Cigna Medical Coverage Policies - Pacemaker Guidelines for Cardiac Implantable Device (CID)

Effective July 1, 2023

Instructions for use

The following coverage policy applies to health benefit plans administered by Cigna. Coverage policies are intended to provide guidance in interpreting certain standard Cigna benefit plans and are used by medical directors and other health care professionals in making medical necessity and other coverage determinations. Please note the terms of a customer's particular benefit plan document may differ significantly from the standard benefit plans upon which these coverage policies are based. For example, a customer's benefit plan document may contain a specific exclusion related to a topic addressed in a coverage policy.

In the event of a conflict, a customer's benefit plan document always supersedes the information in the coverage policy. In the absence of federal or state coverage mandates, benefits are ultimately determined by the terms of the applicable benefit plan document. Coverage determinations in each specific instance require consideration of:

1. The terms of the applicable benefit plan document in effect on the date of service
2. Any applicable laws and regulations
3. Any relevant collateral source materials including coverage policies
4. The specific facts of the particular situation

Coverage policies relate exclusively to the administration of health benefit plans. Coverage policies are not recommendations for treatment and should never be used as treatment guidelines.

This evidence-based medical coverage policy has been developed by eviCore, Inc. Some information in this coverage policy may not apply to all benefit plans administered by Cigna.

These guidelines include procedures eviCore does not review for Cigna. Please refer to the Cigna CPT code list for the current list of high-tech imaging procedures that eviCore reviews for Cigna.

Table of Contents

Guideline Page

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

General Information

Abbreviations

CID
v2.0.2023

- **ACE inhibitor** — Angiotensin-converting enzyme inhibitor
- **AMI** — Acute myocardial infarction
- **ARVC** — Arrhythmogenic right ventricular cardiomyopathy
- **AV** — Atrioventricular
- **CC** — Complications/comorbid conditions
- **CHF** — Congestive heart failure
- **CM** — Cardiomyopathy
- **CRT** — Cardiac resynchronization therapy
- **EP** — Electrophysiology
- **GDMT** — Guideline-directed medical therapy
- **HCM** — Hypertrophic cardiomyopathy
- **ICD** — Implantable cardioverter defibrillator
- **LBBB** — Left bundle branch block
- **LV** — Left ventricle
- **LVEF** — Left ventricular ejection fraction
- **MCC** — Major complications/comorbid conditions
- **MI** — Myocardial infarction
- **NCCM** — Non-compaction cardiomyopathy
- **NYHA** — New York Heart Association functional classification
- **RBBB** — Right bundle branch block
- **RV** — Right ventricle
- **TAVR** — Transcatheter aortic valve replacement
- **VF** — Ventricular fibrillation
- **VT** — Ventricular tachycardia

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

Glossary

CID
v2.0.2023

- **NYHA Heart Failure Definitions** — **class I** - No symptoms and no limitation in ordinary physical activity, e.g. shortness of breath when walking, climbing stairs etc.

  class II - Mild symptoms (mild shortness of breath and/or angina) and slight limitation during ordinary activity.

  class III - Marked limitation in activity due to symptoms, even during less-than-ordinary activity, e.g. walking short distances (20–100 m). Comfortable only at rest.

  class IV - Severe limitations. Experiences symptoms even while at rest. Mostly bedbound patients
- **Abnormal blood pressure response to exercise** — Flat response/failure to augment; rise then fall during exercise; vasoactive cardiovascular drugs may result in an abnormal blood pressure response to exercise
- **Ambulatory class IV CHF** — Class IV heart failure with: 1) no active acute coronary syndrome; 2) no inotropes; and 3) on GDMT
- **Incessant VT:** — Frequent recurrences of ongoing hemodynamically stable VT
- **Hypertrophic cardiomyopathy** — Hypertrophic Cardiomyopathy (HCM) is a clinical diagnosis, established by imaging with 2D echocardiography or cardiovascular magnetic resonance (CMR) showing a maximal end-diastolic wall thickness of ≥15 mm anywhere in the left ventricle, in the absence of another cause of hypertrophy in adults. More limited hypertrophy (13–14 mm) can be diagnostic, particularly when present in family members of a patient with HCM or in conjunction with a positive genetic test, and/or associated with typical dynamic outflow obstruction, or distinctly abnormal ECG patterns.
- **Long QT Syndrome (LQTS):** — A congenital disorder characterized by a prolongation of the QT interval on ECG and a propensity to ventricular tachyarrhythmias, which may lead to syncope, cardiac arrest, or sudden death.

  The QT interval on the ECG, measured from the beginning of the QRS complex to the end of the T wave, represents the duration of activation and recovery of the ventricular myocardium. QT intervals corrected for heart rate (QTc) longer than 0.44 seconds are generally considered abnormal, though a normal QTc can be more prolonged in females (up to 0.46 sec).The Bazett formula is the formula most commonly used to calculate the QTc, as follows: QTc = AT/square root of the R-R interval (in seconds).
- **Non-Compaction Cardiomyopathy:** — A rare congenital cardiomyopathy that affects children and adults. It results from the failure of myocardial development during embryogenesis. It is also called spongiform cardiomyopathy. Symptoms are often a result of a poor pumping performance by the heart. The disease can be associated with other problems with the heart and the body.

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

- **Non-Sustained Ventricular Tachycardia (NSVT):** — Three or more consecutive ventricular beats at a rate of greater than 120 beats/min with a duration of less than 30 seconds
- **Optimal Medical Therapy:** — Three months of heart failure medications in maximally titrated doses as tolerated. These include beta blockers, ACE inhibitors or angiotensin II receptor blockers, and diuretics.
- **Structural Heart Disease:** — A structural or functional abnormality of the heart, or of the blood vessels supplying the heart, that impairs its normal functioning.

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

Preface to the Cardiac Implantable Device (CID) guideline

CID.AD.100.A
v2.0.2023

Guideline development (Preface-1)

- The eviCore evidence-based, proprietary clinical guidelines evaluate a range of advanced imaging and procedures, including CT, MRI, PET, and Radiation Oncology, Sleep Studies, and Cardiac and Spine interventions.
- eviCore healthcare reserves the right to change and update the guidelines. The guidelines undergo a formal review annually. eviCore's guidelines are based upon major national and international association and society guidelines and criteria, peer-reviewed literature, major treatises, and input from health plans, practicing academic and community-based physicians.
- These guidelines are not intended to supersede or replace sound medical judgment, but instead should facilitate the identification of the most appropriate imaging procedure, given the patient's clinical condition. These guidelines are written to cover medical conditions as experienced by the majority of patients. However, these guidelines may not be applicable in certain clinical circumstances, and physician judgment can override the guidelines.
- Clinical decisions, including treatment decisions, are the responsibility of the patient and his/her provider. Clinicians are expected to use independent medical judgment which takes into account the clinical circumstances to determine patient management decisions.
- eviCore supports the Choosing Wisely® initiative (www.choosingwisely.org) by the American Board of Internal Medicine (ABIM) Foundation and many national physician organizations, to reduce the overuse of diagnostic tests that are low value, no value, or whose risks are greater than the benefits.
- eviCore's guidelines are based upon expert consensus and analysis reported by the following specialty societies, publications, studies and trials:
  - The American College of Cardiology (ACC)
  - The American Heart Association (AHA)
  - The Heart Rhythm Society (HRS)

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

- The Multicenter Automatic Defibrillator Implantation Trial (MADIT/MADIT-2)
- The Multicenter Unsustained Tachycardia Trial (MUSTT)
- The Defibrillator in Acute Myocardial Infarction Trial (DINAMIT)
- The Resynchronization/defibrillation for Ambulatory Heart Failure Trial (RAFT)
- The Sudden Cardiac Death in Heart Failure Trial (SCD-HeFT)
- The Resynchronization Reverses Remodeling in Systolic Left Ventricular Dysfunction trial (REVERSE)
- Immediate Risk Stratification Improves Survival trial (IRIS)
- The Comparison of Medical Therapy, Pacing, and Defibrillation in Heart Failure trial (COMPANION)
- The Antiarrhythmic Versus Implantable Defibrillators trial (AVID)
- The Canadian Implantable Defibrillator Study (CIDS)
- The Cardiac Arrest Study Hamburg (CASH)

Benefits, coverage policies, and eligibility issues (Preface-2)

- Benefits, coverage policies, and eligibility issues pertaining to each Health Plan may take precedence over eviCore's guidelines. Providers are urged to obtain written instructions and requirements directly from each payer.
- Medicare Coverage Policies
  - For Medicare and Medicare Advantage enrollees, the coverage policies of CMS (Centers for Medicare and Medicaid Services) may take precedence over eviCore's guidelines
  - Payors may choose to adopt other evidence-based guidelines (such as eviCore's guidelines) rather than using Local Coverage Determinations and other Medicare coverage policy
- Investigational and Experimental Studies
  - Certain imaging studies described in these guidelines are considered investigational by various payors, and their coverage policies may take precedence over eviCore's guidelines
- Clinical and Research Trials
  - Similar to investigational and experimental studies, clinical trial imaging requests will be considered to determine whether they meet health plan coverage and eviCore's evidence-based guidelines
- State and federal legislations may need to be considered in the review of advanced imaging requests

Clinical information (Preface-3)

- The philosophy behind eviCore guidelines entails using an evidence-based approach to determine the most appropriate procedure for each individual, at the most appropriate time in the diagnostic and treatment cycle.
- Procedures should be requested after initial consultation and physician treatment planning, and following full counseling of the individual.

- Current clinical information, which may include history, physical examination, symptoms, laboratory results, and imaging reports, are necessary for determining the medical necessity of implantable cardiac devices.
- The information provided to eviCore should have clinical relevance to the request.
- If the information provided makes no reference to the potential indication for the request, then the medical necessity for the procedure(s) cannot be supported.

References (Preface-4)

- References are available at the end of the guidelines

Copyright information (Preface-5)

Trademarks (Preface-6)

General information (CRID-1)

CID.AD.101.C
v2.0.2023

Procedure codes (CRID-1.1)

Procedure description	CPT®
Insertion of new or replacement of permanent pacemaker with transvenous electrode(s); atrial	33206
Insertion of new or replacement of permanent pacemaker with transvenous electrode(s); ventricular	33207
Insertion of new or replacement of permanent pacemaker with transvenous electrode(s); atrial and ventricular	33208
Transcatheter insertion or replacement of permanent leadless pacemaker, right ventricular, including imaging guidance (e.g., fluoroscopy, venous ultrasound, ventriculography, femoral venography) and device evaluation (e.g., interrogation or programming), when performed	33274
Transcatheter insertion of permanent dual-chamber leadless pacemaker, including imaging guidance (eg, fluoroscopy, venous ultrasound, right atrial angiography, right ventriculography, femoral venography) and device evaluation (eg, interrogation or programming), when performed; complete system (ie, right atrial and right ventricular pacemaker components)	0795T
Transcatheter insertion of right atrial pacemaker component (when an existing right ventricular single leadless pacemaker exists to create a dual-chamber leadless pacemaker system)	0796T
Transcatheter insertion of right ventricular pacemaker component (when part of a dual-chamber leadless pacemaker system)	0797T
Transcatheter removal and replacement of permanent dual-chamber leadless pacemaker, including imaging guidance (eg, fluoroscopy, venous ultrasound, right atrial angiography, right ventriculography, femoral venography) and device evaluation (eg, interrogation or programming), when performed; dual-chamber system (ie, right atrial and right ventricular pacemaker components)	0801T
Transcatheter removal and replacement of right atrial pacemaker component	0802T

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924

Procedure description	CPT®
Transcatheter removal and replacement of right ventricular pacemaker component (when part of a dual-chamber leadless pacemaker system)	0803T

Removal and replacement (CRID-1.2)

- Generator replacement (CPT® 33227, 33228) with a same or similar device is indicated when:
  - Interrogation shows device is nearing Elective Replacement Indicator (ERI) or End of Life (EOL).
  - Interrogation report documents the device is not functioning correctly and requires replacement.

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

Pacemaker Devices

Definite indications for permanent pacemaker implantation (CRID-7)

CID.PM.101.A
v2.0.2023

Guideline Page

Symptomatic bradycardia (CRID-7.1)

Permanent pacemaker implantation is indicated for symptomatic bradycardia for any of the following

- Frequent sinus pauses that produce symptoms
- Any degree of AV block producing symptoms
- Third-degree and advanced second-degree AV block at any anatomic level associated with ventricular arrhythmias presumed due to AV block.
- Any other medical conditions requiring drug therapy that results in symptomatic bradycardia (for example, beta blocker therapy in patients with prior myocardial infarction, or tachy-brady syndrome in atrial fibrillation)

Symptomatic chronotropic incompetence (CRID-7.2)

- Permanent pacemaker implantation is indicated for symptomatic chronotropic incompetence defined as limitations due to the inability to achieve 80% of maximum predicted heart rate (220-age)

Indications for asymptomatic individuals (CRID-7.3)

Permanent pacemaker implantation is indicated in asymptomatic individuals for **any** of the following:

- Third degree AV block
- Advanced second degree AV block (Mobitz type II) with intermittent third degree AV block
- Second degree AV block with documented periods of asystole ≥3.0 seconds
- Second degree AV block in awake, symptom-free individuals with atrial fibrillation with a documented pause of ≥5 seconds
- Alternating bundle branch block

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

- Second degree AV block at any anatomic level associated with neuromuscular diseases known to involve the heart
- Post Transcatheter Aortic Valve Replacement (TAVR) when there is documentation of **both**:
  - Pre-existing right bundle branch block (RBBB)
  - New conduction abnormality onset during or after (TAVR) such as:
    - Transient high-degree AV block
    - PR prolongation
    - QRS axis change

Background and supporting information

Prophylactic permanent pacemaker implantation is not indicated before TAVR in individuals with RBBB and no indication for permanent pacing. See Permanent Pacemaker **Implantation Non-indications (CRID-9.1)**.

Prior to planned catheter ablation (CRID-7.4)

- Permanent pacemaker implantation is indicated prior to a planned catheter ablation of the AV junction intended for a rate control strategy for management of atrial fibrillation.

Persistent second degree AV block (CRID-7.5)

- Permanent pacemaker implantation is indicated for persistent second degree AV block in the His-Purkinje system with alternating bundle branch block or third degree AV block within or below the His-Purkinje system after myocardial infarction.

Syncope (CRID-7.6)

- Permanent pacemaker implantation is indicated for syncope caused by spontaneously occurring carotid sinus stimulation and carotid sinus pressure that induces ventricular asystole of ≥3 seconds

Reasonable indications for permanent pacemaker implantation (CRID-8)

CID.PM.102.A
v2.0.2023

Guideline Page

General considerations (CRID-8.1)

For the reasonable or considered indications listed in this CRID-8 guideline, consensus opinion is less clear about permanent pacing in these settings, with evidence suggesting that device placement may be reasonable or may be considered

Sinus node dysfunction (CRID-8.2)

- Permanent pacemaker implantation is reasonable for individuals with sinus node dysfunction with a resting heart rate of less than 40 bpm when periodic symptomatic bradycardia is suspected

Syncope (CRID-8.3)

- Permanent pacemaker implantation may be reasonable or may be considered for individuals with syncope in the following settings
  - Syncope of unexplained origin when clinically significant abnormalities of sinus node function are discovered or provoked in electrophysiological studies
  - Syncope without clear, provocative events and with a hypersensitive cardioinhibitory response of 3 seconds or longer
  - Significantly symptomatic neurocardiogenic syncope associated with Bradycardia documented spontaneously or at the time of tilt table testing
  - Syncope after cardiac transplantation even when bradyarrhythmia has not been documented

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

Asymptomatic second degree AV block (CRID-8.4)

- Permanent pacemaker implantation is reasonable for individuals with asymptomatic second degree AV block at intra- or infra- His levels found at electrophysiological study.

First or second degree AV block (CRID-8.5)

- Permanent pacemaker implantation is reasonable for individuals with first or second degree AV block with symptoms similar to those of pacemaker syndrome.

Symptomatic recurrent SVT (CRID-8.6)

- Permanent pacemaker implantation is reasonable for individuals with symptomatic, recurrent SVT that is reproducibly terminated by pacing when catheter ablation and/or drugs fail to control the arrhythmia or produce intolerable side effects.

Relative bradycardia - Post-operative cardiac transplant (CRID-8.7)

- Permanent pacemaker implantation may be considered for individuals when relative bradycardia is prolonged or recurrent, which limits rehabilitation or discharge after postoperative recovery from cardiac transplantation or in post-transplant syncope even if bradyarrhythmia has not been documented.

Incidental finding at electrophysiology (EP) study (CRID-8.8)

- Permanent pacemaker implantation may be reasonable for an incidental finding at electrophysiology study of a markedly prolonged HV interval (greater than or equal to 100 milliseconds) or non-physiological intra- or infra- Hisian block in asymptomatic patients.

Neuromuscular diseases known to involve the heart (CRID-8.9)

- Permanent pacemaker implantation may be considered for progressive neuromuscular diseases known to involve the heart with any degree of AV block (including first degree AV block) or any fascicular block, with or without symptoms, because there may be unpredictable progression of AV conduction disease. Progressive neuromuscular diseases known to involve the heart include:
  - Myotonic muscular dystrophy
  - Kearns-Sayre syndrome
  - Erb dystrophy (limb-girdle muscular dystrophy)
  - Peroneal muscular atrophy

Permanent pacemaker implantation - Non-indications (CRID-9)

CID.PM.103.A
v2.0.2023

Permanent pacemaker implantation non-indications (CRID-9.1)

- Permanent pacemaker implantation is **not** indicated in any of the following settings:
  - Sinus node dysfunction in asymptomatic patients
  - Sinus node dysfunction in patients for whom the symptoms, suggestive of bradycardia, have been clearly documented to occur in the absence of bradycardia
  - Sinus node dysfunction in symptomatic patients due to nonessential drug therapy
  - Fascicular block without AV block or symptoms concerning for AV block
  - Incidentally noted hypersensitive cardioinhibitory response to carotid sinus stimulation without symptoms or with vague symptoms
  - Asymptomatic first degree AV block
  - Asymptomatic type I second degree AV block at the supra-His (AV node) level or that which is not known to be intra- or infra-Hisian
  - Permanent ventricular pacing not indicated for asymptomatic transient AV block in the absence of intraventricular conduction defects or in isolated single fascicular block
  - Permanent pacing not indicated for situational vasovagal syncope in which avoidance behavior is effective
  - Prophylactic permanent pacemaker implantation is not indicated before Transcatheter Aortic Valve Replacement (TAVR) in individuals with right bundle branch block (RBBB) and no indication for permanent pacing

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

Leadless pacemaker (CRID-11.1)

CID.PM.104.C
v2.0.2023

CPT® codes addressed

CPT® 33274, CPT® 0795T, CPT® 0796T, CPT® 0797T, CPT® 0801T, CPT® 0802T, CPT® 0803T

See Cigna Coverage Policy **0174 Cardiac Resynchronization Therapy (CRT) and Advanced Cardiac Pacing Technologies**

References

References

CID
v2.0.2023

1. Josephson ME and Nisam S. The AVID trial executive committee. Are implantable cardioverter-defibrillators or drugs more effective in prolonging life? *AmJ Cardiol*. 1997 Mar;79(5):661-663. doi:10.1016/S0002-9149(96)00834-X.
2. Kuck K-H, Cappato R, Siebels J, et al. Randomized Comparison of Antiarrhythmic Drug Therapy With Implantable Defibrillators in Patients Resuscitated From Cardiac Arrest. *Circulation*. 2000;102(7):748-754. doi:10.1161/01.cir.102.7.748.
3. Connolly SJ, Gent M, Roberts RS, et al. Canadian Implantable Defibrillator Study (CIDS). A randomized trial of the implantable cardioverter defibrillator against amiodarone. *Circulation*. 2000 Mar;101(11):1297-1302. doi:10.1161/01.cir.101.11.1297.
4. Gronefeld G, Connoly SJ, and Hohnloser SH. The Defibrillator in Acute Myocardial Infarction Trial (DINAMIT) rationale, design and specific aims. *Card Electrophysiol Rev*. 2003 Dec;7(4):447-451. doi:10.1023/B:CEPR.0000023154.52786.f4.
5. Steinbeck G, Andresen D, Seidl K, et al. Defibrillator implantation early after myocardial infarction.(IRIS). *N Engl J Med*. 2009 Oct;361:1427-1436. doi:10.1056/NEJMoa0901889.
6. Moss A, Hall W, Cannom D, et al. Cardiac-resynchronization therapy for the prevention of heart-failure events (MADIT2). *N Engl J Med*. 2009 Oct; 361:1329-1338. doi:10.1056/NEJMoa0906431.
7. Bardy G, Lee K, Mark D, et al. Amiodarone or an implantable cardioverter-defibrillator for congestive heart failure.(SCD-HeFT). *N Engl J Med*. 2005 Jan;352:225-37. doi:10.1056/NEJMoa043399.
8. Buxton AE, Lee KL, DiCarlo L, et al. Electrophysiologic testing to identify patients with coronary artery disease who are at risk for sudden death. Multicenter Unsustained Tachycardia Trial Investigators. (MUSTT). *N Engl J Med*. 2000 Jun;342:1937-1945. doi:10.1056/NEJM200006293422602.
9. Epstein A, Dimarco J, Ellenbogen K, et al. ACC/AHA/HRS 2008 Guidelines for device-based therapy of cardiac rhythm abnormalities: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to revise the ACC/AHA/NASPE 2002 Guideline update for implantation of cardiac pacemakers and anti-arrhythmia devices): Developed in Collaboration With the American Association for Thoracic Surgery and Society of Thoracic Surgeons. *Circulation*. 2008 May;117(21). doi:10.1161/CIRCUALTIONAHA.108.189742.
10. Russo AM, Stainback RF, Bailey SR, et al. ACCF/HRS/AHA/ASE/HFSA/SCAI/SCCT/SCMR 2013 appropriate use criteria for implantable cardioverter-defibrillators and cardiac resynchronization therapy: a report of the American College of Cardiology Foundation appropriate use criteria task force, Heart Rhythm Society, American Heart Association, American Society of Echocardiography, Heart Failure Society of America, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance. *J Am Coll Cardiol*. 2013 Apr; 10(4):e11-e58. doi:10.1016/j.jacc.2012.12.017.
11. Gersh BJ, Maron BJ, Bonow RO, et al. 2011 ACCF/AHA Guideline for the Diagnosis and Treatment of Hypertrophic Cardiomyopathy. *Circulation*. 2011;124(24). doi:10.1161/cir.0b013e318223e2bd.
12. Caliskan K, Szili-Torok T, Theuns D, et al. Indications and outcome of implantable cardioverter-defibrillators for primary and secondary prophylaxis in patients with noncompaction cardiomyopathy. *J Cardiovasc Electrophysiol*. 2011 Aug;22(8):898–904. doi:10.1111/j.1540-8167.2011.02015.x.
13. Zareba W, Klein H, Cygankiewicz I, et al. Effectiveness of cardiac resynchronization therapy by QRS morphology in Multicenter Automatic Defibrillator Implantation Trial – Cardiac Resynchronization Therapy (MADIT-CRT). *Circulation*. 2011 Mar;123(10):1061-1072. doi:10.1161/CIRCULATIONAHA.110.960898.
14. Tang AS, Wells GA, Talajic M, et al. Cardiac-Resynchronization Therapy for Mild-to-Moderate Heart Failure. *N Engl J Med*. 2010;363(25):2385-2395. doi:10.1056/nejmoa1009540.
15. Linde C, Gold MR, Abraham WT, et al. Rationale and design of a randomized controlled trial to assess the safety and efficacy of cardiac resynchronization therapy in patients with asymptomatic left ventricular dysfunction with previous symptoms or mild heart failure—the Resynchronization reVErses Remodeling in Systolic left ventricular dysfunction (REVERSE) study. *Am Heart J*. 2006 Feb;151(2):288-294. doi:10.1016/j.ahj.2005.03.002.
16. Tracy C, Epstein A, Darbar D, et al. 2012 ACCF/AHA/HRS focused update of the 2008 guidelines for device-based therapy of cardiac rhythm abnormalities: A report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Thorac Cardiovasc Surg*. 2012 Dec; 144(6): e127–e145. doi:10.1016/j.jtcvs.2012.08.032.
17. Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA guideline for the management of heart failure: a report of the American College of Cardiology Foundation/American Heart Association Task Force on practice guidelines. *Circulation*. 2013 Oct;128:e240-e327. doi:10.1161/CIR.0b013e31829e8776.

400 Buckwalter Place Boulevard, Bluffton, SC 29910 (800) 918-8924 www.eviCore.com

18. Daubert J-C, Saxon L, Adamson PB, et al. 2012 EHRA/HRS expert consensus statement on cardiac resynchronization therapy in heart failure: Implant and follow-up recommendations and management: A registered branch of the European Society of Cardiology (ESC), and the Heart Rhythm Society; and in collaboration with the Heart Failure Society of America (HFSA), the American Society of Echocardiography (ASE), the American Heart Association (AHA), the European Association of Echocardiography (EAE) of the ESC and the Heart Failure Association of the ESC (HFA). * Endorsed by the governing bodies of AHA, ASE, EAE, HFSA, HFA, EHRA, and HRS. *Europace*. 2012;14(9):1236-1286. doi:10.1093/europace/eus222.
19. Healey JS, Hohnloser SH, Exner DV, et al. Cardiac resynchronization therapy in patients with permanent atrial fibrillation: results from the Resynchronization for Ambulatory Heart Failure Trial (RAFT). *Circulation: Heart failure*. 2012 Sept:5(5):566-570. doi:10.1161/CIRCHEARTFAILURE.112.968867.
20. Curtis AB, Worley SJ, Adamson PB, et al. Biventricular pacing for atrioventricular block and systolic dysfunction. *N Engl J Med*. 2013 Apr; 368:1585-93. doi:10.1056/NEJMoa1210356.
21. Bristow MR, Saxon LA, Boehmer J, et al. Cardiac-Resynchronization Therapy with or without an Implantable Defibrillator in Advanced Chronic Heart Failure. *N Engl J Med*. 2004 May; 350:2140-2150. doi:10.1056/NEJMoa032423.
22. Kay R, Estioko M, and Wiener I. Primary sick sinus syndrome as an indication for chronic pacemaker therapy in young adults: Incidence, clinical features, and long-term evaluation. *Am Heart J*.1982 Mar;103(3):338-42. doi:10.1016/0002-8703(82)90271-x.
23. Kusumoto F and Goldschlager N. Cardiac pacing. *N Engl J Med*. 1996 Jan; 334:89-99. doi:10.1056/NEJM199601113340206.
24. Rasmussen K. Chronic sinus node disease: natural course and indications for pacing. *Euro Heart J*. 1981 Dec;2(6):455-459. doi:10.1093/oxfordjournals.eurheartj.a061236.
25. Linde-Edelstam C, Nordlander R, Pehrsson SK, et al. A double-blind study of submaximal exercise tolerance and variation in paced rate in atrial synchronous compared to activity sensor modulated ventricular pacing. *PACE*. 1992 Jun;15(6):905-15. doi:10.1111/j.1540-8159.1992.tb03081.x.
26. Charles R, Holt S, Kay JM, et al. Myocardial ultrastructure and the development of atrioventricular block in Kearns-Sayre syndrome. *Circulation*. 1981 Jan;63(1):214-219. doi:10.1161/01.cir.63.1.214.
27. Clemmensen P, Bates ER, Califf RM, et al. Complete atrioventricular block complicating inferior wall acute myocardial infarction treated with reperfusion therapy. TAMI Study Group. *Am J Cardiol*. 1991 Feb;67(4):225-230. doi:10.1016/0002-9149(91)90550-5.
28. Ector H, Rolies L, and De Geest H. Dynamic electrocardiography and ventricular pauses of 3 seconds and more: etiology and therapeutic implications. *PACE*. 1983 May;6(3):548-551. doi:10.1111/j.1540-8159.1983.tb05294.x.
29. Glikson M, Dearani JA, HybergerLK, et al. Indications, effectiveness, and long-term dependency in permanent pacing after cardiac surgery. *Am J Cardiology*. 1997 Nov;80(10):1309-13. doi:10.1016/S0002-9149(97)00671-1.
30. Hiromasa S, Ikeda T, Kubota K, et al. Myotonic dystrophy: ambulatory electrocardiogram, electrophysiologic study, and echocardiographic evaluation. *Am Heart J*. 1987 Jun;113(6):1482-1488. doi:10.1016/0002-8703(87)90665-X.
31. Kastor JA. Atrioventricular block (first of two parts). *N Engl J Med*.1975;292:462-5. doi:10.1056/NEJM197502272920906.
32. Kastor JA. Atrioventricular block (second of two parts).*N Engl J Med*. 1975 Mar;292:572-574. doi:10.1056/NEJM197503132921106.
33. Perloff JK, Stevenson WG, Roberts NK, et al. Cardiac involvement in myotonic muscular dystrophy (Steinert's disease): a prospective study of 25 patients. *Am J Cardiol*.1984 Nov;54(8):1074-81. doi:10.1016/S0002-9149(84)80147-2.
34. Zipes DP. Second-degree atrioventricular block. *Circulation*. 1979 Sept;60(3):465-72. doi:10.1161/01.CIR.60.3.465.
35. LangbergJJ, Chin MC, Rosenqvist M, et al. Catheter ablation of the atrioventricular junction with radiofrequency energy. *Circulation*. 1989 Dec;80(6):1527-1535. doi:10.1161/01.CIR.80.6.1527.
36. Fujimura O, Klein GJ, Yee R, et al. Mode of onset of atrial fibrillation in the Wolff-Parkinson-White syndrome: How important is the accessory pathway? *J Am Coll Cardiol*.1990 Apr;15(5):1082-1086. doi:10.1016/0735-1097(90)90244-J.
37. Reiffel J and Kuehnert M. Electrophysiological testing of sinus node function: diagnostic and prognostic application-including updated information from sinus node electrograms. *PACE*.1994 Mar;17(3):349-65. doi:10.1111/j.1540-8159.1994.tb01397.x.
38. Sheldon R, Koshman ML, Wilson W, et al. Effect of dual-chamber pacing with automatic rate-drop sensing on recurrent neurally mediated syncope. *Am J Cardiol*. 1998 Jan;81(2):158-162. doi:10.1111/j.1540-8159.1994.tb01397.x.
39. Barold SS. Indications for permanent cardiac pacing in first-degree AV block: class I, II, or III? *PACE*. 1996 May;19(5):747-751. doi:10.1111/j.1540-8159.1996.tb03355.x.

40. Connelly DT and Steinhaus DM. Mobitz type I atrioventricular block: an indication for permanent pacing? *PACE*. 1996 Mar;19(3):261-264. doi:10.1111/j.1540-8159.1996.tb03325.x.
41. British Pacing and Electrophysiology Group. Recommendations for pacemaker prescription for symptomatic bradycardia. Report of a working party of the British Pacing and Electrophysiology Group. *Br Heart J*. 1991;66(2):185–191.
42. Connolly SJ, Sheldon R, Thorpe KE, et al. Pacemaker therapy for prevention of syncope in patients with recurrent severe vasovagal syncope: Second Vasovagal Pacemaker Study (VPS II): A randomized trial. *JAMA*. 2003;289(17):2224-2229. doi:10.1001/jama.289.17.2224.
43. Epstein AE, DiMarco JP, Ellenbogen KA, et al. 2012 ACCF/AHA/HRS Focused Update of the 2008 Guidelines for Device-Based Therapy of Cardiac Rhythm Abnormalities: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *Circulation*. 2012 Sept:126(14):p1784-1800. doi:10.1161/CIR.0b013e3182618569.
44. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ACC/HRS Guideline for Management of Patients With Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death. *Circulation*. 2018;138(13). doi:10.1161/cir.0000000000000549.
45. Kusumoto FM, Calkins H, Boehmer J, et al. HRS/ACC/AHA expert consensus statement on the use of implantable cardioverter-defibrillator therapy in patients who are not included or not well represented in clinical trials. *J Am Coll Cardiol*. 2014;64:1143–77. doi:10.1161/CIR.0000000000000056.
46. Bernard ML. Pacing Without Wires: Leadless Cardiac Pacing. *Ochsner J*. 2016;16(3):238-242.
47. Abraham WT, Perl L. Implantable Hemodynamic Monitoring for Heart Failure Patients. *J Am Coll Cardiol*. 2017;70(3):389-398. doi:10.1016/j.jacc.2017.05.052.
48. Reddy VY, Miller MA, Neuzil P, et al. Cardiac Resynchronization Therapy With Wireless Left Ventricular Endocardial Pacing. *J Am Coll Cardiol*. 2017;69(17):2119-2129. doi:10.1016/j.jacc.2017.02.059.
49. Kirkfeldt RE, Johansen JB, Nohr EA, et al. Complications after cardiac implantable electronic device implantations: an analysis of a complete, nationwide cohort in Denmark. *Eur Heart J*. 2014;35:1186–1194. doi:10.1093/eurheartj/eht511.
50. Udo EO, Zuithoff NPA, van Hemel NM, et al. Incidence and predictors of short and long-term complications in pacemaker therapy: The FOLLOWPACE study. *Heart Rhythm*. 2012;9:728–735. doi:10.1016/j.hrthm.2011.12.014.
51. Reynolds D, Duray GZ, Omar R, et al. A leadless intracardiac transcatheter pacing system. *N Engl J Med*. 2016;374:533–541. doi:10.1056/NEJMoa1511643.
52. Tracy CM, Epstein AE, Darbar D, et al. 2012 ACCF/AHA/HRS Focused Update Incorporated into the ACCF/AHA/HRS 2008 Guidelines for Device-Based Therapy of Cardiac Rhythm Abnormalities: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines and the Heart Rhythm Society. *J Am Coll Cardiol*. 2013;61:e6–e75. doi:10.1016/j.jacc.2012.11.007.
53. Okabe T, El-Chami MF, Lloyd MS, et al. Leadless pacemaker implantation and concurrent atrioventricular junction ablation in patients with atrial fibrillation. *Pacing Clin Electrophysiol*. doi:10.1111/pace.13312.
54. Epstein AE, DiMarco JP, Ellenbogen KA, et al. ACC/AHA/HRS 2008 guidelines for device based therapy of cardiac rhythm abnormalities: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the ACC/AHA/NASPE 2002 Guideline Update for Implantation of Cardiac Pacemakers and Antiarrhythmia Devices). *Circulation*. 2008; 117:e350–e408.doi: 10.1161/CIRCUALTIONAHA.108.189742.
55. Boersma LV, Merkely B, Neuzil P, et al. Therapy From a Novel Substernal Lead. *JACC: Clinical Electrophysiology*. 2019;5(2):186-196. doi:10.1016/j.jacep.2018.11.003.
56. Ommen SR, Mital S, Burke MA, et al. 2020 AHA/ACC Guideline for the Diagnosis and Treatment of Patients with Hypertrophic Cardiomyopathy. *Circulation*. 2020;142(25). doi:10.1161/cir.0000000000000937.
57. Al-Khatib SM, Stevenson WG, Ackerman MJ, et al. 2017 AHA/ACC/HRS Guideline for Management of Patients with Ventricular Arrhythmias and the Prevention of Sudden Cardiac Death. *Circulation*. 2018;138(13). doi:10.1161/cir.0000000000000549.
58. Glikson M, Nielsen JC, Kronborg MB, et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy [published correction appears in *Eur Heart J*. 2022 May 1;43(17):1651]. Eur Heart J. 2021;42(35):3427-3520. doi:10.1093/eurheartj/ehab364.