Sudden cardiac death: Primary and secondary prevention

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Definition

- "Sudden cardiac arrest (SCA) and sudden cardiac death (SCD) refer to the sudden cessation of cardiac activity with hemodynamic collapse, typically due to sustained ventricular tachycardia/ventricular fibrillation. These events mostly occur in patients with structural heart disease (that may not have been previously diagnosed), particularly coronary heart disease."
- "The event is referred to as SCA (or aborted SCD) if an intervention (e.g. defibrillation) or spontaneous reversion restores circulation, and the event is called SCD if the patient dies."

Epidemiology

- Approx. 1/1,000 per year
- Male : Female = 3:1
- Peak incidence at 45 – 75 years old
  - Follows incidence of ischemic heart disease
- In those aged <35 = male predominance
  - Sports activity is associated with increased risk of SCD

Pathophysiology

- Most common electrophysiological mechanism leading to SCD = tachyarrhythmias
  - Ventricular Tachycardia
    - Rapid but regular
    - Can lead to VF
    - Monomorphic (all beats the same)
    - Polymorphic
  - Ventricular Fibrillation
    - Rapid and uncoordinated contraction of the ventricles
    - Progresses to Asystole (no cardiac electrical activity) → SCD

Causes

- Structural Abnormalities = most cases
  - MI / post-MI remodeling
    - Premature Ventricular Contractions
  - Ventricular hypertrophy
  - Anomalies in the coronary arteries (congenital or acquired)
  - HOCM (Hypertrophic obstructive cardiomyopathy)
  - Dilated cardiomyopathy
  - Arrhythmogenic right ventricular cardiomyopathy
  - Valvular disease (+/- infective endocarditis)
    - Aortic stenosis
    - Mitral valve prolapse

- Tissue level
  - Re-entry (i.e. WPW)
  - Wave break mechanism

- Sub-cellular
  - Ion channelopathies
    - Congenital long QT syndrome
    - Brugada's syndrome (dysfunctional Na^+ channels in myocytes)
- Other
  - Commotio cordis (traumatic blow to the chest)
  - Myocarditis
  - Kawasaki disease
  - PE
  - Aortic dissection/ ruptured aortic aneurysm

Ischemic Heart Disease

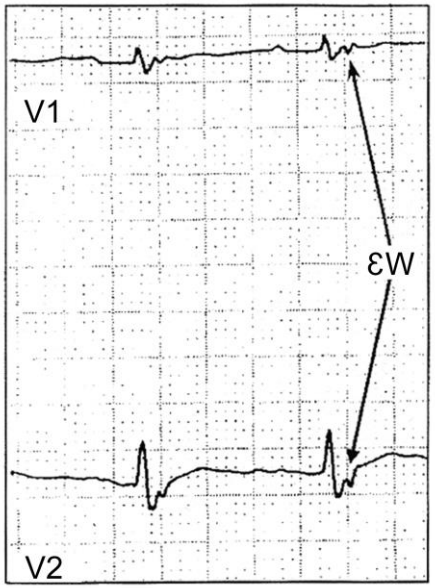
- Post MI remodeling → scar formation + interstitial fibrosis
- Scar can be a focus for reentrant tachyarrhythmias
- Postmortem findings of SCD commonly find extensive atherosclerosis
  - In SCA, 40-86% have 75% stenosis
- Cardiac Surgery Study → improving/restoring blood flow to ischemic myocardium decreased risk of SCD
- Nonatherosclerotic coronary artery problems increase SCD risk:
  - Congenital
  - Coronary artery embolism
  - Coronary arteritis

Non-ischemic cardiomyopathies

- Dilated Cardiomyopathy
  - Can be from previous MI, ischemia, non-ischemic
  - 7.5 / 100,000
  - 10% of SCD cases
  - 10 – 50% mortality within 1 year
  - Causes unknown (viral? AA? Genetic? Alcohol?)
  - Extensive fibrosis of subendocardium → dilated ventricles → reentrant tachyarrhythmias
  - 80% have non-sustained VT (<30 seconds)
    - But not a predictor of SCD
  - Death due to VT
  - Use of antiarrhythmics for NSVT can actually be proarrhythmic and generate VT / VF

- Hypertrophic cardiomyopathy
  - Autosomal dominant (incomplete penetrance)
  - Mutation in 1 of the 45+ genes for proteins in the myocyte sarcomere
  - SCD incidence = 2-4%/year for adults
    - 4-6% / year for <30
  - Most common cause of SCD in those < 30
  - Majority who die from SCD are previously asymptomatic
  - Can occur at rest / minimal effort
    - But usually after vigorous exertion

- Arrhythmogenic right ventricular cardiomyopathy
- RV wall is replaced with firbofatty tissue
  - Inclusion of septum / LV = poorer prog
- Up to 50% = familial
- Men > Women
- Annual incidence of SCD = 2%
- Presentation:
  - RVH/dilation
  - Mono/polymorphic VT
  - LBBB
  - Atrial arrhythmias in 25%
- However, SCD is the 1st manifestation of the disease in many
- Epsilon wave in ECG



Valvular Disease

- Aortic stenosis
  - SCD decreased with Aortic Valve Replacement
  - But still 2nd commonest cause of death post op in this population
  - Highest risk is within 3 weeks post op

Congenital heart disease

- Tetralogy of fallot
- Transposition of the great arteries
- Marfans
- Mitral valve prolapse
- Congenital heart block

Primary electrophysiological abnormalities

- Congenital Long QT syndrome
  - Idiopathic LQTS is Rare familial disorder
  - Jervell-Lange-Nielsen syndrome (10%)
    - associated with congential deafness
    - Autosomal recessive
  - Romano-Ward Syndrome (90%)
    - No congenital deafness
    - Autosomal dominant
  - Ion Channel impairment (Na^+ and K^+)
  - Susceptible to develop Torsade du pointes
  - Risk of SCD increases with:
    - Hypokalemia, certain medications, emotional extremes, vigorous activity

- Probability of congenital LQTS
  - ECG criteria
    - Long QT
    - Torsade du pointes
    - Notched T waves
    - T wave alternans
    - Bradycardia for age
  - Clinical Criteria
    - Syncope (+/- stress)
    - Deafness
  - Family history of LQTS or SCD

- Acquired LQTS
  - Antiarrhythmics
    - Especially:
      - class 1a (Quinidine / procainamide)
      - Class III (sotolol / amiodarone)
  - Electrolyte abnormalities
  - Cerebrovascular disease
  - Altered nutritional state
  - Drugs (tricyclic's, Haldol, erythromycin)

Wolff-Parkinson-White Syndrome

- Rare cause of SCD
- Atrio-ventricular accessory pathway results in ventricular pre-excitation
  - Short PR / Wide QRS / delta wave
- SCD from AF + rapid ventricular response that induces VF
- Treatment with digoxin / adenosine / verapamil are CONTRAINDICATED in WPW + AF
  - Accelerates conduction through accessory pathway → potentiates VF and SCD

Others

- 2 other important causes of SCD to mention
- PE
- Aortic dissection / aneurysmal rupture

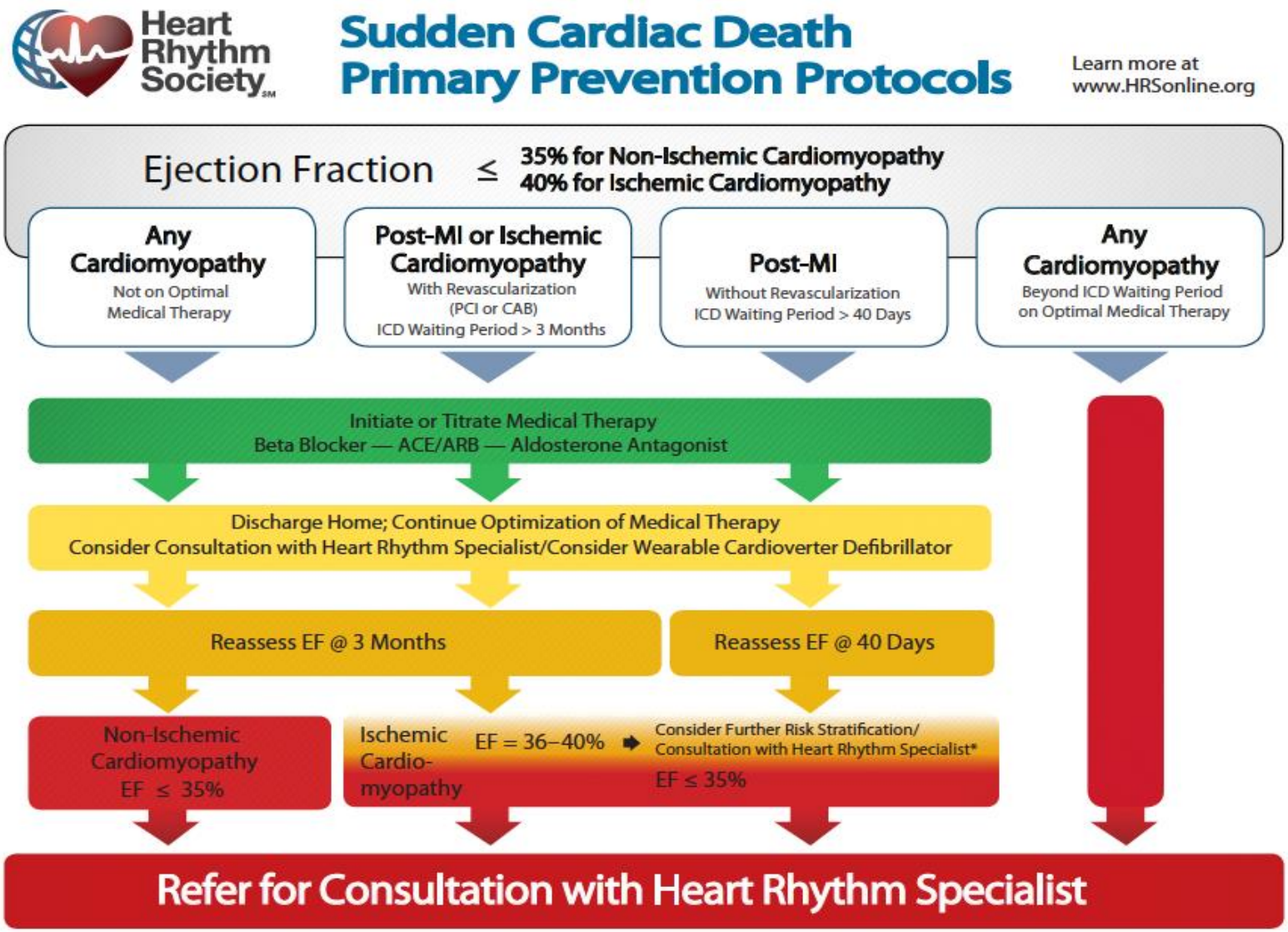
Risk Factors

- Left Ventricular impairment (EF <30 - 35%)
  - Most potent risk factor
- Same for those of Ischemic heart disease
- Family history
- Heart Failure
- Impaired left ventricular systolic function
- Non-sustained VT
- Sustained VT (>30 seconds)
- Previous MI
- Cocaine / amphetamine use
- Hypokalemia / hypomagnesaemia

Primary prevention

- Reduce risks of ischemic heart disease
- Testing of other relatives if a diagnosis is made
- Pre-participation cardiovascular screening of young competitive athletes by a 12-lead ECG
- Detection and treatment of cardiac abnormalities such as hypertrophic / dilated cardiomyopathy.
- ICD for patients with a substantial risk of SCD associated with cardiac arrhythmias
- Education/training in CPR for those you live with

Primary prevention



- Beta Blockers probably decrease ischemia
  - also increase the VF threshold
  - Also decrease the rate of ventricular ectopy in post MI patients

Investigation of 1st degree relatives

- 12-lead ECG
- Echo
- Holter monitor
- Exercise ECG
- Imaging
  - CXR
  - Cardiac MR / CT / nuclear
- Cardiac catheterisation
  - Assessment of ventricular function
  - Assessment of coronary arteries
- Genetics
  - LQTS, Brugada's, HOCM

Secondary Prevention

- ICD (implantable cardioverter-defibrillator)
- Ablative surgery / trans-catheter ablation
- Cardiac transplant
- Education/training in CPR for those you live with

Thank You!