Pathophysiology of Cardiac Arrhythmias

**Brady-arrhythmias**
- **↓ SA node automaticity** (i.e. sinus bradycardia)
  - (↑ parasympathetic, ↓ sympathetic stimulation)
  - If SA node rate ↓ enough, AV node & Purkinje fibers initiate impulses called "escape beats".
  - A series of escape beats = "escape rhythm"

**Altered Impulse Formation**
- ↑ automaticity

**↑ SA node automaticity**
- (↑ sympathetic stimulation of β1-adrenergic receptors)

**↑ automaticity of latent pacemakers**
- If the AV node and Purkinje fibers intrinsically depolarize faster than SA node (produce "ectopic beats"), they'll control impulse formation (produce an "ectopic rhythm") – i.e. AV Junctional Tachycardia

**Abnormal automaticity** (ectopic pacemakers in atrial &/or ventricular myocytes)
- If normally non-conducting heart cells depolarize faster than SA node, they'll produce an abnormal ectopic rhythm
- Usually due to myocyte injury

**Triggered activity** ("R on T phenomenon")
- "after-depolarizations" cause extra ventricular contractions during their repolarization.
- Early after-depolar's in Long QT pts → torsades de pointes
- Delayed after-depolar's in high-Ca²⁺-pts → idiopathic V-tach

**Conduction Block** (i.e. AV block, BB block)
- Delayed propagation of impulse due to electrically unexcitable tissue (from ischemia, fibrosis, inflammation, drugs)

**Altered Impulse Conduction**
- Re-entry loops
  - An impulse travels continuously around a circular (re-entrant) path in the myocardium, continuously depolarizing that cardiac region.
  - Re-entry loops occur in branched, dysfunctional/fibrotic myocardium w/:
    1) **Unidirectional block**: when impulses can't conduct forwards, but can be conducted backwards, in the piece of myocardium
    2) **Slowed retrograde conduction velocity**: backward impulse conduction speed is slow, allows normal myocardium to repolarize so that the impulse propagates in a loop

**More on Re-entry loops:**
- Rate of re-entrant circuits is only limited by the refractory period of the tissues involved. Thus, re-entry can ↑ contractions >300bpm!
- Re-entry loops around distinct anatomical pathways → monomorphic tachycardia on ECG (each QRS looks the same)
- Re-entry loops that are disorganized and constantly changing → Polymorphic tachycardia on ECG (no distinct QRS complexes visible)

**Tachy-arrhythmias**
- Ex. VT due to ventricular scar, A-flutter, AVNRT, AVRT (WPW)
- Ex. Polymorphic VT, V-fib, A-fib

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