OUTLINE: THE SYMPATHETIC INNERVATION OF THE HEART

1. Introduction
    a. Purpose
        i. Sympathetic outflow to the heart regulates normal responses to stress, but leads to pathology in disease states. Cardiac disease should be viewed from the perspective of sympathetic dysfunction.
    b. Objectives / overview
        i. Review the relevant anatomy of the neurocardiac axis
        ii. Understand the physiology of cardiac sympathetic innervation in normal circumstances
        iii. Learn through examples of sympathetic toxicity in pathological states
        iv. Identify treatment paradigms in place, and consideration of future directions targeting the ANS
2. Relevant cardiac anatomy
    a. Historical descriptions of sympathetic innervation
        i. Evolutionary perspective of development of sympathetic nervous system in vertebrates ("management of the internal environment of the organism")
    b. Neurocardiac axis overview
        i. Pathways connecting the brain, spinal cord, and heart
        ii. Respective anatomical innervations of the ventricles and atria, focusing on the conduction systems and relevant myocardium
        iii. Imaging and anatomical evidence of how the heart is innervated (MIBG, clinically relevant imaging techniques)
3. Normal cardiovascular responses to sympathetic tone
    a. Sympathovagal interaction and local neurotransmitters
        i. Nor epinephrine, epinephrine, galanin, neuropeptide Y, acetylcholine
        ii. Chronotropy, inotropy as physiological responses to innervation
    b. Coronary perfusion
        i. Coronary blood flow and vasoconstriction/vasodilation
        ii. Coronary artery innervation
4. Pathological responses to sympathetic tone
    a. Ventricular fibrillation
        i. Psychological factors precipitating sudden cardiac death
        ii. Change in ventricular fibrillatory threshold with psychological stress
    b. Myocardial ischemia and infarction
        i. Myocardial scars lead to a focus for VF/VT and SNS heterogeneity
        ii. Myocardial infraction leads to asymmetrical effects based on location of injury
    c. Catecholamine excess
        i. Lead to heterogeneous, receptor-density-dependent changes in the myocardium (e.g. stress cardiomyopathy)
        ii. Catecholamines lead to hypertrophy, neuronal edema, and vagal withdrawal (e.g. obesity and hypertension)
5. Treatment methods
    a. Historical methods
        i. Stellate ganglion block and stellectomy lead to reduction in VT and VF events
    b. Neurohormonal blockade
        i. Beta blockers as protective in ischemia, VT, but mixed role in chronically elevated SNS states (e.g. hypertension, chronic heart failure)
        ii. Discussion of nor epinephrine spill over in different disease states
        iii. Angiotensin converting enzyme inhibitors
6. Conclusion
    a. Review central purpose of paper: how cardiac disease are also manifestations of inappropriate SNS responses
    b. Future directions including treatment with other sympatholytic techniques (e.g. ablations on cardiac ganglia, vagal nerve stimulation)