
  - 75% in the lower extremity
  - 10% in the brain
  - Intestines, kidneys, spleen and upper extremities



# SYSTEMIC EMBOLISM

Consequences depends on

- **Vulnerability** of the affected tissue to ischemia
- The **caliber** of the occluded vessel
- Presence of **collateral** circulation



# OTHER RARE TYPES OF EMBOLI

- AIR
- FAT and MARROW
- AMNIOTIC FLUID
- TUMOUR EMBOLI



# Air Embolism

**Refers to gas bubbles within circulation obstructing vascular flow and causing distal ischemic injury**

**Bubbles of air or gas → obstruct vascular flow  
→ tissue injury → (Barotrauma)**

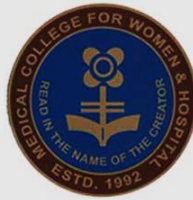




# Air Embolism

**Air can get access into the circulation**

- (1) Operations on the head and neck**
- (2) During haemodialysis**
- (3) During obstetric / laparoscopic procedures**
- (4) During artificial pneumoperitoneum/  
pneumothorax**
- (5) Injury to the lungs or chest wall**



# Air Embolism

Can be **fatal** when

- a very small volume of air trapped in a **coronary artery** during bypass surgery

Or

- introduced in the **cerebral circulation** by neurosurgery in the sitting position



# Air Embolism

A larger volume of air (generally **100 cc or more**) is necessary to produce a clinical effect in the pulmonary circulation





# Air Embolism

## *Decompression sickness*

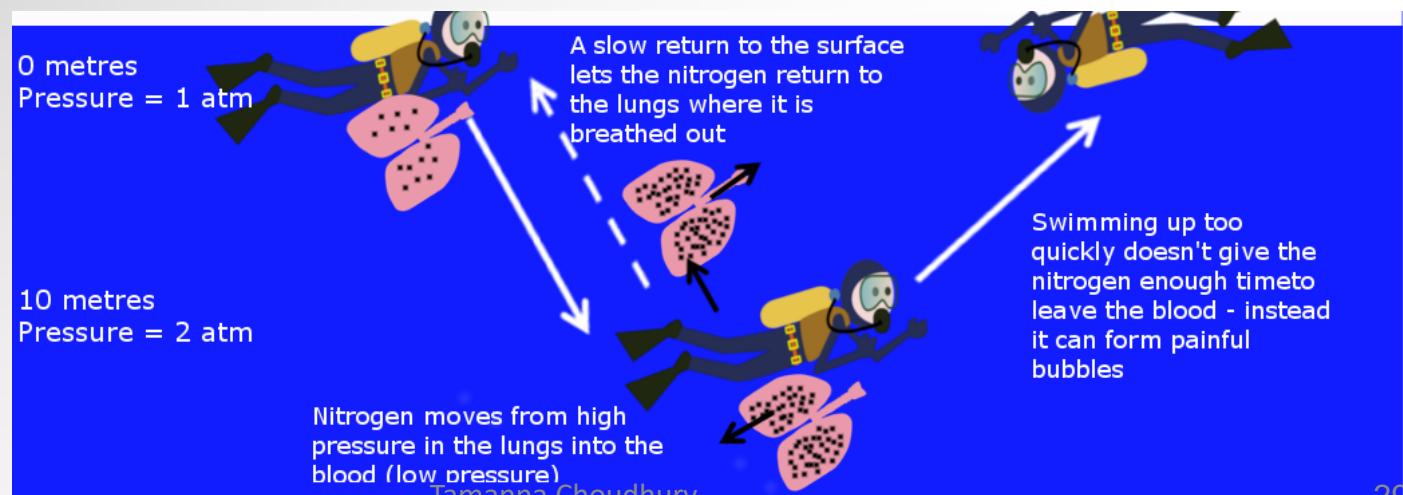
- A particular form of air embolism
- Caused by **sudden decreases** in atmospheric pressure
  - *Deep sea divers*
  - *Underwater construction workers*



# Air Embolism

## *Decompression sickness*

- ❑ When air is breathed at **high pressure** ( e.g., during a deep sea dive), increased amount of gas (particularly nitrogen) are dissolved in the blood and tissues
- ❑ If the person ascends (depressurize) **too rapidly** then nitrogen comes out of solution in the tissues and blood as gas bubbles





# Air Embolism

## *Decompression sickness*



- **Bends** – formation of gas bubbles within skeletal muscles and supporting tissues in and around joints causes painful *bends*
- **Chokes** - in the lungs gas bubbles in the vasculature cause edema, haemorrhage and focal emphysema leads to respiratory distress called *chokes*





# Air Embolism

## *Caisson disease*

- A more chronic form of decompression sickness is ***Caisson disease***
- Persistent gas emboli in poorly vascularized portions of the skeleton (heads of femur, tibia and humeri) lead to ischaemic necrosis



# Treatment of Decompression sickness

- By placing the individual in a chamber under sufficiently **high pressure**
- This forces the gas bubbles back into solution
- Subsequently **slow decompression** permits gradual **resorption** and exhalation of the gases
- This prevents obstructive bubbles from reforming





# Treatment of decompression sickness

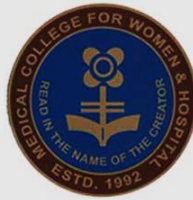
**TREATMENT OF  
DECOMPRESSION SICKNESS  
INVOLVES IMMEDIATE  
RECOMPRESSION, FOLLOWED  
BY GRADUAL  
DECOMPRESSION**





# Amniotic Fluid Embolism

- **Fifth common cause of maternal mortality worldwide**
- Though incidence is low but mortality rate is up to 80%
- Permanent neurologic deficits in in as many as 85% of survivors
- Ominous complication of labour and the immediate postpartum period



# Amniotic Fluid Embolism

Infusion of amniotic fluid or fetal tissue into maternal circulation

## Causes:

- Tear in the placental membrane
- Rupture of uterine veins



# Amniotic Fluid Embolism

- The syndrome is characterized by sudden severe dyspnea, cyanosis and shock
- Followed by neurologic impairment-headache to seizures and coma
- If the patient survives the initial crisis-pulmonary edema develops subsequently

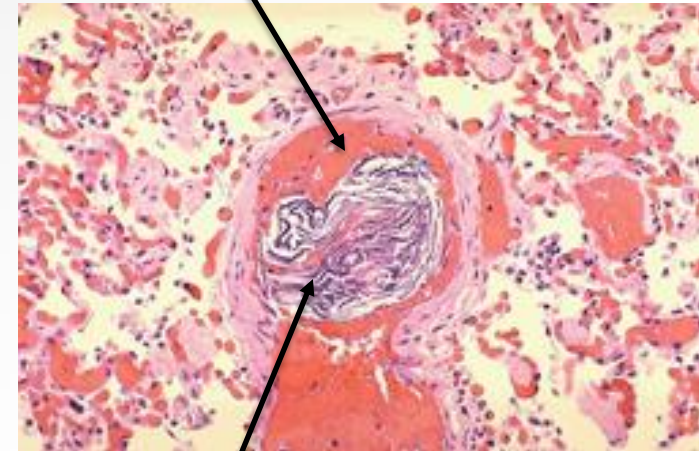




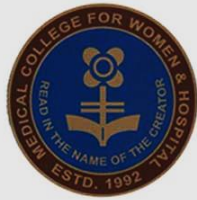
# Amniotic Fluid Embolism

- **Biochemical activation of coagulation factors** and components of the immune system by the substances in the amniotic fluid
- **Mechanical obstruction** by amniotic debris (squamous cells from fetal skin, lanugo hair, fat from vernix caseosa, mucin from fetal respiratory/ GIT)

Pulmonary arteriole



Fetal squamous cells




# Fat Embolism

## Causes :

- After fractures of long bones
- Burns
- Soft tissue trauma

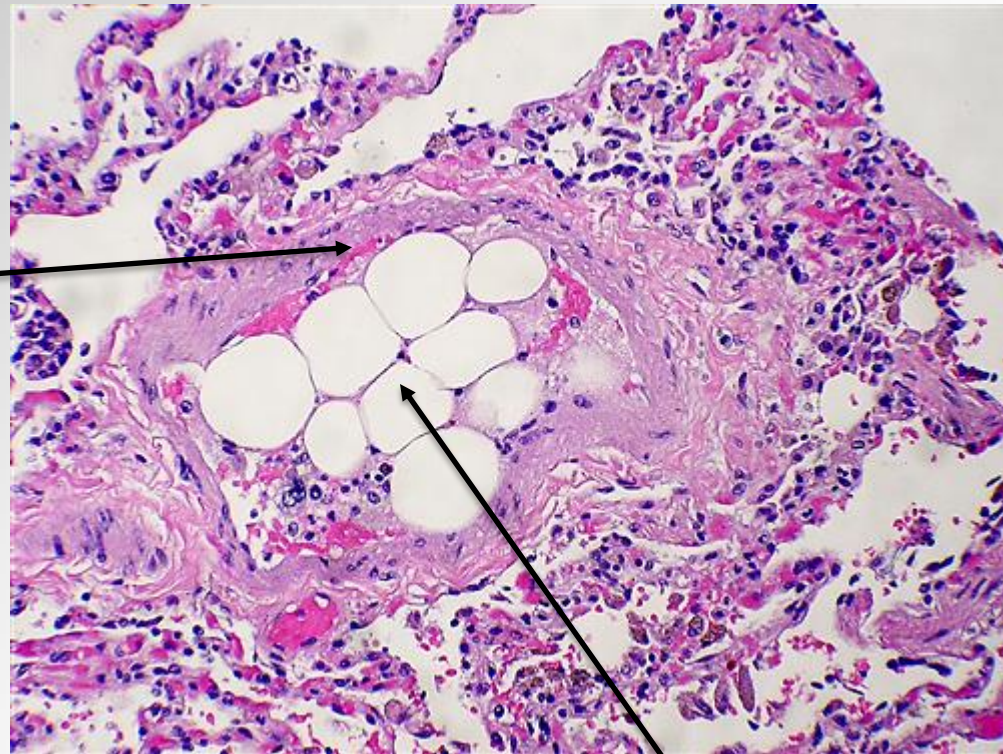
# Fat Embolism

- 
- Injuries cause rupture of vascular sinusoids in the marrow/ small venules  
→ marrow / adipose tissue herniate into vascular spaces → travel to the lung
  - Fat embolism occurs in 90% of severe skeletal injuries



# Fat Embolism

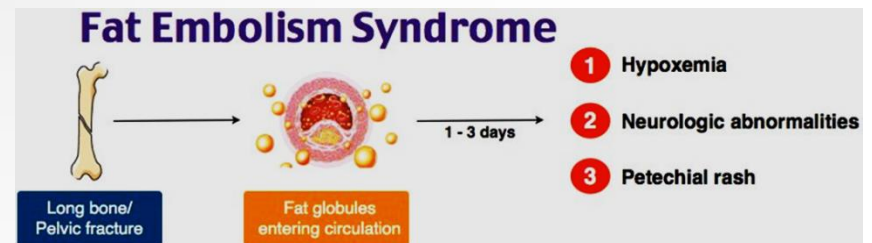
**Blood  
vessel**



**Fat globules**

# Fat Embolism Syndrome

- When patients become symptomatic
- Fatal in about 5%-15% of cases



# Practice questions

- What is an embolus?
- What are the types of emboli?
- What are the sources of pulmonary emboli? Discuss the consequences of pulmonary embolism.
- What is systemic embolism? What are its sources?
- What do you mean by paradoxical embolism?
- What is air embolism? How air enters into circulation?
- What is decompression sickness? What is chokes and bends?
- Write short notes on amniotic fluid embolism.
- What is fat embolism syndrome? How fat gain entrance into circulation?





# Thank You