

# **Sudden Natural Death**

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# Objectives

- ▶ Define Sudden natural death
- ▶ Explain the medicolegal importance of sudden natural death
- ▶ Identify and classify the major causes of sudden natural death
- ▶ Describe sudden infant death syndrome (SIDS) and its main characteristics

- ▶ Natural death : Death occurring due to some natural disease or pathological condition , old age , debility or devitalization ; here the death is not intended or attempted or accidental .
- ▶ Sudden Deaths : Mostly natural deaths that occur immediately or within 24 hours of the terminal symptoms , which may be completely different from the symptoms that the patient was having so long .
- ▶ Forensic ???

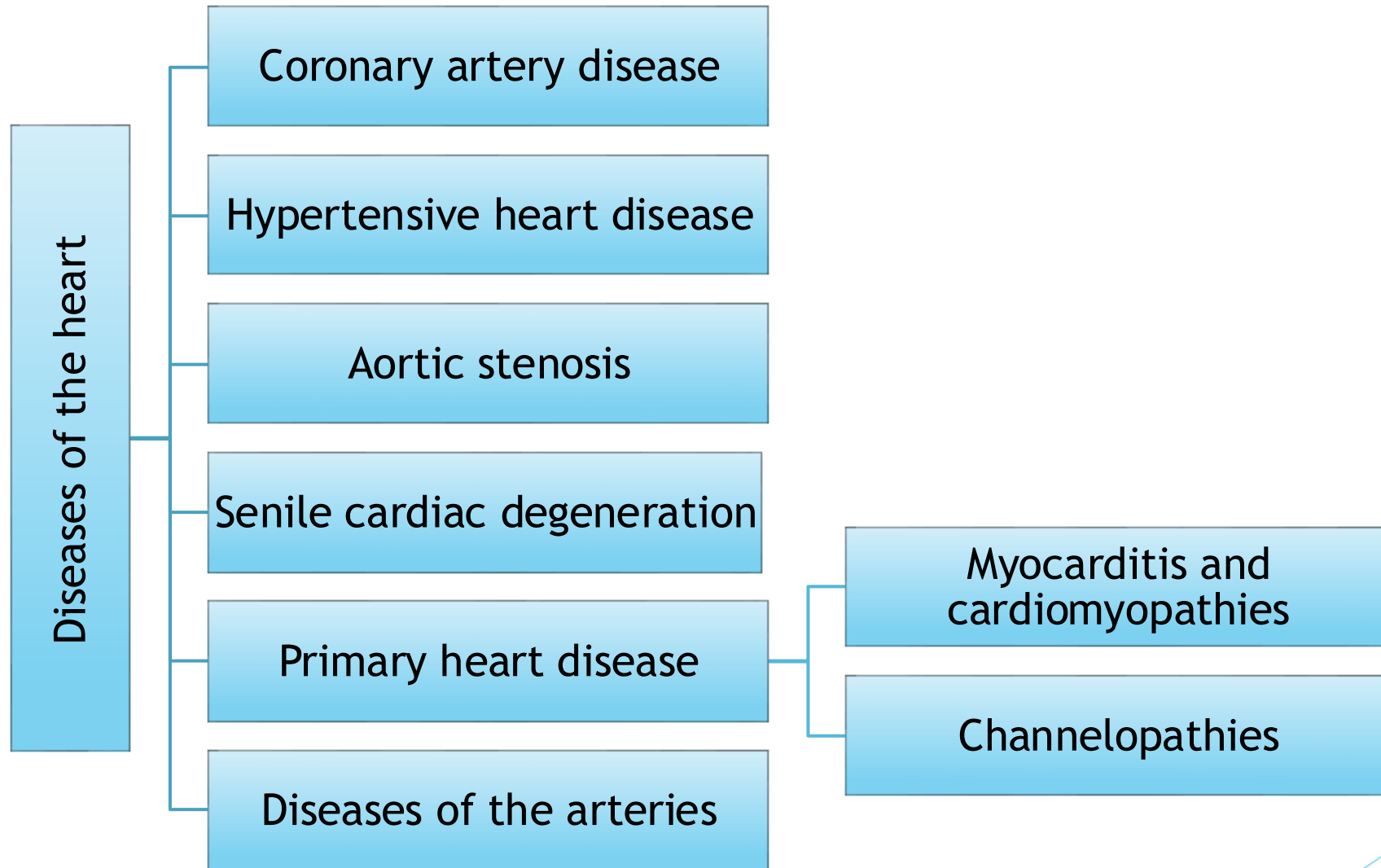
# Why ?

- ▶ Avoid the danger of acceptance of the obvious
- ▶ Screening and recommendations

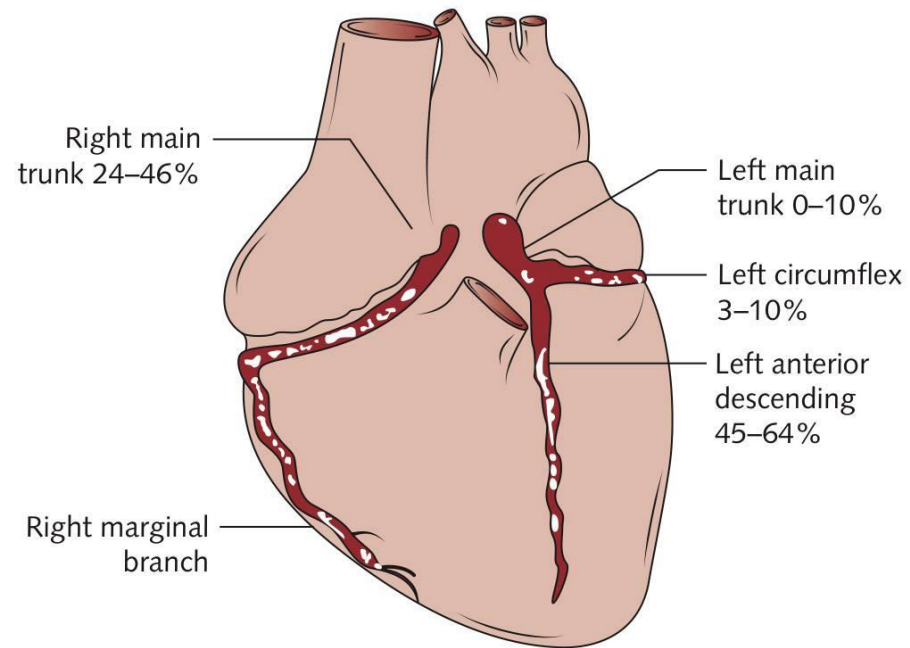


# Cardiovascular system

- ▶ Sudden Cardiac Death (SCD): the unexpected natural death from a cardiac cause within a short time period, generally  $\leq 1$  hour from the onset of symptoms, in a person without any prior condition that would appear fatal.
  
- ▶ The most common cause of sudden natural death and it includes :
  1. Diseases of the heart
  2. Disease of the valves
  3. Diseases of the arteries



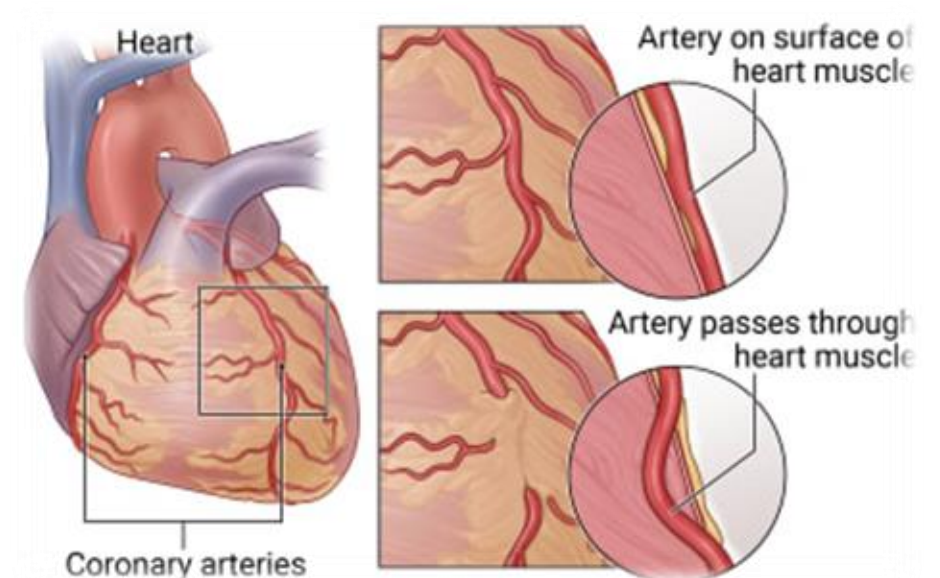
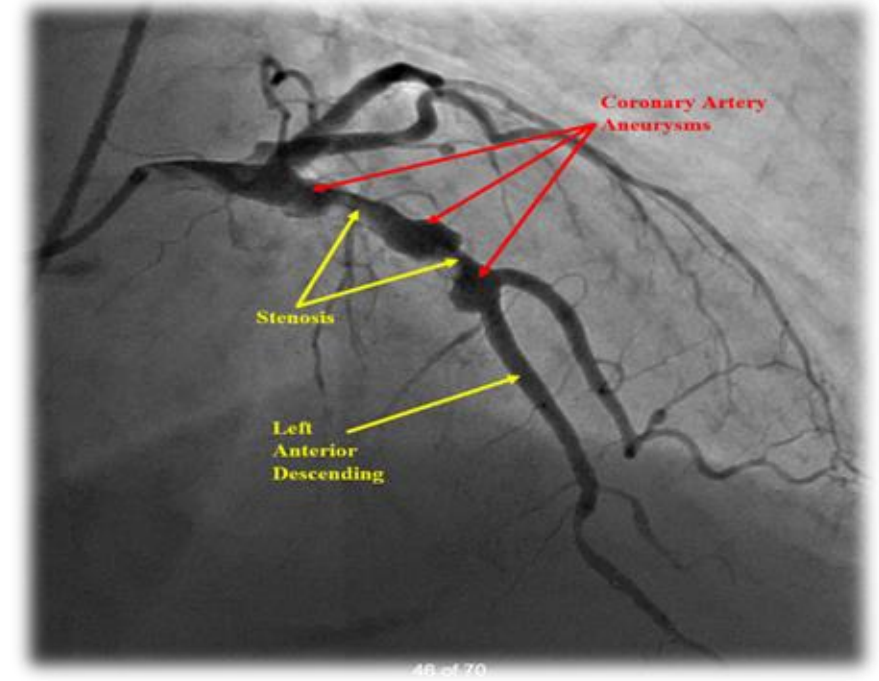
# Coronary arteries anatomy



**Fig. 5.1** The main coronary arteries with the most frequent sites of occlusion.

# Coronary arteries diseases

- ▶ Coronary stenosis or complete occlusion due to atheroma
- ▶ Coronary artery spasm
- ▶ Dissecting coronary aneurysm
- ▶ Myocardial bridging



# Coronary atherosclerosis

- ▶ The most common cause of sudden death .
- ▶ The basic mechanism is stenosis or occlusion of one or more major branches of the coronary arteries by atheromatous lesion , or one of the complications of such a lesion .
- ▶ Complications include (ulceration , hemorrhage , thrombosis )
- ▶ Severity of stenosis is debatable !

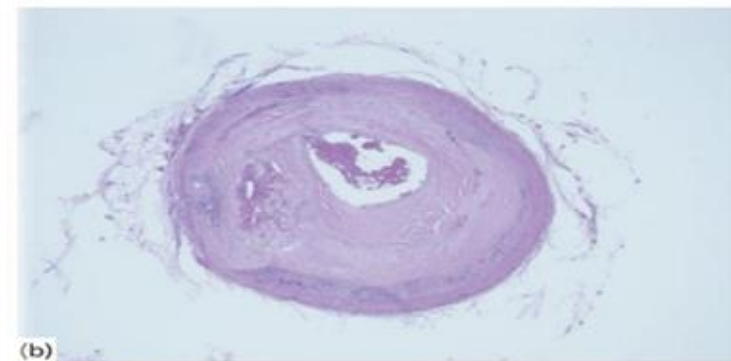
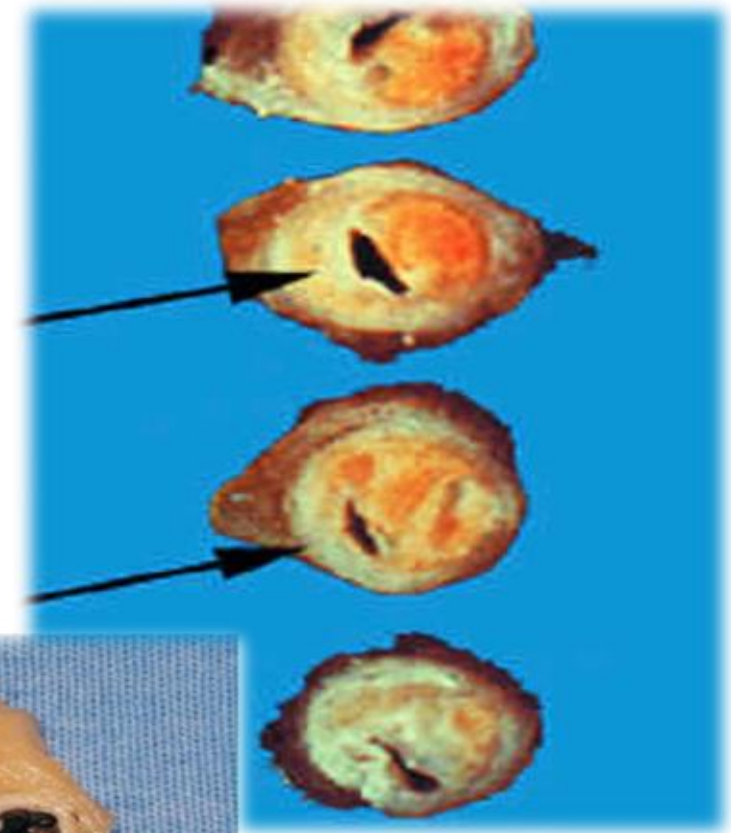


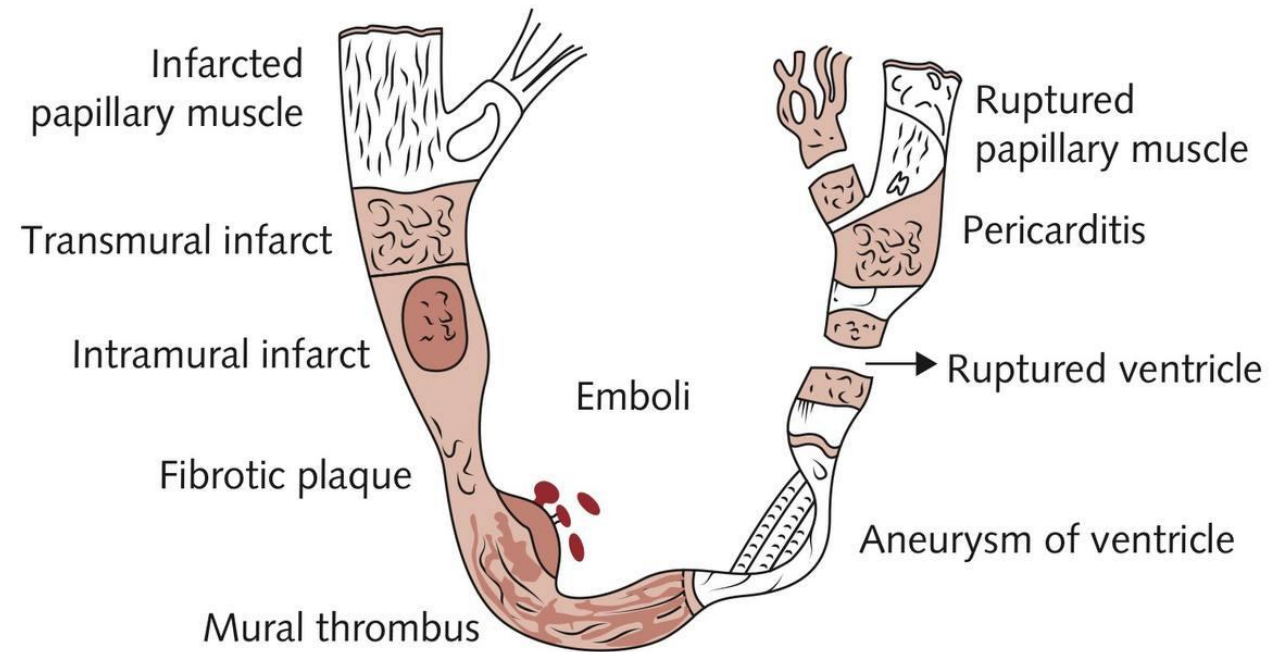
Figure 6.1 Significant coronary artery atherosclerosis and acute thrombosis. Macroscopic (a) and microscopic (b) appearance.

# Myocardial infarction

- ▶ Almost all myocardial infarcts are caused by atheromatous lesions and their complications . A few are the result of other types of coronary obstruction (polyarteritis , vasculitis , aortic stenosis , congenital anomalies...etc)
- ▶ The original lumen must be reduced to 20% or less before the ischemia in the distribution zone is sufficient to cause MI .
- ▶ Death can be attributed to coronary artery disease (CAD) with less stenosis if other signs of chronic myocardial ischemia are apparent (left ventricular hypertrophy [LVH], fibrosis, previous infarct).



# MI complications



**Fig. 5.2** The possible sequelae of coronary occlusion.

# Early complications of MI

- ▶ In the first 24 hours ,the most common complications are (ventricular fibrillation and cardiogenic shock)
- ▶ Gross necrosis of the myocardium appears after 24 hours , while histopathological changes (necrosis) begin to appear on microscopy after 6 hours

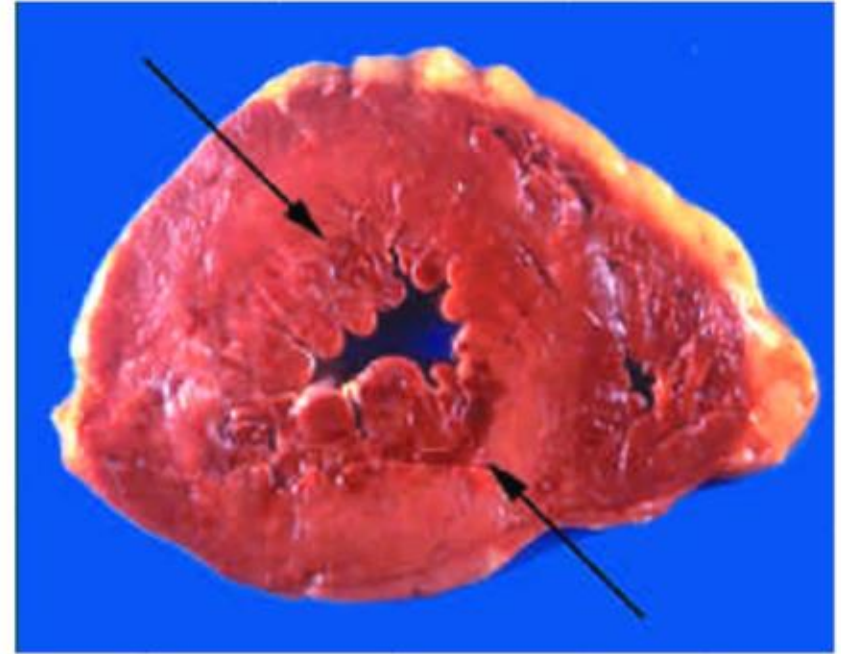


FIGURE 5.3 The earliest noticeable signs of a heart attack is dark colored muscle (arrows). This discoloration reveals the heart attack to be hours old at the time of death.

# Late complications of MI

## 1) Rupture of myocardial infarct :

The area of the myocardial infarct is weakest between 3 days and 14 days after the clinical onset of the infarct, due to the beginning of the healing process using granulation tissue (which is relatively weak). and it is at this time that the weakened area of myocardium may rupture, leading to sudden death from :

- ▶ Hemopericardium
- ▶ Cardiac tamponade
- ▶ The rupture occasionally occurs through the interventricular septum, resulting in a left- right shunt

# Late complications of MI ...cont

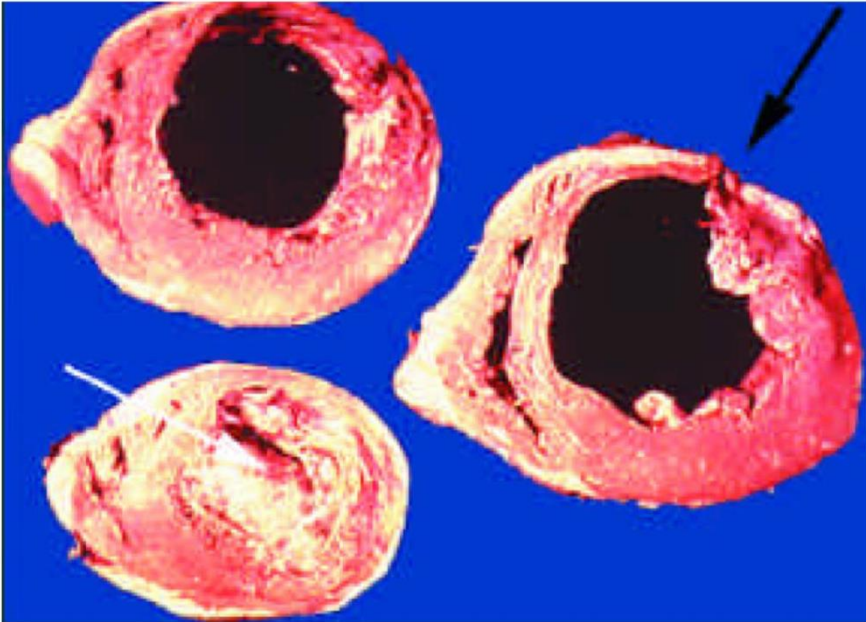


FIGURE 5.7 The complications of heart attacks include a rupture of the heart wall (black arrow) and the formation of a blood clot (white arrow).

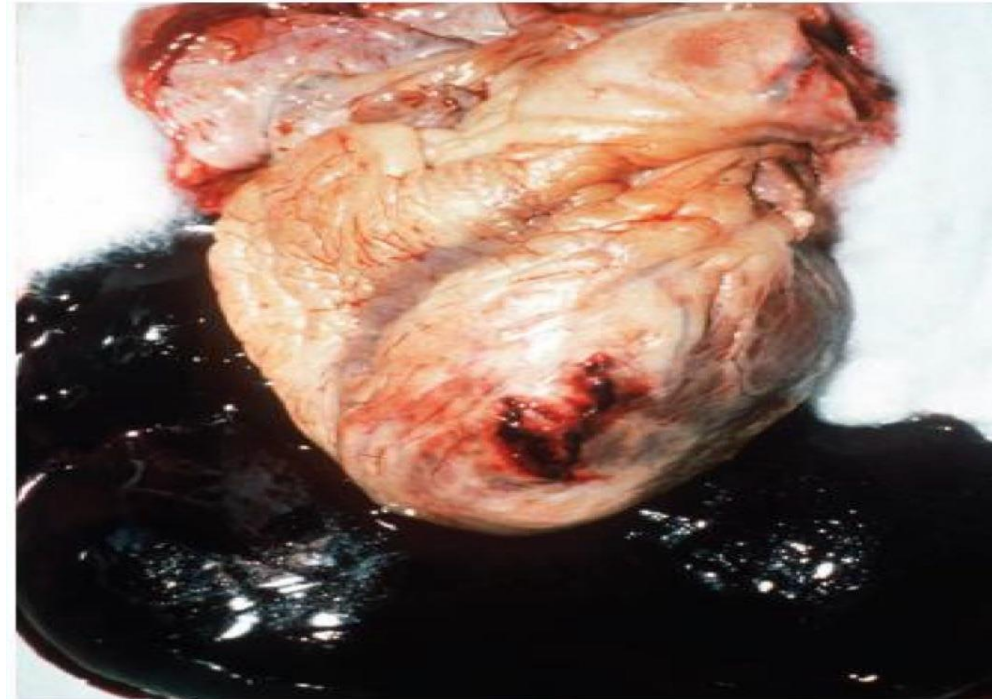


Figure 25.16 A haemopericardium due to a ruptured infarction of the left ventricular anterior wall. The large blood clot caused death from cardiac tamponade.

# Late complications of MI ...cont

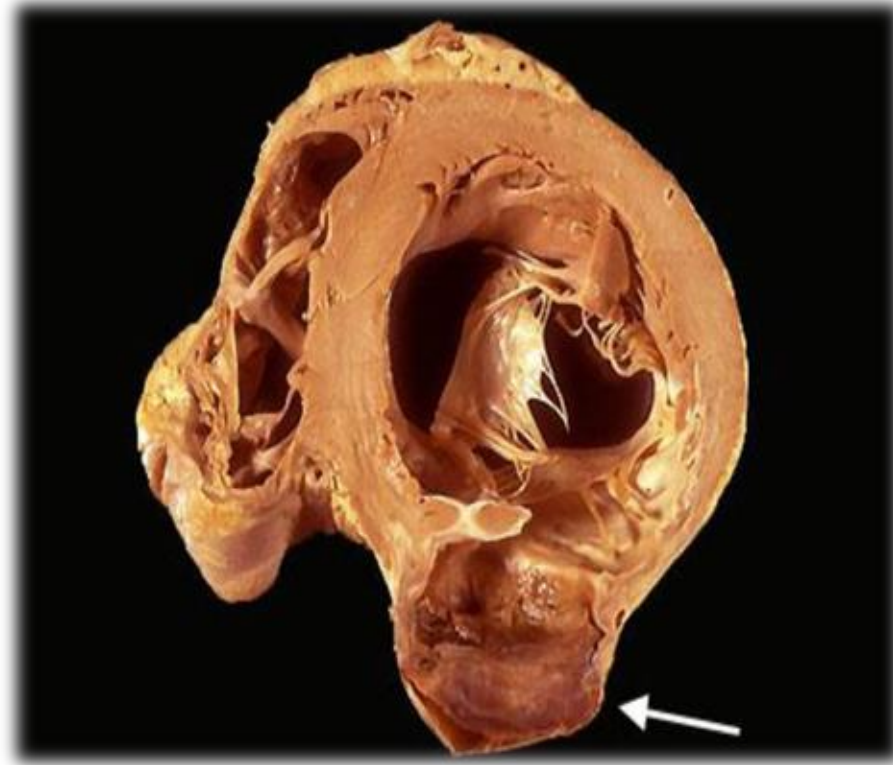
## 2) Papillary muscle rupture :

- 2-7 days post MI.
- Allow part of the mitral valve to prolapse or may present as a sudden onset of valve insufficiency.
- Posteromedial vs anterolateral ???

# Late complications of MI ...cont

## 3) Cardiac aneurysm :

- ▶ 3-14 days post MI
- ▶ May form at sites of infarction . They may calcify and they may rupture



# Hypertensive heart disease

- ▶ There is an etiological connection between hypertension and coronary atheroma , so the two conditions are often present together in a victim of sudden death .
- ▶ Presence of concentric hypertrophy in the absence of valve disease or cardiomyopathy , with characteristic changes in other vessels and organs .
- ▶ chronic myocardial hypoxia and electrical instability which, when combined with a ‘trigger’ , can result in a fatal arrhythmia
- ▶ Heart size ??? (variable )

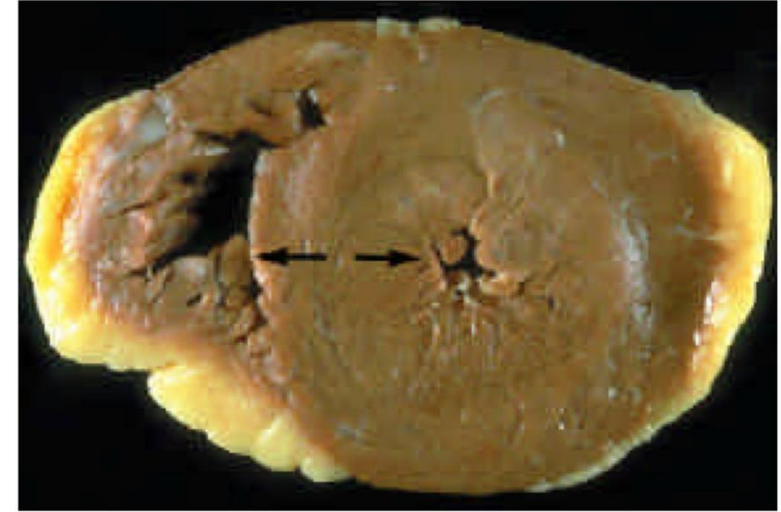


FIGURE 5.19 The wall (arrows) in this cross-section is very thick. This is a sign of hypertension (high blood pressure).

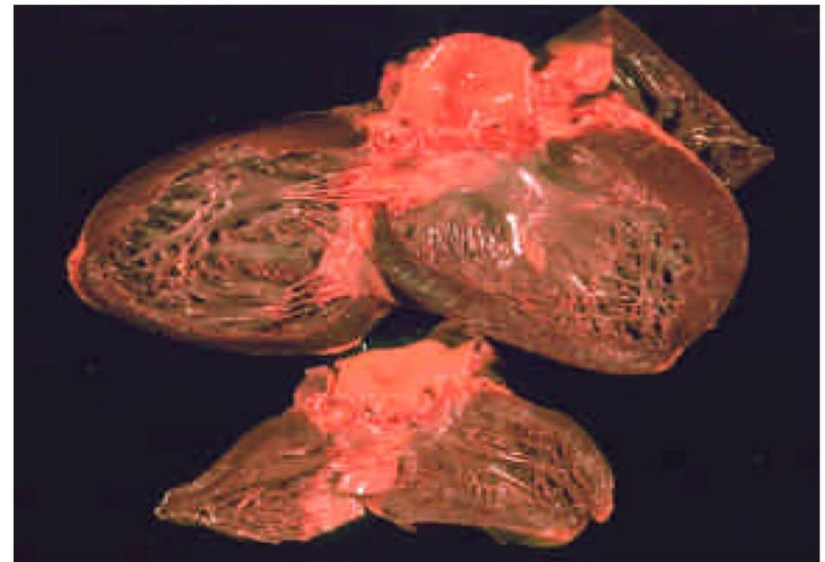


FIGURE 5.18 An enlarged heart from obesity or high blood pressure (top) may be twice the size of normal (bottom).

# Senile myocardial degeneration

- ▶ Senescence is a well-accepted concept in all animals, and few humans survive beyond 90 -100 years.
- ▶ The cause of a sudden death in these elderly individuals can be very difficult to determine.
- ▶ The senile heart is small, the surface vessels are tortuous, and the myocardium is soft and brown owing to accumulated lipofuscin in the cells



Figure 1 Senile myocardium of a man 94 years old

# Aortic stenosis

- ▶ Affects older individuals with calcified tricuspid aortic valve , or younger individuals who have a congenital bicuspid aortic valve
- ▶ The accompanied myocardial hypertrophy is similar to that caused by hypertension , and myocardial perfusion is reduced by the narrow valve , which results in a lower pressure in the coronary ostia and hence , the coronary arteries .
- ▶ Sudden death is common .



FIGURE 25.13 *Calcific aortic stenosis, a common cause of sudden unexpected death especially in older men. Though the stenosed valves are often bicuspid, the stenosis often deforms normal valves, as in this illustration. Marked left ventricular hypertrophy usually ensues, the large muscle mass becoming ischaemic, especially in the inner layers.*

# Primary diseases of the Myocardium (Myocarditis)

- ▶ The fourth most common cause of SCD
- ▶ Many infective diseases produce an acute myocarditis ,which may be the immediate cause of death (diphtheria).
- ▶ The clinical manifestation of the acute picture may range from none to acute heart failure to sudden death , days to weeks after the main clinical symptoms

# Myocarditis ...cont

- ▶ More important is “Isolated myocarditis” , where the condition is primary and usually of unknown etiology (Aka , Fiedler’s or Saphris myocarditis )
- ▶ Complications include sudden death, arrhythmias, heart block, mural thrombus with systemic emboli

# Myocarditis...cont

- ▶ Histological confirmation of multifocal inflammatory cell infiltrates and associated myocyte necrosis requires extensive sampling at post-mortem examination .
- ▶ macroscopically pale or hemorrhagic foci in the myocardium (having a 'mottled' appearance)

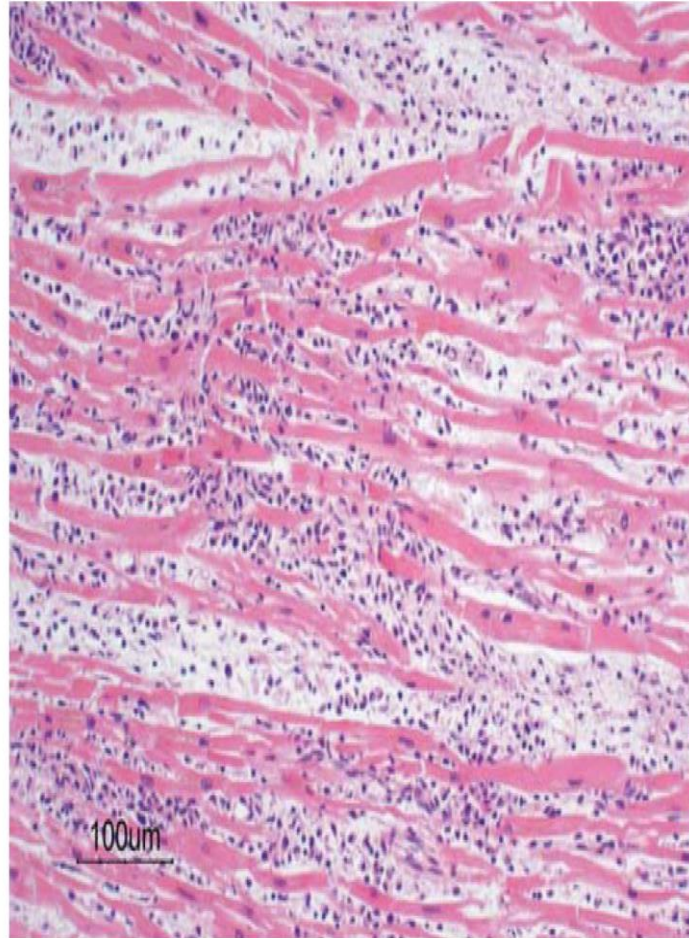
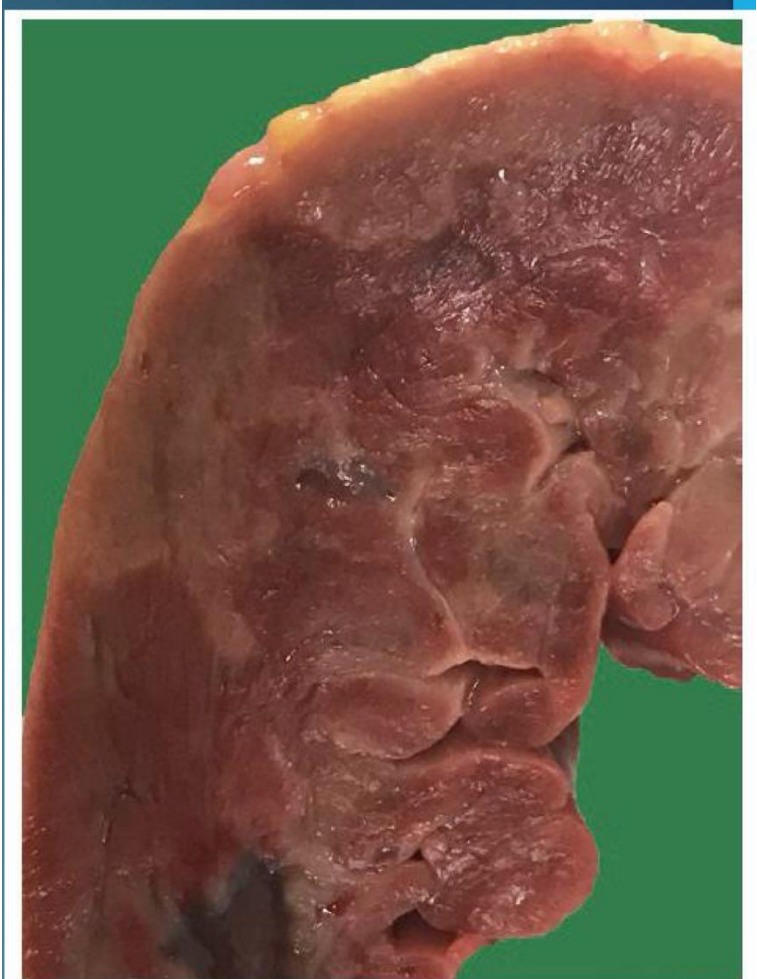


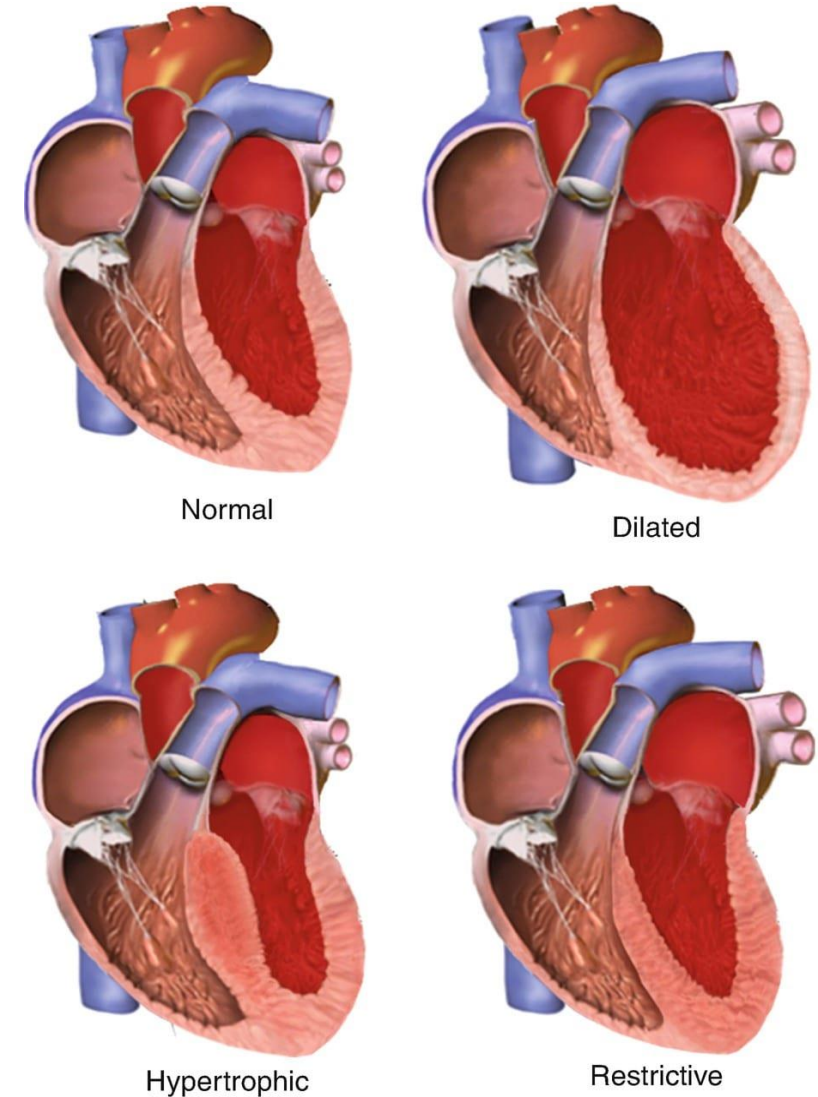
FIGURE 25.15 *Severe diffuse lymphocytic myocarditis with destruction of myocytes. (HE, original magnification  $\times 10$ .)*



**Fig. 2** Close up macroscopic view of a case of myocarditis showing a mottled appearance, not aligned to a vascular territory. This is clearly different to infarction as in early myocarditis

# Cardiomyopathies

- ▶ The second most common cause of SCD .
- ▶ Cardiomyopathies are a heterogeneous group of diseases of the myocardium associated with mechanical and/or electric dysfunction that usually exhibit inappropriate ventricular hypertrophy or dilatation and are due to a variety of causes that frequently are genetic.
- ▶ They include :
  - 1) Dilated cardiomyopathy (DCM)
  - 2) Hypertrophic cardiomyopathy (HCM)
  - 3) Restrictive cardiomyopathy
  - 4) Arrhythmogenic right ventricular cardiomyopathy (ARVC)



# Cardiomyopathies ....cont

## ▶ Dilated cardiomyopathy(DCM)

- The most common cause of congestive heart failure
- It can be familial , idiopathic , viral , immune or toxic
- Characterized by dilated ventricular chamber and reduced contractility without coronary , valvular or pericardial disease

## ▶ Arrhythmogenic right ventricular cardiomyopathy (ARVCM):

an inherited condition which is characterized by predominantly right-ventricular thinning with fibro fatty myocyte replacement.

## ▶ Restrictive cardiomyopathy

- Decreased compliance of the ventricular endomyocardium that restricts filling during diastole
- Associated with: amyloidosis , sarcoidosis , post-radiation fibrosis and hemochromatosis.

# Cardiomyopathies (cont)

- ▶ Hypertrophic cardiomyopathy (HCM):
  - Inherited (AD) or sporadic
  - Disease of cardiac muscle sarcomeric proteins, that causes asymmetrical hypertrophy, and characterized by myocyte disarray. This leads to stiff ventricle and decreased compliance
  - Leading cause of sudden cardiac death in young athletes, mainly due to ventricular fibrillation and may be the first manifestation.

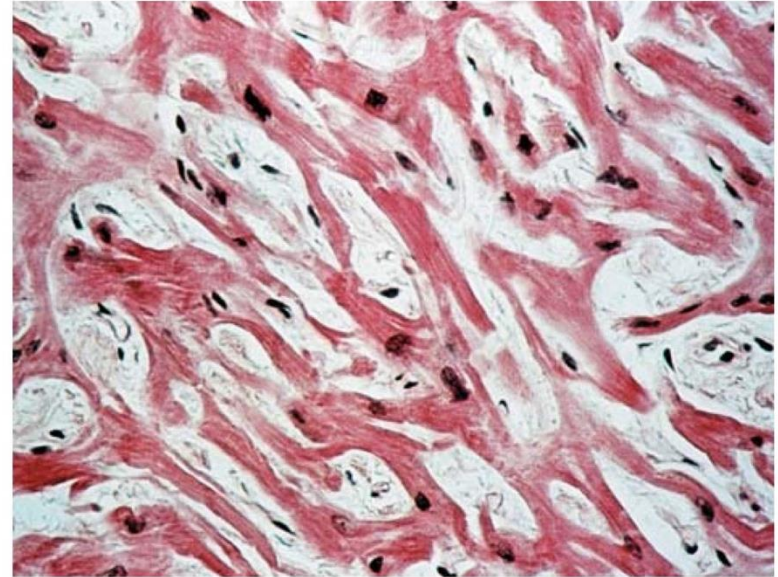
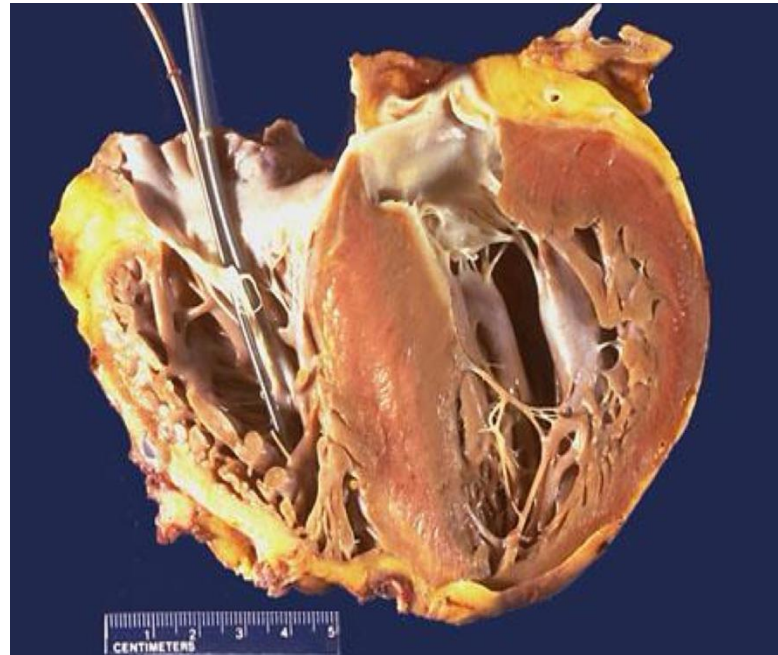


FIGURE 25.14 *Myofibre disarray in hypertrophic cardiomyopathy.*

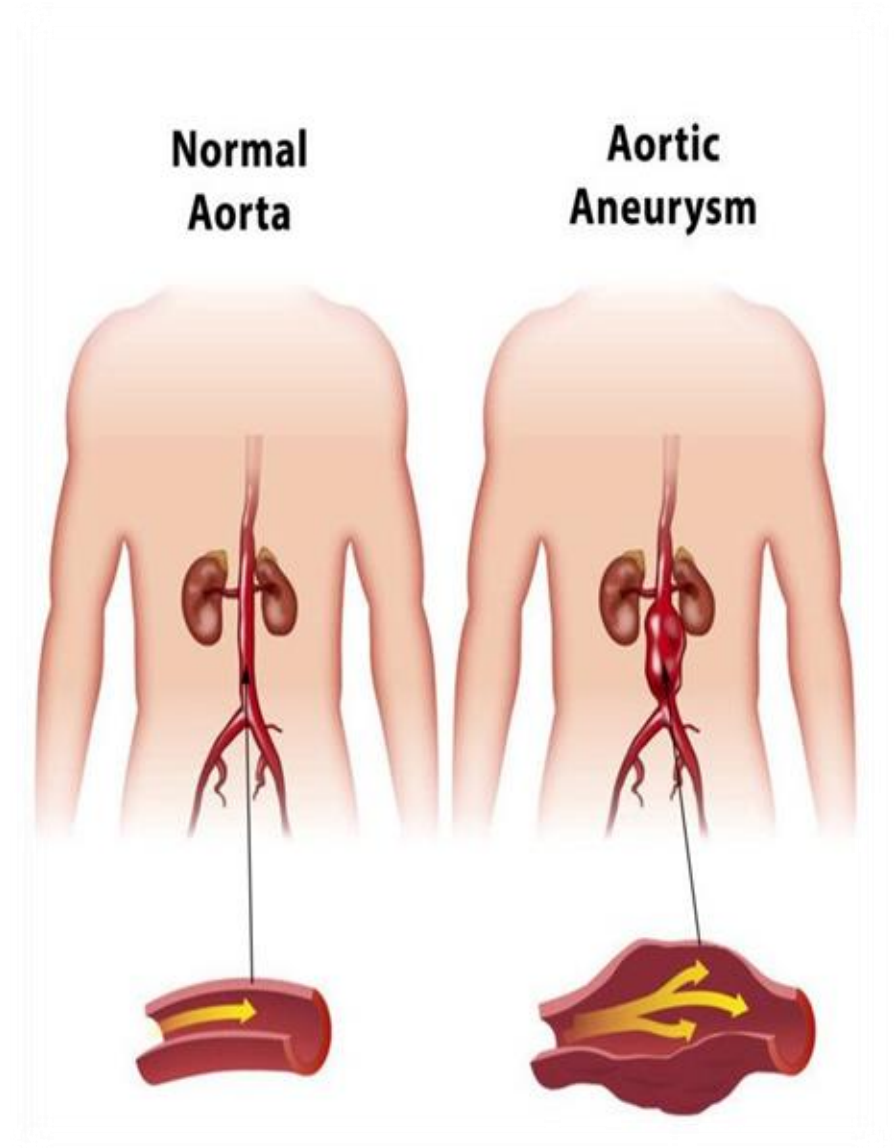


# Channelopathies (Functional abnormality)

- ▶ The third most common cause of SCD
- ▶ They are a group of disorders that represent a relatively small proportion of sudden deaths, presumed to be of cardiac origin, where investigations have failed to identify an alternative explanation for death.
- ▶ Defects in genes encoding myocyte contractile units have been characterized, and these affect the function of sodium, potassium and calcium channels
- ▶ These sudden deaths are often 'triggered' by a stimulus, including exercise, sudden loud noises or even during sleep. Such deaths are often characterized as falling into the broad category of sudden adult death syndrome (SADS).

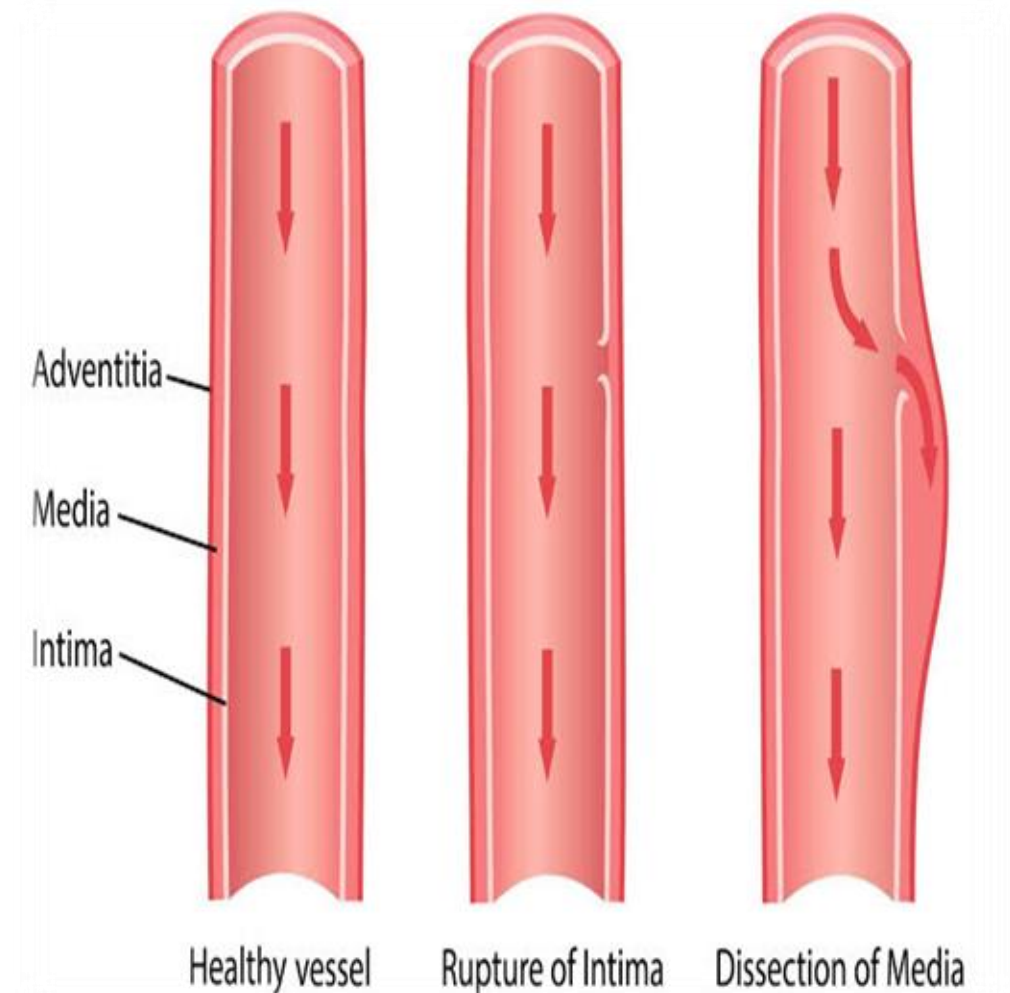
# Diseases of the arteries

- ▶ The atheromatous aneurysm :
  - The most common type and is seen mainly in the abdominal segment of the aorta
  - Fusiform or saccular in shape
  - Progressive destruction of the media leading to weakening of the aortic wall , bulging , platelet and fibrin deposition and eventually , retroperitoneal bleeding
  - Dark red mound may be seen projecting forwards over the lumbar spine , bulging at the root of the mesentery



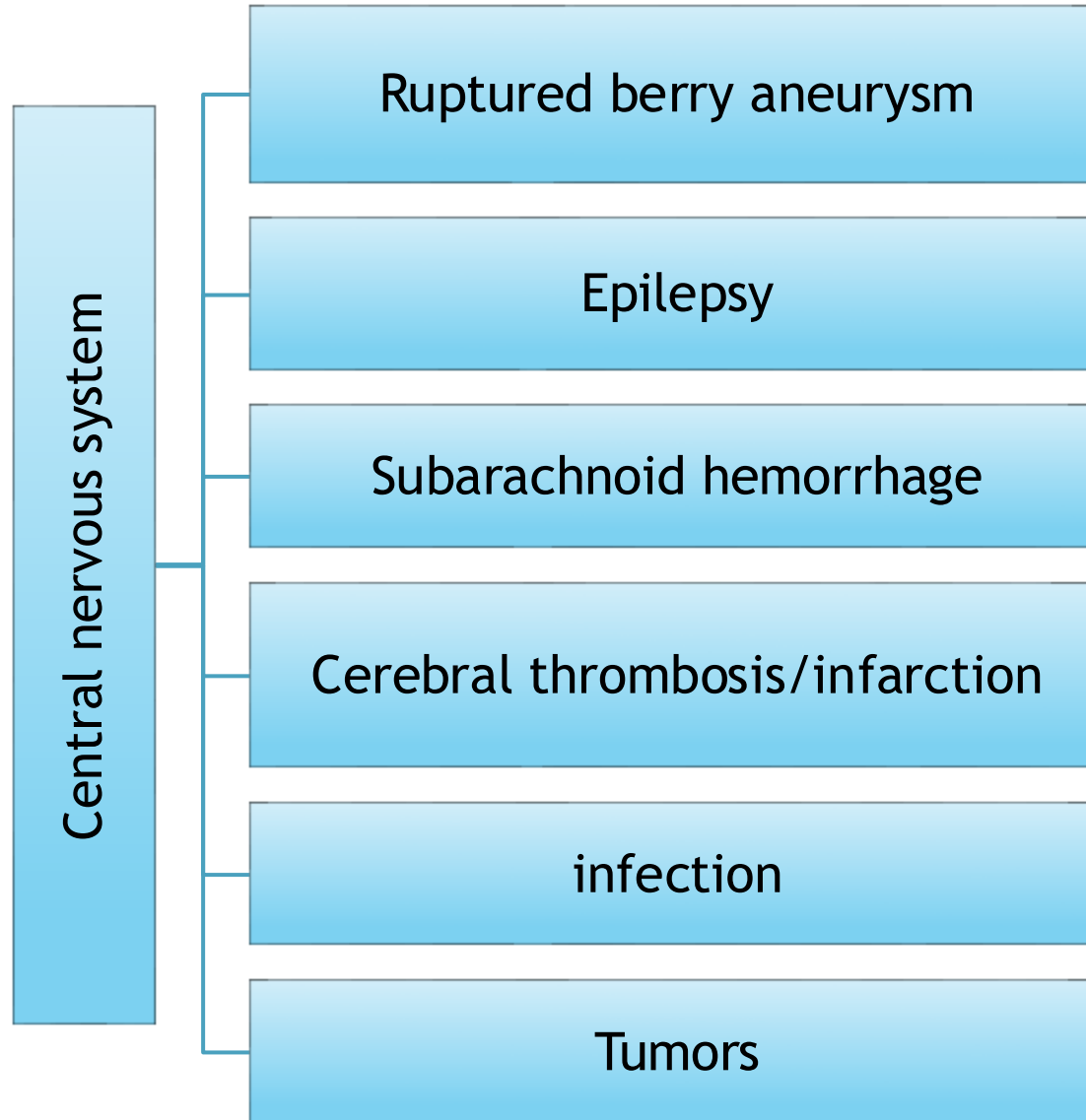
# Diseases of the arteries ...cont

- ▶ The dissecting aneurysm :
  - The commonest site of origin is in the thoracic aorta (proximal 10 cm) and the dissection usually tracks distally towards the abdominal region. It can produce a hemopericardium, cardiac tamponade and sudden death.
  - Other causes of death: MI, hypovolemic shock and it may reach cerebral arteries.
  - Aortic dissection are principally found in individuals with hypertension but may also be seen in younger individuals with connective tissue defects, such as Marfan syndrome



# Valvular heart diseases

- ▶ Rheumatic heart disease
- ▶ Bicuspid aortic valve
- ▶ Mitral valve prolapse
- ▶ Bacterial endocarditis



# Rupture of berry aneurysm

- ▶ Spontaneous rupture of an aneurysm of the circle of willis at the base of the brain
- ▶ A useful rule of thumb , when presented with the sudden death of a woman of child-bearing age , to consider a complication of pregnancy ,self poisoning , PE and SAH as the first choices
- ▶ It is also one of the most common causes of death in young adults , if CAD is excluded
- ▶ Suggested mechanism of death : sudden bathing of the brainstem in blood causing cardiac arrest
- ▶ Arterial spasm ???

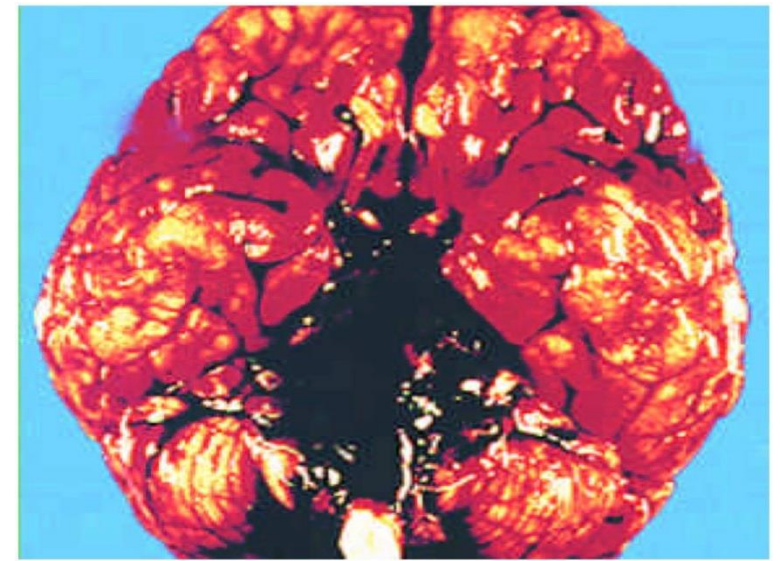


FIGURE 5.39 Another case of marked subarachnoid hemorrhage originating over the base of the brain. Most of these hemorrhages occur naturally from ruptured aneurysms; however, some can be caused by minor trauma or rupture secondary to drugs such as cocaine and methamphetamine.

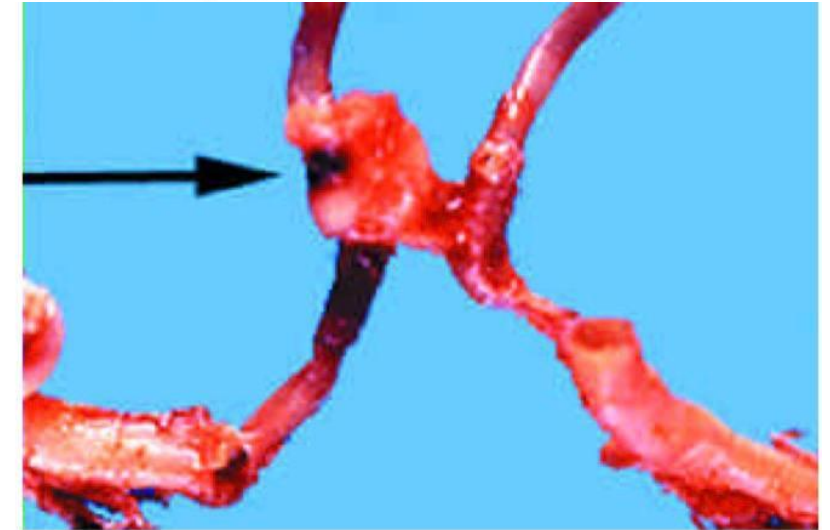


FIGURE 5.40 This is an aneurysm (ballooned-out blood vessel) which was located on the base of the brain. It ruptured and caused death.

# Epilepsy (Most common)

- ▶ Epilepsy, Recurrent unprovoked seizures , is associated with an increased risk of mortality
- ▶ Sudden unexpected death in epilepsy (SUDEP) : The sudden , unexpected and nontraumatic death of person with epilepsy in whom the postmortem examination fails to reveal a gross anatomical , toxicological or environmental cause of death . The event can be witnessed or unwitnessed and can occur with or without evidence of a seizure (excluding documented status epilepticus )
- ▶ Seizure induced arrhythmia , seizure-mediated inhibition of respiratory centers or a complication of antiepileptic treatment

## SUDDEN UNEXPECTED DEATH IN EPILEPSY SUDEP RISK FACTORS



Early age of  
epilepsy  
onset



Generalized  
tonic-clonic  
seizures



Uncontrolled  
or frequent  
seizures



Not taking  
meds as  
prescribed



**SUDEP ACTION DAY**  
**#BREAKDOWNBARRIERS**

Source: [cdc.gov/epilepsy/about/sudep](https://cdc.gov/epilepsy/about/sudep)

# Cerebral thrombosis and infarction

- ▶ A cerebral infarction is an area of necrotic tissue in the brain resulting from a blockage or narrowing in the arteries supplying blood and oxygen to the brain
- ▶ Sudden bleeding into brain tissue is common, usually in old age and in those with significant hypertension
- ▶ If a large stroke happens in a part of the brain vital to breathing or the heart, it can lead to death in a short time. If the stroke is very large, it can cause widespread damage that the brain can't survive even if the cause of a clot or a bleed is treated.

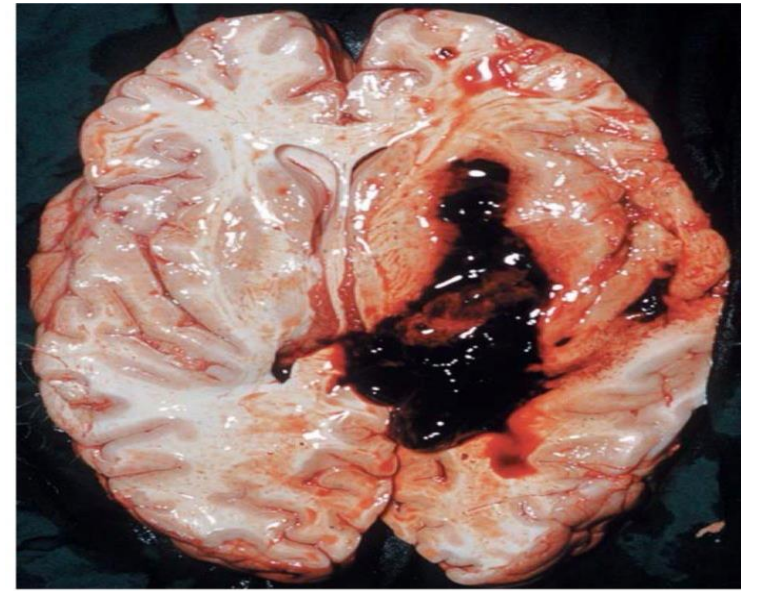


FIGURE 25.20 A large recent intracerebral haemorrhage in a person with hypertension. The bleeding has originated in the region of the external capsule from a lenticulostriate branch of the middle cerebral artery then broken through into the posterior horn of the lateral ventricle.

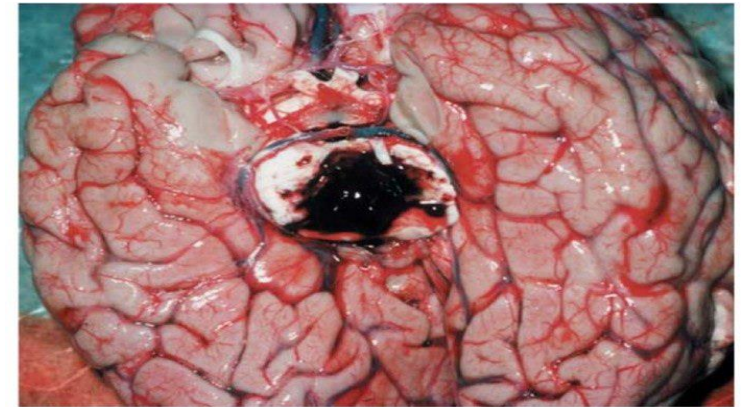
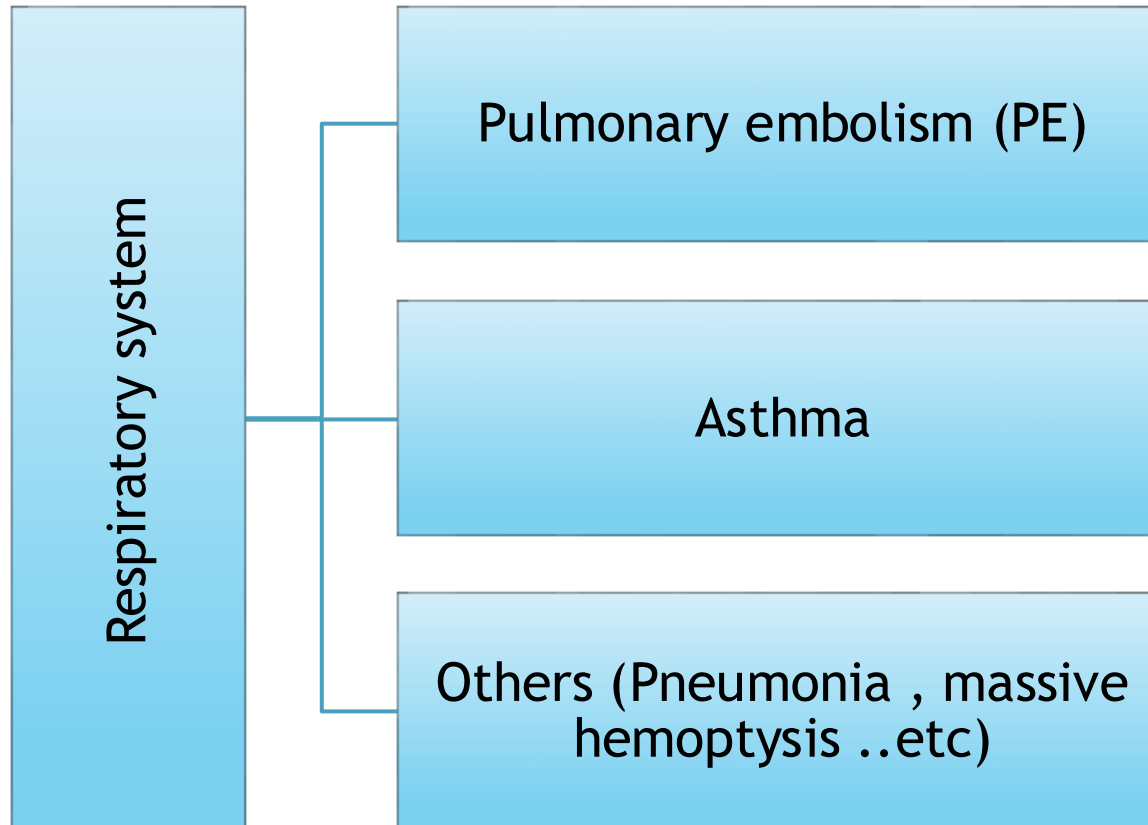


FIGURE 25.25 A massive pontine haemorrhage in a person with hypertension. The circumstances and the irregular distribution of the bleeding within the brainstem distinguish this primary haemorrhage from the secondary lesions seen in raised intracranial pressure. Sometimes a natural intracranial haemorrhage may precipitate an accidental fall or traffic accident, however, and the resulting head injury may make it more difficult to identify the nature of the brain haemorrhage.

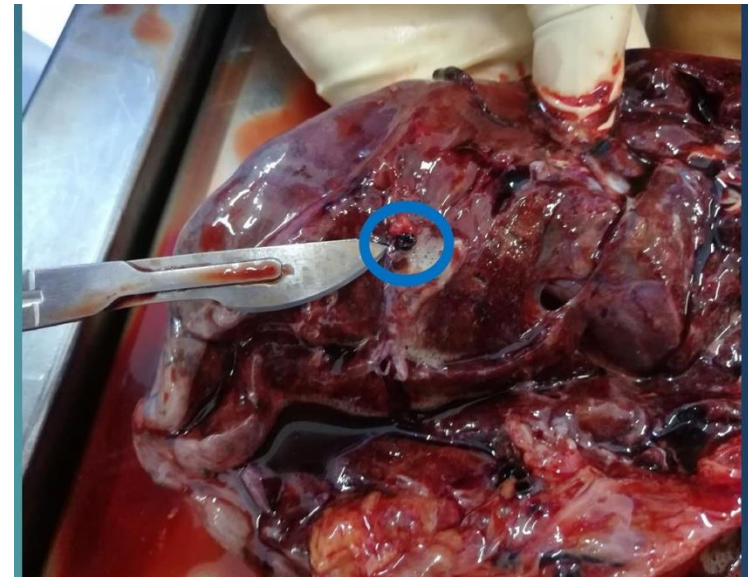
# Infection

- ▶ Hyperacute bacterial meningitis in the very young and the elderly can lead to death within 24 hours of onset of symptoms
- ▶ Mechanisms leading to sudden death include (cerebral edema , CSF flow obstruction and systemic collapse )
- ▶ At autopsy , purulent exudates may not be apparent on gross inspection of the brain . Postmortem blood cultures and /or cerebrospinal fluid cultures need to be taken in such cases
- ▶ Encephalitis: is a serious neurological condition and unfortunately, despite improvements in specific and more supportive treatments such as excellent intensive care management, it still has a high mortality rate. When death happens it is usually because of the brain swelling as a result of its severe inflammation.



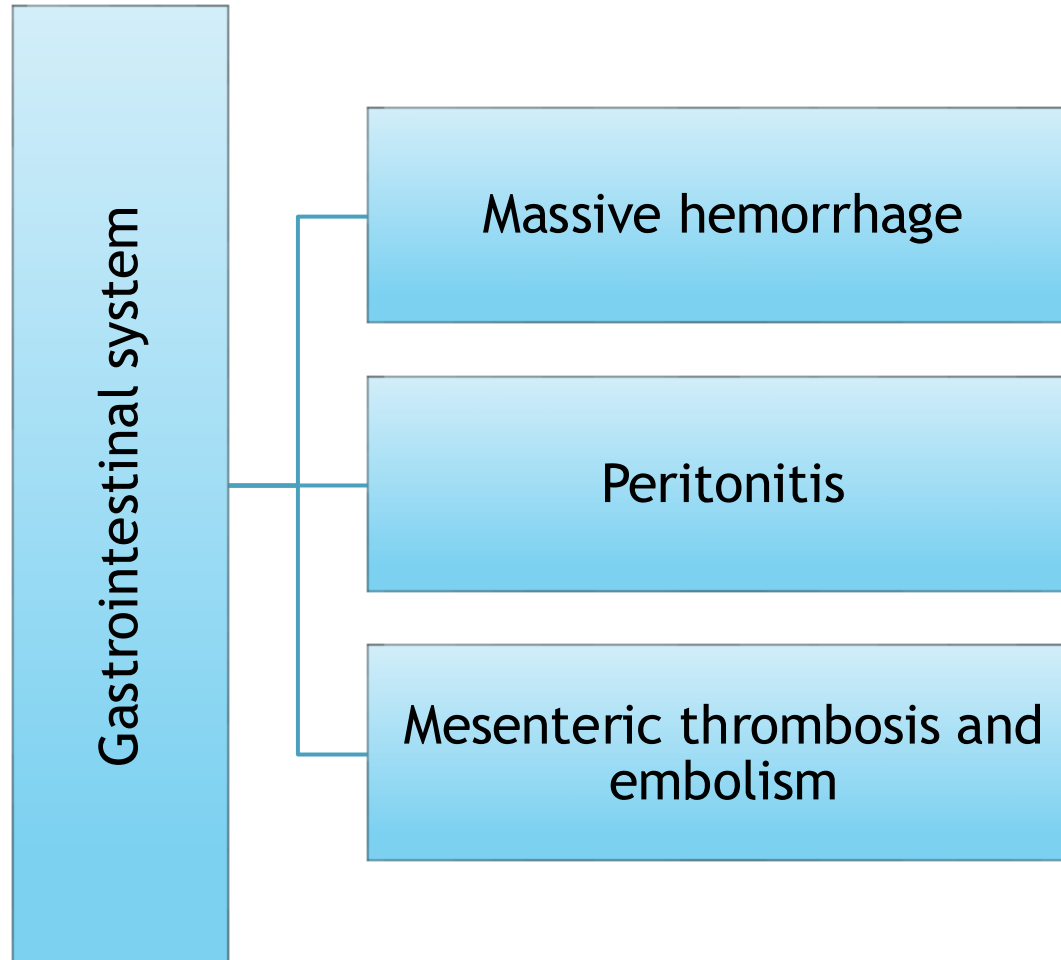
# Pulmonary embolism (Most common )

- ▶ The most underdiagnosed cause of death
- ▶ The source of emboli is the deep leg or pelvic veins
- ▶ PE is more common with advancing age , obesity , and with majority of instances there is a predisposing factor such as trauma , surgical operation , confinement to bed or immobility
- ▶ Large vs small thromboemboli



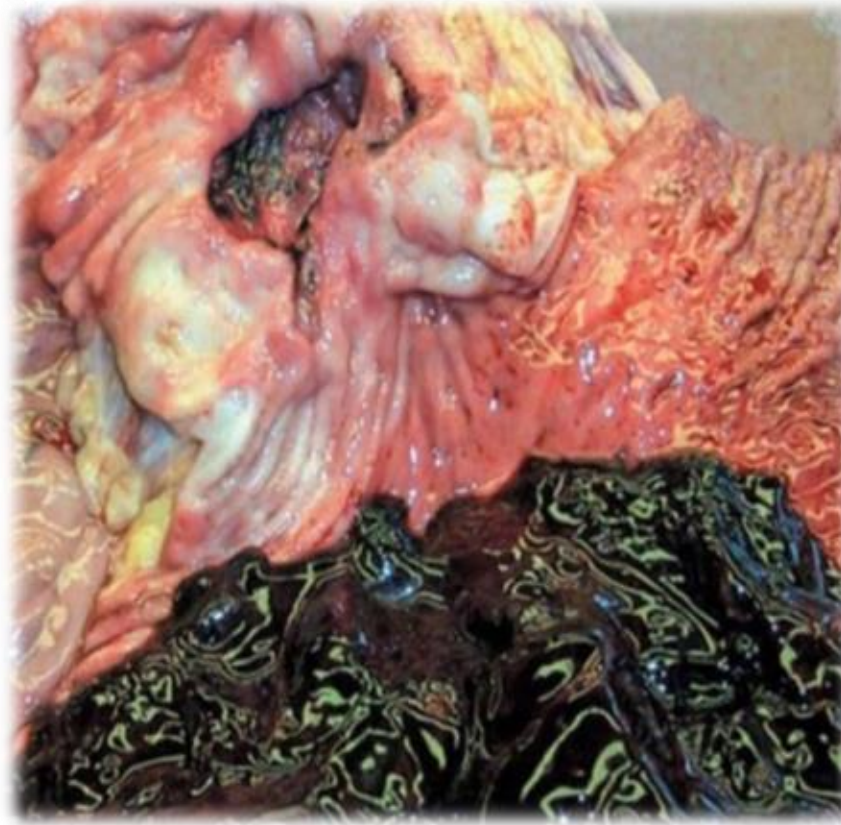
# Asthma

- ▶ Sufferers from asthma may die suddenly and unexpectedly , without necessarily being in status asthmaticus .
- ▶ Hypoxia and respiratory acidosis occur in asthma and increase myocardial irritability .
- ▶ Inhalers containing bronchodilators ???



# Massive hemorrhage

- ▶ The main causes of sudden death in the gastrointestinal system are predominantly vascular in nature, E.g. Severe bleeding from:
  - 1) Esophageal varices
  - 2) Gastric and duodenal ulcers
  - 3) Others (gastric / colonic tumors ..etc )



# Mesenteric thrombosis and embolism / peritonitis

- ▶ Mesenteric thrombosis and embolism , usually related to aortic or more generalized atherosclerosis, may result in infarction of the gut; a rapid but not sudden death is expected if the infarction remains undiagnosed. Intestinal infarction owing to a strangulated hernia, or obstruction owing to torsion of the bowel as a consequence of adhesions can also prove rapidly fatal .
- ▶ Peritonitis , following perforation of a peptic ulcer, diverticulitis or perforation at the site of a colonic tumor for example, can be rapidly fatal if not treated Many of these conditions present as sudden death in elderly people because they cannot, or will not, seek medical assistance at the onset of the symptoms, and are then unable to do so as their condition worsens

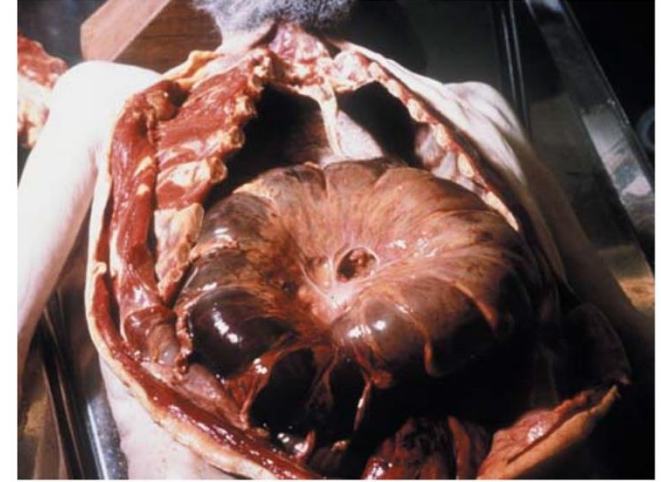
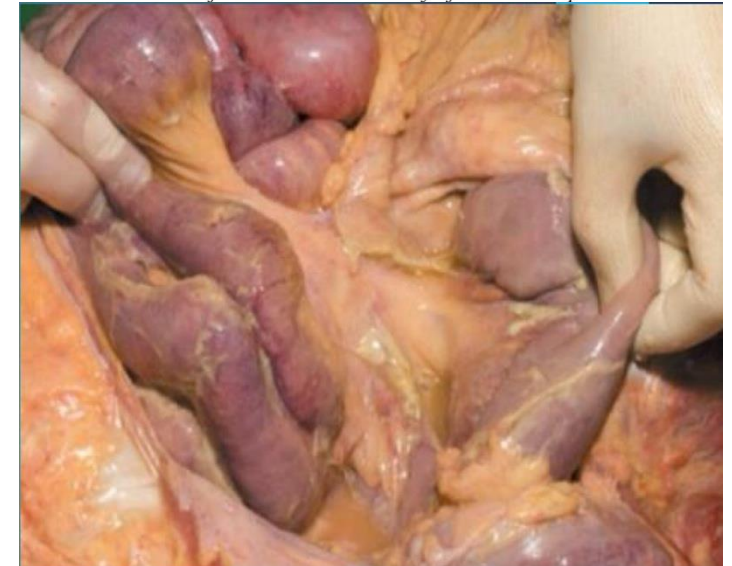
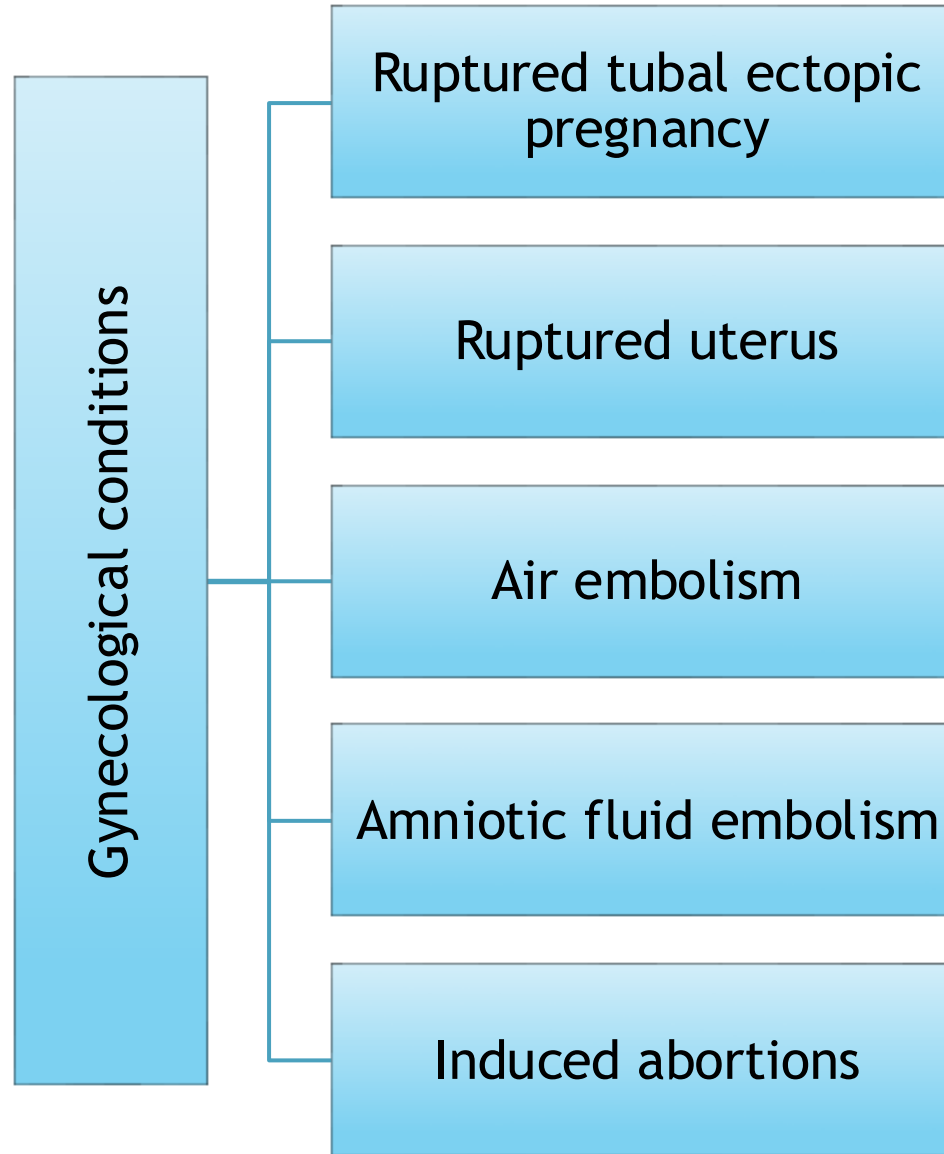


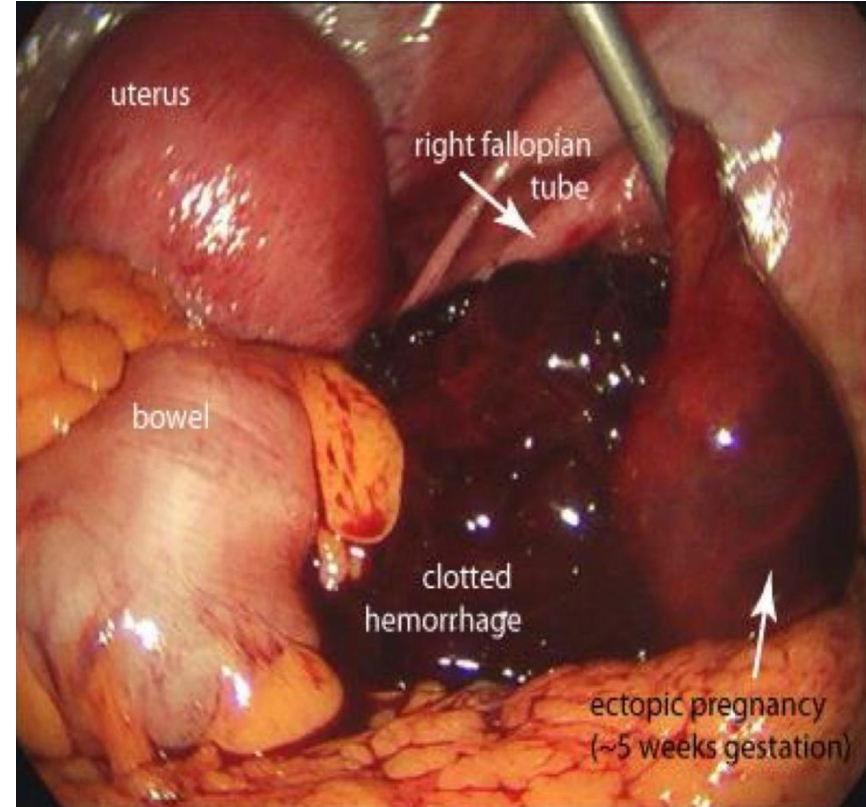
FIGURE 25.24 *Great distension of colon due to volvulus of sigmoid colon. Deceased found dead with history of abdominal pain.*





# Gynecological system

- ▶ Ectopic pregnancy , usually in the tubes , can rupture with massive intraperitoneal hemorrhage .
- ▶ Induced abortions , unless under reputable medical control , are another source of death from hemorrhage , air embolism , perforation of vagina or uterus , infection and the use of toxic substances



# Deaths associated with pregnancy (Maternal deaths )

- ▶ Maternal deaths: Deaths of women while pregnant or within 42 days of the end of the pregnancy from any cause related to or aggravated by the pregnancy or its management, but not from accidental or incidental causes, and is classified into direct and indirect:
  - 1) Direct Deaths: resulting from obstetric complications of the pregnant state (pregnancy, labor and puerperium), from interventions, omissions, incorrect treatment or from a chain of events resulting from any of the above.
  - 2) Indirect Deaths: resulting from previous existing disease, or disease that developed during pregnancy and which was not due to direct obstetric causes, but which was aggravated by the physiologic effects of pregnancy.

# Sudden Infant death syndrome (SIDS)

- ▶ The sudden death of any infant or young child that is unexpected by history and in whom a thorough necropsy fails to demonstrate an adequate cause of death .
- ▶ Multiple theories , each provides the possible cause in a proportion of infants . The findings of most studies in England support the view that sudden infant death is essentially a mode of death in children suffering from some occult illness
- ▶ Risk factors include (winter season , respiratory disease , male gender , younger age , poor socioeconomic status ...etc )

## Sudden infant death syndrome (cont)

- ▶ exclude child abuse or an 'accidental death'.
- ▶ Birth weight and full measurements must be taken. Gross examination should include all the orifices.
- ▶ Swabs need to be collected from air passages, middle ear , and blood from heart may be preserved for microbiological culture.

# Sudden infant death syndrome ...cont

- ▶ A separate piece of lung may be sent for virological culture
- ▶ Petechial haemorrhages on the visceral pleura, epicardium and thymus may be seen in a few cases
- ▶ The findings of gastric contents in the air passages may not be used as a cause of death in itself. It should be evaluated in conjunction with the other attending circumstances.

# Negative autopsy

- ▶ Cases where no apparent cause of death can be found after performing a full autopsy with full investigations . Causes of negative autopsy include :
  - 1) Endocrinopathies (DKA , hypoglycemia ,thyroid storm , adrenocortical insufficiency )
  - 2) Electrolyte abnormalities
  - 3) Cardiac dysrhythmia : Channelopathies
  - 4) Others : seizure , anaphylaxis , Neuroleptic malignant syndrome , serotonin syndrome .

# References

- ▶ Knight's forensic pathology , third edition
- ▶ Textbook of forensic medicine and toxicology , principles and practice , fifth edition
- ▶ Forensic medicine slides

NOT THE END