**Objectives:** Describe the most common causes of sudden cardiac death, their pathophysiology, and ability to identify them.

**Sudden cardiac death (SCD):** sudden and unexpected cessation of cardiac activity where the patient becomes unresponsive and lacks a pulse. It is the most common cause of “dropping dead” in the world. It accounts for ~400,000 deaths in the US alone per year. In those >40 years old, ventricular fibrillation from an MI is the most common cause. In those <40, ventricular fibrillation secondary to hypertrophic obstructive cardiomyopathy (HOCM) is the most common cause in the US.

**Fast facts:** without CPR, survival from cardiac arrest caused by VF declines by approximately 10% for each minute without defibrillation, and after more than 12 minutes without CPR, the survival rate is <5%. Survival to hospital discharge for those treated between 1998 and 2001 has not significantly changed, and this can most likely be contributed to time of CPR onset at the scene. Education regarding bystander CPR needs to become a priority in prehospital care.

**What causes people to literally drop dead?**

Causes of sudden cardiac death: broken up into several categories for ease of organization. First, think cardiac vs noncardiac. Cardiac is by far the most common cause. Secondly, is it because of a structural (muscular) issue in the heart or electrical (nonstructural) conduction? Finally, if structural, is the cause due to ischemic heart disease or non-ischemic heart disease. Overall, IHD/CAD is the most common cause of SCD.

**Cardiac**

- Myocardial infarction
- Dissection
- Coronary vasospasm (cocaine)

**Noncardiac**

- Intracranial hemorrhage
- Sudden infant death
- Electrolyte disturbances
- pH disturbances
- Temperature disturbances
- Any toxins or drug overdose

**Ischemic heart disease**

- Hypertrophic obstructive cardiomyopathy
- Dilated Cardiomyopathy
- Valvular disease
- Congenital heart disease
- Myocarditis
- Pericardial tamponade
- ARVC

**Non-ischemic heart disease**

- Long QT syndrome
- Complete heart block
- Brugada syndrome
- Wolff-Parkinson-White
- Commotio cordis

Depending on the patient’s age, some diseases are more common than others.

**<35 years old:** HOCM is the most common (50% of the time), followed by other major causes like congenital heart disease, nonstructural heart disease, cocaine use, and dissection in no particular order.

**>35 years old:** MI (80% of the time!), followed by PE, dissection, and dilated cardiomyopathy as major causes.

This simple point underlies a major board question topic: **Those <35 years old who present on board exams with chest pain do NOT have Acute Coronary Syndrome.** Studies have shown there is a <10% of MI in those <35 years old, which means on board tests you will never see a patient <35 with chest pain due to MI or angina. Of course, in real life there are people in their 20s who present with MI, so never ignore them if it’s a concerning story!

**Pathophysiologic course of sudden cardiac death**

Loss of oxygenated blood flow to coronary arteries either due to 1) structural heart disease, 2) electrical pathology, 3) noncardiac cause → loss of consciousness in seconds-minutes due to cerebral ischemia → development of tachyarrhythmia (most commonly ventricular fibrillation) → loss of heart function with eventual death.

Generalized presentation: symptoms and warning signs are uncommon. Which is quite scary. Only 50% of the time a patient can display signs of chest pain or 20% of the time display dyspnea.

**Brief review of the high yield offenders…**

**Myocardial infarction:** due to >70% stenosis of the coronary arteries. 50% of the time a patient has an MI, they develop cardiac arrest. The other 50% the patient will be conscious and (usually) present to the ED with associated symptomatology.

**Aortic Dissection:** largest risk factor is hypertension, especially in those >35. Patients will typically have tearing chest pain that radiates to the back. The classic widened mediastinum on x-ray is actually only positive about 60-70% of the
Shot through the heart: Sudden Cardiac Death and its causes

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time. In those <35, connective tissue disorders such as Marfan’s or Ehlers-Danlos are classic on boards. See our handout on aortic dissection for more details on our website.

**Hypertrophic Obstructive Cardiomyopathy**: genetic defect in sarcomere genes (classically beta-myosin), resulting in a disordered hypertrophy of the myocardium. Eventually, the enlarged myocardial wall impairs diastolic filling. The major concern for HOCM is septal obstruction leading to coronary ischemia. During states of increased left ventricular contractility, the thick musculature on the septum can press against the mitral valve leaflet and prevent outflow of blood into the aorta. This results in coronary ischemia and eventual fatal tachyarrhythmia.

**Long QT Syndrome**: Prolongation of the QT interval (>430 in men; >450 in women) delays repolarization in cardiac myocytes and leads to torsades de pointe, a form of polymorphic ventricular tachycardia (polymorphic because it changes in amplitude). Long QT can be acquired or inherited. Inherited conditions include the infamous Romano-Ward and Jervell-Lange-Nielson disorders, both of which have Na-K channel defects. Jervell-Lange-Nielson also causes sensorineural hearing loss.

Acquired conditions are much more common and more well known. Think electrolyte issues and drugs.

- Electrolyte issues: hypokalemia, hypocalcemia, hypomagnesemia
- Certain medications: Sotalol, Risperidone (and other antipsychotics), Macrolides, Chloroquine, Protease inhibitors, Quinidine, Thiazides

**Wolff-Parkinson-White**: an accessory pathway that allows electrical conduction to bypass the AV node and stimulate the ventricles, causing a narrow, tachyarrhythmia called SVT. The HR will be >150 bpm, therefore preventing the effective diastolic filling and eventual coronary ischemia and infarction. Classically, there is a shortened PR interval with an upstroke of the Q wave instead of its normal dip downward. This is a delta wave. In real life this is very difficult to see due to the rapidity of the arrhythmia. A shortened PR interval can also be seen. Please see handout regarding tachyarrhythmias for approaches to acute management.

**Commotio Cordis**: exceedingly rare, but classic on pediatric board questions. Physical impact to the chest wall causes the heart to enter ventricular fibrillation. Children are more prone due to their immature thoracic cage. Classically the child will be in a baseball game or some sporting event where they are hit by a ball or puck or another player.

**Pulmonary Embolus**: massive emboli, in simple terms, are those which cause the patient to be hemodynamically unstable, and can often block the enter pulmonary artery, especially at the pulmonary trunk (i.e. saddle embolus). These emboli require thrombolitics (although this a hotly debated topic in medicine).

**Arrhythmogenic Right Ventricular Cardiomyopathy**: paroxysmal ventricular arrhythmias → sudden death. More common in Mediterranean descent. Basically there is fibrous-fat infiltration of the right ventricle of the myocardium. 2nd most common cause of death in those <35 after HOCM. Similar presentation to HOCM as well: palpitations, syncope, exertional dyspnea, etc. The older patients get, the more the RV will begin to falter leading to biventricular dilated cardiomyopathy.

EKG: epsilon wave (only seen in ~1/3 of patients), T wave inversions (>80% of patients), prolonged S wave upstroke in V1-V3. Echocardiography should be performed but high rate of false negatives. Most accurate is cardiac MRI.

Tx: urgent ICD placement. Antiarrhythmic therapy until ICD is warranted in most cases (e.g. sotalol, BB’s).

**Brugada Syndrome**: mutation in sodium channel, leading to unexplained sudden cardiac death, especially at night. Type 1 Brugada sign (coved STE >2mm in >1 V1-3 with a NEGATIVE T wave). Must be associated with one of these to make the diagnosis: VF or polymorphic VT, FH of SCD <50, same EKG in family members, syncope, nocturnal agonal respiration.

Type 2 Brugada: saddleback STE in V1-V3.

Type 3 is a mix of the first two with <2 mm.

Tx: urgent ICD placement. Antiarrhythmic therapy until ICD is warranted in most cases (e.g. sotalol, BB’s).