2020 HRS Educational Framework for Clinical Cardiac Electrophysiology

General Concepts

a. Pathophysiologic Basis of Cardiac Arrhythmias and Basic Electrophysiology

1. Know normal cardiac anatomy, including the anatomy of the conduction system.
2. Know abnormal cardiac anatomy, such as acquired or congenital heart disease, as it relates to arrhythmias.
3. Know normal basic cardiac electrophysiology, including the phases and currents that drive the action potential in different cardiac tissues.
4. Know abnormalities of cardiac electrophysiology, including altered ion channel function (inherited and drug-induced) and their effect on action potentials.
5. Know the principles of cardiac impulse propagation and repolarization.
6. Know the mechanisms of cardiac arrhythmias including re-entry, triggered activity, and abnormal automaticity, as well as associated triggers such as ischemia, changes in autonomic tone, and drugs.
7. Know the systemic disorders, as well as metabolic and electrolyte abnormalities associated with arrhythmias and conduction abnormalities.
8. Know the biophysics of radiofrequency ablation, cryoablation, electroporation and other energy sources.

b. Communication Skills and Shared Decision Making

9. Know how to communicate effectively and age-appropriately with patients, families and interprofessional teams across a broad range of cultural, ethnic, and socioeconomic backgrounds, including those with special needs.
10. Know basic concepts of shared decision making.
11. Know how to use decision aid tools to facilitate a shared decision regarding primary prevention implantable cardioverter-defibrillator (ICD), left atrial appendage occlusion, participation in athletics and other clinical scenarios.
12. Know how to proactively communicate with patients and families about options for end-of-life care including device deactivation.

c. Diagnostic Testing

i. Monitoring and other noninvasive diagnostic testing

13. Know how to select the appropriate monitoring strategy based on symptom type and frequency, including 12-lead electrocardiogram (ECG), Holter monitor, event monitor, mobile continuous outpatient telemetry, insertable cardiac monitor (ICM) or commercially available, personal wearable monitor.
14. Skill to interpret the surface ECG, ambulatory ECG recordings and signal-averaged ECG.

15. Know the ECG features of normal and abnormal atrioventricular conduction including accessory atrioventricular pathways as well as variant pathways.
16. Know how and when to use direct-to-consumer monitors.
17. Skill to interpret the recordings from direct-to-consumer monitors.
18. Know the indications for, as well as complications and follow-up of ICM.
19. Skill to insert and remove ICMs.
20. Skill to interpret ICM recordings and recognize common artifacts and misdiagnoses.
21. Skill to interrogate, program, and troubleshoot ICMs, including the use of remote monitoring.
22. Know the indications for and limitations of tilt-table testing.
23. Skill to perform and interpret results of tilt-table testing.
24. Know the indications for exercise stress testing, with or without imaging, in the evaluation and risk stratification of patients with cardiac arrhythmias including ventricular pre-excitation, long QT syndrome (LQTS), catecholaminergic ventricular tachycardia (CPVT) and hypertrophic cardiomyopathy, or who are taking class 1C antiarrhythmic medications.

ii. Invasive electrophysiological testing

25. Know the indications, contraindications, techniques, and complications of invasive electrophysiology (EP) studies.
26. Know how to enhance occupational and patient health and safety through minimizing radiation exposure, reducing risk of chronic spine injury, and reducing fire hazards.
27. Know the general concepts of how electrogram signals are acquired, filtered, amplified, and processed.
28. Know the biophysical basis for generation of unipolar and bipolar electrograms, as well as their roles in the diagnosis and catheter-based treatment of arrhythmias.
29. Know the methods of programmed electrical stimulation, including the roles of provocative drug testing/stimulation, and characteristic findings in patients with pathologic conduction disease or tachyarrhythmias.
30. Skill to use pacing maneuvers to evaluate the sinus node, atrioventricular node, and His-Purkinje system.
31. Skill to perform invasive EP study including placing sheaths in the venous and arterial systems, positioning diagnostic catheters in the heart, measuring intervals, and performing diagnostic pacing maneuvers in patients with normal hearts, acquired structural heart disease, or corrected or uncorrected congenital heart disease.
32. Skill to appropriately utilize and monitor sedation during procedures.
33. Know how to identify patients in whom general anesthesia should be considered for EP procedures and the electrophysiologic consequences of anesthesia and sedation.
34. Skill to maintain appropriate hemodynamics of the patient during invasive EP procedures.
35. Skill to recognize and manage complications associated with invasive EP study.
36. Know how to integrate the findings from invasive EP testing with clinical and other testing results in the management of patients with arrhythmias or conduction disturbances.

Bradyarrhythmias

a. Sinus Node Dysfunction and Atrioventricular Block

37. Know the pathophysiological basis of sinus node dysfunction and atrioventricular (AV) block, as well as the degrees and subtypes.
38. Know how to diagnose first, second (Mobitz Type 1 & 2) and third-degree AV block; know factors that favor 2:1 or complete AV block being more likely in the AV node vs His-Purkinje system.
39. Know the methods and tools to diagnose and manage sinus node dysfunction and AV block (acquired and congenital).
40. Know the genetic basis of bradyarrhythmias, including inherited ion channel abnormalities.
41. Know the systemic disorders and metabolic abnormalities associated with bradyarrhythmias and conduction abnormalities.
42. Know the infectious, inflammatory, infiltrative and surgical causes of bradyarrhythmias.
43. Know the characteristics of normal variants of sinus and AV nodal pathophysiology such as those due to athletic training and other causes of high vagal tone.
44. Know how to differentiate paroxysmal complete heart block from vagally mediated AV block.
45. Identify mimics of sinus bradycardia and/or AV block such as atrial or junctional rhythm including concealed junctional extrasystoles or isorhythmic rhythms.
46. Know the pathophysiological basis, diagnosis, and management of patients with pulseless electrical activity and AV block/asystole.

b. Pacemakers

47. Know the indications for implantation of permanent pacemakers.
48. Know the indications for temporary transvenous or transcutaneous pacing.
49. Know the management of AV block following myocardial infarction and cardiac surgery.
50. Know how to select the appropriate type of pacemaker for a given bradyarrhythmia and patient, including transvenous, epicardial, and leadless technologies.
51. Know the methods, techniques, associated tools, and equipment to perform pacemaker implantation.
52. Know how congenital heart conditions require modifications with respect to access, implant locations, and contraindications.
53. Know when general anesthesia should be considered for cardiac implantable electronic device procedures.
54. Know the role of selective conduction system pacing.
55. Skill to implant transvenous atrial and ventricular pacemakers, including leadless and conduction system.
56. Skill to implant temporary pacing catheters.

57. Skill to test for potential interactions of pacing systems with separately implanted electrical devices.
58. Skill to test and troubleshoot conduction system pacemakers.
59. Skill to remove and replace pacemaker generators.
60. Skill to upgrade pacemakers from single to dual chamber devices.
61. Skill to revise pacemaker pockets.
62. Skill to recognize and manage complications associated with implantation of various types of cardiac pacemakers.
63. Know how to interpret intracardiac electrogram tracings and other information downloaded from cardiovascular implantable electronic device (CIED), with respect to both arrhythmias and heart failure management.
64. Know the principles of cardiac implantable device-mediated pro-arrhythmia.
65. Know indications for remote monitoring.
66. Know how to monitor for and treat pacing-induced cardiomyopathy.
67. Skill to remotely monitor device patients and run a device clinic.
68. Know how to manage pacemaker advisories.
69. Know how to manage pacemaker patients undergoing surgery, MRI, and therapeutic radiation.
70. Know how to manage pacemaker deactivation in patients desiring this intervention.

c. Resynchronization Therapy

71. Know the various forms of bundle branch block and fascicular block and differentiate them from intraventricular conduction delay.
72. Know the indications for cardiac resynchronization therapy, based on QRS morphology and duration, symptoms, functional class, ejection fraction, and type of heart disease.
73. Know the principles of cardiac resynchronization therapy-mediated pro-arrhythmia.
74. Know the methods, techniques, associated tools, and equipment to insert left ventricular (LV) leads.
75. Skill to implant cardiac resynchronization therapy devices.
76. Skill to access the coronary sinus safely and effectively with varying anatomies.
77. Skill to identify and access lateral coronary sinus branches for LV pacing.
78. Skill to select the optimal site for LV pacing.
79. Skill to recognize and manage the complications associated with implantation of a cardiac resynchronization therapy device.
80. Skill to interrogate, program, optimize, and troubleshoot cardiac resynchronization devices.
81. Skill to assess response while following cardiac resynchronization therapy devices and to troubleshoot non-responders.
82. Skill to identify and trouble shoot phrenic nerve stimulation during implant and follow-up.

d. Lead Management

83. Know the methods for identifying and diagnosing lead malfunction or failure.
84. Know the methods for identifying and diagnosing CIED infection.
85. Skill to manage lead malfunction or failure.
86. Skill to manage CIED infection.
87. Skill to identify anatomic location of transvenous and epicardial leads based on fluoroscopic or x-ray imaging.
88. Know the indications and complications of transvenous lead extraction, including the risks/benefits/alternatives when managing lead failure, malfunction, or CIED infection.
89. Know the role of the multidisciplinary team in transvenous lead extraction.
90. Know the methods, techniques, associated tools, and equipment to perform transvenous lead extraction.
91. Skill to perform transvenous lead extraction, extraction of subcutaneous lead systems, leadless pacemakers and other transvenous devices.
92. Skill to manage compromised or occluded vascular access, including venoplasty, extraction, and tunneling.
93. Skill to snare leads.
94. Skill to recognize and manage complications associated with lead extraction.

Tachyarrhythmias

a. Supraventricular

i. Supraventricular tachycardia

95. Know the epidemiology of supraventricular arrhythmias.
96. Know the various clinical presentations of supraventricular tachycardias (SVT) including asymptomatic, palpations, syncope, tachycardia-induced cardiomyopathy, and sudden cardiac death.
97. Know the pathophysiological basis of atrioventricular nodal reentrant tachycardia, accessory pathway-mediated tachycardia (orthodromic and antidromic), atrial tachycardia (including multifocal atrial tachycardia), and junctional tachycardia.
98. Know the electrophysiology properties of atrioventricular, atriofascicular, fasciculoventricular, nodofascicular, and nodoventricular accessory pathways.
99. Know how to manage patients with atrioventricular, atriofascicular, fasciculoventricular, nodofascicular and nodoventricular accessory pathways, including when ablation is indicated.
100. Know how to differentiate the different forms of SVT using the ECG.
101. Know both the methods and limitations of invasive and non-invasive risk stratification for sudden cardiac death in patients with manifest ventricular pre-excitation.
102. Know how to localize accessory pathways and atrial tachycardia sites of origin using the ECG.
103. Know the indications for and selection of acute and long-term drug therapy for patients with SVT, including during pregnancy.
104. Know the indications and contraindications for SVT ablation, including during pregnancy.
105. Skill to apply diagnostic pacing maneuvers to distinguish between different forms of SVTs.
106. Skill to perform catheter ablation for treatment of patients with SVT.
107. Skill to use advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and electroanatomic activation and voltage/substrate maps.
108. Skill to recognize and manage complications associated with SVT ablation.

ii. Atrial fibrillation and flutter

109. Know the epidemiology of atrial fibrillation (AF) and flutter.
110. Know the various clinical presentations of atrial fibrillation and flutter, including tachycardia-mediated cardiomyopathy.
111. Know the pathophysiological basis and proposed mechanisms of AF and atrial flutter.
112. Know the methods to diagnose atrial fibrillation and flutter.
113. Know the role and limitations of screening populations for asymptomatic atrial fibrillation and flutter for stroke prevention.

114. Know the influences of modifiable risk factors such as obesity, sleep apnea, hypertension and cardiovascular fitness on AF and indications for referring patients for additional testing and treatment.
115. Know the definition of paroxysmal, persistent, long-standing persistent and permanent AF.
116. Know the indications, targets, pharmacological and nonpharmacologic options for rate control.
117. Know when to recommend ablation of the atrioventricular node for rate control.
118. Know the indications for electrical and pharmacological cardioversion of atrial fibrillation and flutter.
119. Know the stroke prevention strategies (anticoagulation/TEE) before and after cardioversion.
120. Skill to perform electrical and pharmacological cardioversion.
121. Skill to recognize and manage complications associated with cardioversion.
122. Know how to manage AF following surgery and other potentially reversible causes.

1. Antiarrhythmic medications

123. Know when to recommend antiarrhythmic medications for patients with atrial fibrillation and flutter and how to select the most appropriate drug considering the patient's age and comorbidities, including during pregnancy.
124. Know the mechanisms, classifications, pharmacokinetics, and pharmacodynamics of antiarrhythmic medications.
125. Know the adverse effects of antiarrhythmic medications, including drug–drug and drug–device interactions, as well potential for pro-arrhythmia.
126. Know safe procedures for starting antiarrhythmic drugs, including need for hospitalization, checking relevant baseline laboratory values, assessing for structural heart disease, and monitoring ECG intervals when appropriate.
127. Know safe procedures for following patients on antiarrhythmic drugs longitudinally, including monitoring for pro-arrhythmia, relevant laboratory values, pulmonary function, ECG intervals, and interval development of structural heart disease.

2. Anticoagulation

128. Know the methods to assess risk of embolic stroke and bleeding in patients with AF using validated risk scores (such as the CHA_2DS_2-VASc score).
129. Know when to prescribe short-term and long-term anticoagulation in the setting of atrial fibrillation and flutter, including during pregnancy.
130. Know the indications and contraindications of anticoagulants.
131. Know the clinical pharmacokinetics and pharmacodynamics of anticoagulants.
132. Know the adverse effects of anticoagulants, including drug–drug interactions, and methods to reverse anticoagulation in the setting of bleeding or emergent surgery.

133. Know how to manage anticoagulation in combination with the need for antiplatelet agents, such as following percutaneous coronary intervention.
134. Know the major differences between currently available oral anticoagulants.
135. Know how to manage perioperative anticoagulation, including bridging when appropriate.

3. Left atrial appendage management

136. Know the indications, contraindications, and complications associated with left atrial (LA) appendage occlusion and closure.
137. Know the methods, techniques, associated tools, and equipment including emerging technologies associated with LA appendage occlusion.
138. Skill to perform LA appendage occlusion and closure.
139. Skill to recognize and manage complications of LA appendage occlusion and closure.
140. Know how to follow, interpret imaging, and manage anticoagulants and/or antiplatelet agents following LA appendage occlusion and closure.
141. Know the benefits and risks of LA appendage exclusion in patients undergoing cardiac surgery.

4. Catheter ablation

142. Know the indications, contraindications, expected outcomes and complications associated with catheter ablation of atrial fibrillation and flutter, including during pregnancy.
143. Know the methods, techniques, associated tools, and equipment including emerging technologies to perform catheter ablation of atrial fibrillation and flutter.
144. Skill to perform catheter ablation of atrial fibrillation and flutter.
145. Know the special considerations for ablation of atrial fibrillation and flutter in adults with congenital heart conditions with or without prior cardiac surgery.
146. Know the stroke prevention strategies (anticoagulation/TEE) before, during and after catheter ablation for atrial fibrillation and flutter.
147. Skill to utilize cardiovascular magnetic resonance and cardiovascular computed tomography for procedure planning and to facilitate intracardiac mapping and catheter ablation of atrial arrhythmias.
148. Skill to use intracardiac echocardiography to facilitate catheter positioning, mapping and ablation, as well as to monitor for complications.
149. Skill to introduce sheaths and catheters into the left atrium via a patent foramen ovale or transseptal puncture.
150. Skill to use advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and electroanatomic activation and voltage/substrate mapping.
151. Skill to perform magnetic and robotic catheter manipulation.
152. Skill to perform pulmonary vein isolation and confirm entrance and exit block.
153. Skill to perform linear ablation when indicated and test for bidirectional block.
154. Skill to elicit, map, and ablate non-pulmonary vein triggers of AF.

155. Know the value of additional adjunctive ablation including posterior left atrium, complex fractionated atrial electrograms, rotational or focal activities, ganglionated plexi, left atrial appendage, superior vena cava and Ligament of Marshall.
156. Skill to recognize and manage complications associated with catheter ablation of atrial fibrillation and flutter.
157. Skill to perform pericardiocentesis when indicated.
158. Know the role of antiarrhythmic drugs following ablation.
159. Know the follow-up and management of recurrent atrial arrhythmia following ablation.

5. Surgical ablation

160. Know the indications for surgical ablation of atrial fibrillation and flutter, both as a standalone procedure, and in conjunction with other indicated cardiac surgery.
161. Know the indications, contraindications, expected outcomes, and complications associated with surgical ablation, including hybrid procedures for atrial fibrillation and flutter.
162. Know the different lesion sets used in surgical AF ablation.
163. Know how to recognize complications in patients who have undergone surgical treatment of atrial fibrillation or flutter.

6. Atrial flutter

164. Know the mechanism of atrial flutter and how to distinguish typical atrial flutter, atypical atrial flutter and atrial fibrillation using the surface ECG.
165. Skill to perform ablation in patients with typical and atypical atrial flutter.
166. Know the principles of mapping atrial flutter, including activation, entrainment, and high-density mapping.
167. Skill to identify abnormal atrial electrogram amplitude and morphology.
168. Skill to select ablation targets in relation to the mapped flutter circuits.

b. Ventricular

i. Ventricular tachycardia

169. Know the epidemiology of ventricular arrhythmias.
170. Know the pathophysiologic basis and mechanisms of ventricular arrhythmias, including premature ventricular complexes, non-sustained ventricular tachycardia, torsades de pointes, polymorphic ventricular tachycardia, monomorphic ventricular tachycardia and ventricular fibrillation.
171. Know how to distinguish ventricular tachycardia from other wide complex tachycardias using the history, physical exam, and the ECG.
172. Know the indications and techniques for electrical and pharmacological cardioversion and defibrillation.
173. Know the indications for advanced imaging, such as cardiovascular computed tomography, cardiovascular magnetic resonance, and positron emission tomography, in

the evaluation for underlying disease in patients with ventricular arrhythmias and aborted arrests.

174. Know how to identify the arrhythmogenic substrate using the ECG in sinus rhythm and ventricular tachycardia, as well as results of imaging studies.
175. Know how to identify and when/how to manage idiopathic ventricular arrhythmias, such as those originating from the right and left ventricular outflow tracts, papillary muscles and fascicles.
176. Know how to evaluate and manage ventricular arrhythmias in patients with conditions such as ischemic, inherited, infiltrative, infectious, inflammatory, and congenital cardiomyopathies, as well as other forms of structural diseases.
177. Know how to manage ventricular tachycardia storm.

1. Antiarrhythmic medications

178. Know when to recommend antiarrhythmic medications for patients with ventricular arrhythmias and how to select the most appropriate drug considering the patient's age and comorbidities, including during pregnancy.
179. Know the mechanisms, classifications, pharmacokinetics, and pharmacodynamics of antiarrhythmic medications.
180. Know the effects of antiarrhythmic medications on capture threshold, defibrillation threshold and ventricular tachycardia cycle length.
181. Know the adverse effects of antiarrhythmic medications, including drug–drug and drug–device interactions, as well potential for pro-arrhythmia.
182. Know safe procedures for starting antiarrhythmic drugs, including need for hospitalization, checking relevant baseline laboratory values, assessing for structural heart disease, and monitoring ECG intervals when appropriate.
183. Know safe procedures for following patients on antiarrhythmic drugs longitudinally, including monitoring for pro-arrhythmia, relevant laboratory values, pulmonary function, ECG intervals, and interval development of structural heart disease.

2. Catheter ablation

184. Know the indications, contraindications, and complications associated with catheter ablation of ventricular arrhythmias, including endocardial and epicardial ablation, including during pregnancy.
185. Know the methods, techniques, associated tools, and equipment including emerging technologies such as stereotactic body radiation therapy associated for ablation of ventricular arrhythmias, including epicardial ablation.
186. Skill to perform catheter ablation of ventricular arrhythmias, including epicardial ablation.
187. Skill to manage existing CIEDs during ventricular arrhythmia ablations.
188. Know the indications, contraindications, and potential complications of the various forms of hemodynamic support for ventricular arrhythmia ablations.

189. Skill to insert and remove percutaneous hemodynamic support devices for ventricular arrhythmia ablations.
190. Skill to perform and interpret results of ventricular programmed stimulation.
191. Skill to access the left ventricle from a retrograde aortic approach as well as a transseptal approach.
192. Skill to perform magnetic and robotic catheter manipulation.
193. Skill to map the coronary venous system when indicated.
194. Skill to determine the mechanism of ventricular tachycardia using pacing maneuvers.
195. Skill to map ventricular arrhythmias, including activation, entrainment, and pace mapping.
196. Skill to use advanced 3-dimensional mapping systems, including anatomical chamber reconstruction, image integration, and electroanatomic activation and voltage/substrate mapping.
197. Skill to identify abnormal ventricular electrogram amplitude and morphology.
198. Skill to utilize cardiovascular magnetic resonance and cardiovascular computed tomography for procedure planning and to facilitate intracardiac mapping and catheter ablation of ventricular arrhythmias.
199. Skill to use intracardiac echocardiography to facilitate catheter positioning, mapping and ablation, as well as to monitor for complications.
200. Skill to select ablation targets in relation to the arrhythmogenic substrate and results of mapping and pacing maneuvers.
201. Know how to identify appropriate candidates for and assess risk/benefit of epicardial approach to ventricular tachycardia ablation.
202. Skill to place sheaths in the epicardial space.
203. Know when surgical epicardial access is indicated.
204. Skill to perform epicardial ventricular tachycardia ablation and understand the unique complications to be vigilant for, including injury to abdominal organs, coronary arteries, and the phrenic nerve.
205. Skill to assess ablation endpoints, including inducibility, elimination of abnormal potentials, electrical inexcitability, and other substrate-based endpoints.
206. Skill to recognize and manage complications associated with catheter ablation of ventricular arrhythmias.

3. Surgical ablation

207. Know the indications for surgical ventricular tachycardia ablation, both as a stand-alone procedure as well as in conjunction with other indicated cardiac surgery.
208. Know how to define ablation targets using results of imaging studies, ECG of ventricular tachycardia and intracardiac mapping prior to surgery to guide surgical ablation.
209. Skill to map ventricular arrhythmias intraoperatively.
210. Skill to test the results of surgical ventricular tachycardia ablation, including by ventricular programmed stimulation, intraoperatively and post-operatively.

ii. Ventricular fibrillation and sudden cardiac arrest/death

211. Know the epidemiology of sudden cardiac arrest/death.
212. Know the appropriate diagnostic testing for survivors of sudden cardiac arrest including monitoring, imaging, genetic, and invasive electrophysiologic testing and postmortem evaluation of non-survivors.
213. Know treatment strategies for protecting from and preventing recurrent ventricular fibrillation depending on the underlying etiology.
214. Know the role of PVC-induced ventricular fibrillation, and the role of PVC suppression with medication or catheter ablation to reduce episode frequency.
215. Know how to screen the family of a patient with sudden cardiac arrest/ death.

iii. Premature ventricular complexes

216. Know the range of clinical presentations for premature ventricular complexes (PVCs), including asymptomatic, symptomatic, cardiomyopathy, and rarely ventricular fibrillation.
217. Know how to localize PVC site of origin using the ECG.
218. Know when and how to evaluate patients with PVCs for underlying heart disease.
219. Know warning signs when PVCs may not be idiopathic in origin, including multiple or unusual sites of origin and concerning symptoms such as syncope.
220. Know when treatment of PVCs is indicated.
221. Know medical treatment options for PVCs, including beta blockers, calcium channel blockers, antiarrhythmic drugs, and lifestyle modifications.
222. Know indications and contraindications for PVC ablation, including during pregnancy.
223. Skill to perform PVC ablation.

iv. Implantable cardioverter-defibrillators

224. Know how to determine sudden cardiac death risk in patients with heart disease or risk factors.
225. Know the indications and contraindications for implantation of an ICD for primary prevention of sudden cardiac death in patients with ischemic and nonischemic cardiomyopathy as well as other arrhythmogenic conditions (including channelopathies and other cardiomyopathies) and for secondary prevention of sudden cardiac death.
226. Know the indications for, limitations, complications and follow up of wearable defibrillators.
227. Know how to select the appropriate ICD type and leads for a patient for transvenous, epicardial and subcutaneous technologies, including special populations such as the young, and those with congenital heart conditions, hemodialysis, and limited vascular access.
228. Know the methods, techniques, associated tools, and equipment to implant ICDs.
229. Skill to perform transvenous and subcutaneous ICD implantation.
230. Know the indications and contraindications for defibrillation threshold testing and noninvasive programmed stimulation.

231. Skill to perform defibrillation threshold testing and noninvasive programmed stimulation.
232. Know how to decrease high defibrillation thresholds.
233. Skill to recognize and manage complications associated with ICD implant.
234. Skill to interrogate, program, and troubleshoot ICDs, including the appropriate use of anti-tachycardia pacing to minimize inappropriate, unnecessary, and recurrent shocks.
235. Know how to interpret intracardiac electrogram tracings and other information downloaded from CIED, with respect to both arrhythmias and heart failure management.
236. Know indications for remote monitoring.
237. Skill to remotely monitor device patients and run a device clinic.
238. Know how to manage device advisories.
239. Know how to manage ICD patients undergoing surgery, MRI, and therapeutic radiation.
240. Know how to manage ICD deactivation in patients desiring this intervention.

Other Arrhythmia Syndromes

a. Inherited Arrhythmia Syndromes and Genetic Testing

241. Know the epidemiology of inherited arrhythmia syndromes.
242. Know the genetic basis of arrhythmias, including genetically based ion channel abnormalities, J-wave syndromes, and inherited cardiomyopathies.
243. Know how to recognize inherited arrhythmia syndromes and arrhythmogenic cardiomyopathies.
244. Know the principles of autosomal dominant/recessive inheritance, incomplete penetrance and variable expressivity.
245. Know the indications and methods to diagnose inherited arrhythmia syndromes and arrhythmogenic cardiomyopathies, including the roles and limitations of genetic testing and the importance and limitations of family screening.
246. Know how to interpret the results of genetic testing, the limitations of this test and the meaning of variants of uncertain significance.
247. Know the epidemiology of inherited arrhythmia syndromes, including emerging diagnoses.
248. Know the inheritance pattern of these conditions.
249. Know the pathophysiological and genetic basis of arrhythmias that occur in patients with an inherited arrhythmia syndrome.
250. Know the relationship to ion channel function and the changes in the action potential.
251. Know the channels involved in the 3 most common types of Long QT Syndrome (LQT1, LQT2, LQT3), as well as the phenotype and arrhythmia risks.
252. Know the basics of Timothy Syndrome (LQT8) and Andersen Tawil Syndrome and the cardiac and noncardiac phenotypic manifestations of these and other syndromic arrhythmia conditions, including arrhythmia risks.
253. Know the basics of calmodulin mutations (calmodulinopathies), CALM 1, 2 and 3, and their phenotype and arrhythmia risks.
254. Know the most common ion channel mutations associated with Brugada Syndrome and the phenotype and arrhythmia risks.
255. Know the ion channel mutations associated with Short QT Syndrome, their phenotype and arrhythmia risks.
256. Know the mutations most commonly associated with Catecholaminergic Polymorphic Ventricular Tachycardia (CPVT) and the phenotype and arrhythmia risks.
257. Know the indications and limitations of provocative drug testing and exercise testing in the diagnosis, management and risk assessment of genetic arrhythmia syndromes.
258. Know the methods to manage patients with inherited arrhythmia syndromes, including pharmacotherapy, ablation, cardiac sympathetic denervation, lifestyle modifications and device therapy.
259. Know the risks/side effects of each of these treatment strategies.

260. Know the methods of family cascade screening specific to each diagnosis, including ECG, imaging, exercise testing, and genetic testing, as well as the limitations of each.
261. Know the management of asymptomatic family members identified through cascade screening.
262. Know how to perform risk assessment for sudden cardiac death in these conditions.
263. Know how to discuss lifestyle modifications and sports participation in patients with inherited arrhythmia syndromes, using Shared Decision Making.
264. Skill to tailor device choice and programing to the individual patient with an inherited arrhythmia syndrome.
265. Know how to evaluate and manage patients with these conditions who manifest ventricular arrhythmias including PVCs, sustained and non-sustained ventricular tachycardia, torsades de pointes, and ventricular fibrillation.
266. Know how to evaluate and manage atrial arrhythmias in patients with inherited arrhythmia syndromes.
267. Know how to evaluate and manage bradyarrhythmias in patients with inherited arrhythmia syndromes.

b. Arrhythmogenic Cardiomyopathies

268. Know the epidemiology of arrhythmic cardiomyopathies, including emerging diagnoses.
269. Know the broad spectrum of genetic, systemic, infectious, and inflammatory disorders that make up the arrhythmogenic cardiomyopathies, including hypertrophic cardiomyopathy, arrhythmogenic right/left ventricular cardiomyopathy, cardiac amyloidosis, sarcoidosis, Chagas Disease, left ventricular noncompaction and muscular dystrophies.
270. Know how to diagnose arrhythmogenic cardiomyopathies, including the role of imaging, laboratory testing and genetic testing.
271. Know the principles of autosomal dominant/recessive inheritance, incomplete penetrance and variable expressivity.
272. Know how changes in myocardial structure and electrophysiology can cause disease in arrhythmogenic cardiomyopathy.
273. Know the diagnostic criteria for arrhythmogenic cardiomyopathies, such as the Task Force criteria for diagnosing arrhythmogenic right/left ventricular cardiomyopathy.
274. Know the factors that contribute to disease progression in arrhythmogenic cardiomyopathy.
275. Know Lamin A/C, PRKAG2, Desmin and other high-risk mutations, as well as the structural and electrophysiological manifestations of these diseases.
276. Know how to perform risk assessment for sudden cardiac death in these conditions.
277. Know the methods to manage patients with arrhythmogenic cardiomyopathies, including the pharmacotherapy, ablation, lifestyle modifications and device therapy.
278. Know how to discuss lifestyle modifications and sports participation in patients with inherited arrhythmia syndromes, using Shared Decision Making.

279. Know how to evaluate and manage patients with these conditions who manifest ventricular arrhythmias including PVCs, sustained and non-sustained ventricular tachycardia, torsades de pointes, and ventricular fibrillation.
280. Know how to evaluate and manage atrial arrhythmias in patients with inherited arrhythmia syndromes.
281. Know how to evaluate and manage bradyarrhythmias in patients with inherited arrhythmia syndromes.

c. Syncope and Autonomic Dysfunction

282. Know the epidemiology and differential diagnosis of syncope, including structural abnormalities, arrhythmias, and autonomic conditions, as well as mimickers of syncope including neurologic and psychiatric conditions.
283. Know how to determine the cause of syncope in pediatric and adult populations, including the role and limitations of the clinical history, physical exam, ECG, noninvasive arrhythmia monitoring, insertable cardiac monitors, cardiac imaging, invasive electrophysiology testing, and autonomic and tilt-table testing.
284. Know the situational triggers, prodromal symptoms and the natural history of vasovagal syncope, in pediatric and adult populations.
285. Know how to treat vasovagal syncope, including lifestyle modifications, maneuvers, medications and pacing (for profound cardioinhibitory responses).
286. Skill to program pacemakers when used for vagal syncope.
287. Know the symptoms, pathophysiology and diagnostic criteria (including autonomic testing) in postural tachycardia syndrome (POTS) and inappropriate sinus tachycardia (IST), in pediatric and adult populations.
288. Know how to distinguish POTS and IST from primary atrial tachyarrhythmias.
289. Know the role of deconditioning in the etiology of these conditions.
290. Know the nonpharmacologic treatment for vasovagal syncope, POTS and IST, including fluid, salt, exercise and compression stockings.
291. Know the pharmacologic therapies for POTS and IST.
292. Know the role of multidisciplinary teams including neurology, gastroenterology, physical therapy and others in treatment of autonomic dysfunction.