# OUTLINE: THE SYMPATHETIC INNERVATION OF THE HEART

1. Introduction
   1. Purpose = Why did he die on a Tuesday? ~ Zipes
      1. SNA is important part of the trigger of sudden death (VF, IHD, HF) but little is known
      2. SNA is important because it helps c- homeostasis/internal regulation
      3. Examples of “fight or flight” response in normal and pathophysiological stress
   2. Objectives to be understand and outline of paper
      1. Historical position of sympathetic innervation of heart (sympathectomy)
      2. Relevant anatomy and reflexes of heart (thoracic spinal cord injury, heart transplant)
      3. Ventricular substrate for VT/VF (neuropsychological effects on VF threshold)
      4. Coronary blood flow regulation in VT/VF events, explaining normal coronary anatomy and MI events
      5. Resulting changes of myocardial ischemia and infarction (including scars)
      6. Catecholamine excess and neurohormonal blockade
      7. Treatment paradigms and future directions
2. Neurocardiac axis
   1. Importance of SNS and heart clinically shown in with first sympathectomy, described as neurocardiac axis
   2. Explanation of cardiac sympathetic innervation/anatomy (include figure)
   3. What happens if nerves cut (e.g. thoracic spinal cord injury)?
      1. Address normal reflexes (Bainbridge, Bezold-Jarish, Baroreflex), including in pathological states (e.g. NE and bradycardia in cirrhosis)
      2. Address changes after transection/epidural of T1-T6 nerves
3. Ventricular substrate and VT/VF
   1. Most important example for SNA is that VT/VF can be triggered by SNA. Example first proposed or relevant by John MacWilliam at introduction of ventricular substrate.
   2. Review ventricular substrate concept using clinical examples of VT/VF events based on substrate changes (HTN, cardiomyopathy, long QT)
   3. Concept of triggers of VF/VT – “nervous heart” and the story of sudden death (Rahe, Engels, etc)
   4. Bernard Lown introducing causes of SCD (four precursors that lead to SCD events). Advent of CCU and arrhythmia prophylaxis
   5. Further studies on VF threshold using neurological stimulation testing
   6. Psychological studies looking at VF/VT events
   7. Concluding that brain/heart connection through SNS is important in pathology
4. Coronary blood flow
   1. Clinically relevant example of CBF – SCA c- VT/VF have high chance of CAD
   2. Coronary anatomy and relation to innervation, explaining normal reflexes to stress
   3. Explain abnormal reflexes d/t pathophysiological changes in SNA
   4. Acute MI events lead to changes in VF threshold. CCU example of changing baseline sensitivity to VT/VF and induction/trigger of VT/VF (may mention beta blockers in prevention/protection of threshold)
5. Chronic myocardial ischemia and scars
   1. Douglas Zipes introduction to scars as a nidus for VT/VF
   2. Anatomy of myocardial innervation at histological layers, and again in overall density (MIBG)
   3. Cardiac remodeling after MI, including scar formation and physiology of VT/VF currents
   4. Chronic changes that lead to resting SNA tone after MI (Rosenberg and Dyx)
6. Catecholamine excess
   1. How do catecholaminergic states lead to increased VT/VF events?
   2. Important local and systemic neurotransmitters (nor epinephrine, epinephrine, galanin, neuropeptide Y, acetylcholine)
   3. Effect of neurohormonal regulation systemically
      1. Example of ICM c- remodeling of heart due to neurohormonal changes
      2. Effect of ACEI and stopping cardiac remodeling
   4. Effect of neurohormonal regulation locally
7. Conclusion
   1. Review central purpose of paper (SNA activity leads to normal cardiac control, but also pathological conditions)
   2. Treatment paradigms of the future (alpha-methyldopa, reserpine, ablation of cardiac ganglia, carotid sinus stimulation, vagal nerve stimulation)
   3. Future directions