National Imaging Associates, Inc.*	
Clinical guidelines **CARDIAC RESYNCHRONIZATION THERAPY (CRT)**	**Original Date: February 2013**
CPT Codes: 33221, 33224, 33225, 33231	**Last Revised Date: February 2022**
Guideline Number: NIA_CG_320	**Implementation Date: January 2023**

GENERAL INFORMATION

It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.

INDICATIONS FOR CARDIAC RESYNCHRONIZATION THERAPY (CRT)[1-8]

Indications for CRT for patients are based upon LV ejection fraction (LVEF), QRS duration, New York Heart Association (NYHA) functional class (presence or absence of symptoms), and need for ventricular pacing regardless of etiology (ischemic or non-ischemic cardiomyopathy). The beneficial effects of CRT have been extensively proven in patients with NYHA class II, III, and IV; there is limited evidence of CRT benefit in patients with NYHA functional class I.

Hence, for the most part, CRT is recommended in only defined subsets of the HF patient population, the majority being symptomatic (NYHA class II-IV) HF patients in SR with a reduced LVEF and a QRS duration ≥130 ms. Other special situations, such as patients with atrial fibrillation or who require an upgrade from a conventional pacing or ICD system, will be addressed below as well.

Patients with cardiomyopathy on GDMT for 3 months or on GDMT and 40 days after MI; or with implantation of pacing or defibrillation device for special indications

CRT-D Indications By NYHA Heart Failure Class (see full definitions further below in document)

- Class I: No limitation of functional activity:
  - LVEF ≤ 30%, QRS ≥ 150ms, LBBB, Sinus Rhythm

- Class II: Slight limitation of activity:
  - LVEF ≤ 35%, QRS ≥ 120ms, LBBB, Sinus Rhythm
  - LVEF ≤ 35%, QRS ≥ 150ms, non-LBBB, Sinus Rhythm

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- Class III and Ambulatory Class IV: Severe limitation of activity but not refractory to therapy
  - LVEF ≤ 35%, QRS ≥ 120ms, LBBB or non-LBBB, Sinus Rhythm

Special Situations

- Independent/Regardless of NYHA Heart Failure Class
  - Patients with HFrEF <40% who have an indication for ventricular pacing and high degree AV block or are expected to be paced more than 40% of the time; this includes patients with Atrial fibrillation

- Atrial fibrillation and LVEF ≤ 35% if:
  - Patient requires ventricular pacing or otherwise meets CRT criteria; AND
  - AV nodal ablation or pharmacologic rate control will allow nearly 100% ventricular pacing with CRT

- LVEF ≤ 35% and undergoing new or replacement device with anticipated requirement for significant (> 40%) ventricular pacing

- In patients with nonobstructive HCM who have NYHA class II to IV heart failure with LBBB, LVEF < 50%, CRT therapy for symptom reduction is reasonable

NOT Indicated for Cardiac Resynchronization Therapy (CRT)

- NYHA class I and non-LBBB pattern with QRS duration < 150 ms,[3] except as in Special Situations section above

- Comorbidities and/or frailty expected to limit survival with good functional capacity to <1 year

- Active bloodstream infection

- Reversible causes are present, such as toxic-, metabolic- or tachycardic-mediated cardiomyopathy. Would require reassessment once the situation is corrected

Indications for CRT in Adult Congenital Heart Disease[9-11]

Systemic LV

- Systemic LV EF ≤ 35%, sinus rhythm, wide QRS complex ≥ 130 ms NYHA function Class II— IV

Any Systemic V

- Systemic ventricle any EF (not restricted to ≤ 35%), intrinsic narrow QRS complex, NYHA function Class I—IV and are undergoing new device placement or replacement with anticipated requirement for significant (>40%) ventricular pacing.

Any CHD

- CRT may be considered for patients with a severe subpulmonary RV dysfunction and dilatation despite interventions to decrease RV volume overload, NYHA function Class II—ambulatory IV and wide QRS complex ≥ 150 ms due to a complete RBBB

- NYHA function Class IV and severe ventricular dysfunction who would otherwise be candidates for heart transplantation or mechanical circulatory support

NOT Indicated for CRT in Adult Congenital Heart Disease

- Patients whose co-morbidities and/or frailty limit survival with good functional capacity to less than 1 year

INDICATIONS FOR CRT AS THE APPROPRIATE PACING MODALITY IN SPECIAL SITUATIONS WITH < 3 MONTHS OF GDMT[6, 12, 13]

Criteria are met for a non-elective implantable cardioverter defibrillator (ICD) or pacemaker and based upon the low likelihood of improvement in symptoms and adequate recovery of LVEF, despite less than 3 months GDMT for heart failure or < 40 days post myocardial infarction or 3 months post revascularization, criteria for CRT are otherwise met. This avoids a second implantation procedure within less than 3 months.

BACKGROUND[1, 3-6]

CRT, which paces the left and right ventricle in rapid sequence, also known as biventricular pacing, improves coordination of ventricular contraction in the presence of a wide QRS complex in systolic heart failure.

CRT improves cardiac function and quality of life, and it decreases cardiac events and mortality among appropriately chosen patients. In the proper patient population, improved survival in patients with CRT can be greater than that provided by ICD insertion alone.

Guiding principles in the consideration of CRT:

- NYHA class is an important qualifying factor, with candidacy based on functional class, EF, and QRS duration.

- Bundle branch block or intraventricular conduction delay should be persistent, not rate-related.[6]

- GDMT should have been in place continuously for at least 3 months[3-5] and recovery of LVEF from myocardial infarction (40 days) if no intervening revascularization or > 3 months if revascularization was performed. Reversible causes (e.g., ischemia) should be excluded.

- The patient should have expected survival with reasonably good functional status for more than 1 year.[3, 5, 10]

OVERVIEW

NYHA Class Definitions[6, 14]

- Class I: No limitation of functional activity. Ordinary physical activity does not cause symptoms of HF

- Class II: Slight limitation of activity. Comfortable at rest but ordinary physical activity results in symptoms of HF

- Class III: Marked limitation of activity. Comfortable at rest but less than ordinary activity causes symptoms of HF

- Class IV: Unable to carry on any physical activity without symptoms of HF, or symptoms of HF at rest

Heart Block Definitions[3]

- First Degree: All atrial beats are conducted to the ventricles, but with a delay of > 200 ms.

- Second Degree: Intermittent failure of conduction of single beats from atrium to ventricles.

    - Type I: Conducted beats have variable conduction times from atrium to ventricles.
    - Type II: Conducted beats have uniform conduction times from atrium to ventricles.
    - Advanced: Two or more consecutive non-conducted beats (premature atrial beats might not normally be conducted).

- Third Degree: No atrial beats are conducted from atrium to ventricle.

Guideline-Directed (or Optimal) Medical Therapy in Heart Failure[4, 15]

- Angiotensin converting enzyme inhibitor (ACE-I), angiotensin receptor blocker (ARB), or combined angiotensin receptor inhibitor and neprilysin inhibitor (ARNI)

- Beta blocker

Other options/considerations for GDMT

- Addition of loop diuretic for all NYHA class II – IV patients

- Addition of hydralazine and nitrate for persistently symptomatic African Americans, NYHA class III-IV

- Addition of an aldosterone antagonist, provided eGFR is ≥ 30 ml/min/1.73m2 and K+ < 5.0, NYHA class II-IV

- Not required for consideration of CRT: Ivabradine for NYHA class II – III, when a beta blocker has failed to reduce a sinus rate to < 70 bpm.

Abbreviations

ACE-I	Angiotensin converting enzyme inhibitor
ARB	Angiotensin receptor blocker
ARNI	Combined angiotensin receptor inhibitor and neprilysin inhibitor
AV	Atrioventricular
CAD	Coronary artery disease, same as ischemic heart disease
CHD	Congenital heart disease
CHF	Congestive heart failure
CRT	Cardiac resynchronization therapy (also known as biventricular pacing)
CRT-D	Cardiac resynchronization therapy defibrillator
ECG	Electrocardiogram
EF	Ejection Fraction
eGFR	Estimated glomerular filtration rate
EPS	Electrophysiologic Study
GDMT	Guideline-Directed Medical Therapy
HCM	Hypertrophic Cardiomyopathy
HF	Heart failure
HFrEF	Heart failure with reduced ejection fraction
HV	His-ventricular
ICD	Implantable cardioverter-defibrillator
LBBB	Left bundle branch block
LV	Left ventricular/left ventricle
LVEF	Left ventricular ejection fraction
MI	Myocardial infarction
ms	Milliseconds
NYHA	New York Heart Association

RBBB	Right bundle branch block
RV	Right ventricle
SND	Sinus node dysfunction
SR	Sinus rhythm
STEMI	ST-Elevation Myocardial Infarction
VT	Ventricular tachycardia

POLICY HISTORY

Date	Summary
February 2022	• Added blood stream infection and reversibility as contraindication • Reworded NYHA • Removed single ventricle and RV
March 2021	• Added indication and reference for hypertrophic cardiomyopathy with reference • Added indication for patient with expected ventricular pacing > 40% of the time • Updated /Reorganized Section: Patients with cardiomyopathy on GDMT for 3 months or on GDMT and 40 days after MI; or with implantation of pacing or defibrillation device for special indications • Updated /Reorganized Section: Indications for CRT in Adult Congenital Heart Disease • Updated Abbreviations Section
	• Added general information section as Introduction which outlines requirements for documentation of pertinent office notes by a licensed clinician, and inclusion of laboratory testing and relevant imaging results for case review • Removed comment that single site pacing from the systemic ventricular apex or mid-lateral wall may be considered as an alternative from the indication systemic ventricular EF ≤ 35%, intrinsic narrow QRS complex, NYHA class I to ambulatory class IV and undergoing new or replacement device implantation with anticipated requirement for significant (>40%) ventricular pacing. • Removed the following from the Guideline Directed Medical Therapy section: Ivabradine listed as a class IIa recommendation, while others are class I recommendations. CRT trials antedated routine use of ivabradine.

August 2019	• Changed ms from 130 to 150 in indication: 'left ventricular ejection fraction (LVEF) ≤ 35%, sinus rhythm, left bundle branch block (LBBB) with a QRS ≥ 150 ms, and NYHA class II, III or ambulatory class IV symptoms on GDMT' • Added indication for LVEF ≤ 35%, sinus rhythm, LBBB with a QRS duration 120 to 149 ms, and NYHA class II, III, or ambulatory class IV symptoms on GDMT • Changed ms from 130 to 150 in indication: 'LVEF ≤ 35%, sinus rhythm, a non-LBBB pattern with a QRS duration ≥ 150 ms, and NYHA III or ambulatory class IV symptoms on GDMT' • Revised indication to state that LVEF ≤ 35% and are undergoing new or replacement device placement with anticipated requirement for significant (> 40%) ventricular pacing • Removed indication for LVEF ≤ 30%, ischemic etiology of HF, sinus rhythm, LBBB with a QRS duration ≥ 150 ms, and NYHA class I on GDMT • Removed indication for LVEF ≤ 35%, sinus rhythm, a non LBBB pattern with a QRS duration ≥ 150 ms, and NYHA class II on GDMT • Adult congenital heart disease, added indication for systemic LVEF ≤ 35%, sinus rhythm, complete LBBB with a QRS complex 120 - 149 ms (spontaneous or paced), and NYHA class II to ambulatory IV • Adult congenital heart disease, removed the following indications: o Cardiac surgery with a QRS duration > 150 ms o Systemic RV with significant tricuspid valve regurgitation o Severe subpulmonic RV dysfunction o Severe ventricular dysfunction and NYHA class IV in attempt to delay transplant or mechanical support • The following statement has been revised to add 'or 3 months post-revascularization.' Criteria are met for a non-elective implantable cardioverter defibrillator (ICD) or a non-elective pacemaker, either initial or replacement, and based upon the low likelihood of improvement in symptoms and adequate recovery of LVEF, despite less than 3 months GDMT for heart failure or < 40 days post myocardial infarction or 3 months post revascularization, criteria for CRT are otherwise met. The following statement has been added: 'This avoids a second implantation procedure within less than 3 months.'

REFERENCES

1. Brignole M, Auricchio A, Baron-Esquivias G, et al. 2013 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: the Task Force on cardiac pacing and resynchronization therapy of the European Society of Cardiology (ESC). Developed in collaboration with the European Heart Rhythm Association (EHRA). *Eur Heart J*. Aug 2013;34(29):2281-329. doi:10.1093/eurheartj/eht150
2. Cleland JG, Daubert JC, Erdmann E, et al. The effect of cardiac resynchronization on morbidity and mortality in heart failure. *N Engl J Med*. Apr 14 2005;352(15):1539-49. doi:10.1056/NEJMoa050496
3. Epstein AE, DiMarco JP, Ellenbogen KA, 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. *Circulation*. Jan 22 2013;127(3):e283-352. doi:10.1161/CIR.0b013e318276ce9b
4. 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*. Oct 15 2013;128(16):e240-327. doi:10.1161/CIR.0b013e31829e8776
5. Ponikowski P, Voors AA, Anker SD, et al. 2016 ESC Guidelines for the diagnosis and treatment of acute and chronic heart failure: The Task Force for the diagnosis and treatment of acute and chronic heart failure of the European Society of Cardiology (ESC)Developed with the special contribution of the Heart Failure Association (HFA) of the ESC. *Eur Heart J*. Jul 14 2016;37(27):2129-2200. doi:10.1093/eurheartj/ehw128
6. 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*. Mar 26 2013;61(12):1318-68. doi:10.1016/j.jacc.2012.12.017
7. Glikson M, Nielsen JC, Kronborg MB, et al. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy: Developed by the Task Force on cardiac pacing and cardiac resynchronization therapy of the European Society of Cardiology (ESC) With the special contribution of the European Heart Rhythm Association (EHRA). *European Heart Journal*. 2021;42(35):3427-3520. doi:10.1093/eurheartj/ehab364
8. Baumgartner H, De Backer J, Babu-Narayan SV, et al. 2020 ESC Guidelines for the management of adult congenital heart disease. *Eur Heart J*. Feb 11 2021;42(6):563-645. doi:10.1093/eurheartj/ehaa554
9. Hernández-Madrid A, Paul T, Abrams D, et al. Arrhythmias in congenital heart disease: a position paper of the European Heart Rhythm Association (EHRA), Association for European Paediatric and Congenital Cardiology (AEPC), and the European Society of Cardiology (ESC)

Working Group on Grown-up Congenital heart disease, endorsed by HRS, PACES, APHRS, and SOLAECE. *Europace*. Nov 1 2018;20(11):1719-1753. doi:10.1093/europace/eux380
10. Khairy P, Van Hare GF, Balaji S, et al. PACES/HRS Expert Consensus Statement on the Recognition and Management of Arrhythmias in Adult Congenital Heart Disease: developed in partnership between the Pediatric and Congenital Electrophysiology Society (PACES) and the Heart Rhythm Society (HRS). Endorsed by the governing bodies of PACES, HRS, the American College of Cardiology (ACC), the American Heart Association (AHA), the European Heart Rhythm Association (EHRA), the Canadian Heart Rhythm Society (CHRS), and the International Society for Adult Congenital Heart Disease (ISACHD). *Heart Rhythm*. Oct 2014;11(10):e102-65. doi:10.1016/j.hrthm.2014.05.009
11. Stout KK, Daniels CJ, Aboulhosn JA, et al. 2018 AHA/ACC Guideline for the Management of Adults With Congenital Heart Disease: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. *J Am Coll Cardiol*. Apr 2 2019;73(12):1494-1563. doi:10.1016/j.jacc.2018.08.1028
12. 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. *Heart Rhythm*. Jul 2014;11(7):1271-303. doi:10.1016/j.hrthm.2014.03.041
13. Marine JE, Russo AM. Primary prevention of sudden cardiac death in patients with cardiomyopathy and heart failure with reduced LVEF. Wolter Kluwer. Updated March 12, 2021. Accessed October 28, 2021. https://www.uptodate.com/contents/primary-prevention-of-sudden-cardiac-death-in-patients-with-cardiomyopathy-and-heart-failure-with-reduced-lvef
14. Goldman L, Hashimoto B, Cook EF, Loscalzo A. Comparative reproducibility and validity of systems for assessing cardiovascular functional class: advantages of a new specific activity scale. *Circulation*. Dec 1981;64(6):1227-34. doi:10.1161/01.cir.64.6.1227
15. Yancy CW, Jessup M, Bozkurt B, et al. 2017 ACC/AHA/HFSA Focused Update of the 2013 ACCF/AHA Guideline for the Management of Heart Failure: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Failure Society of America. *J Am Coll Cardiol*. Aug 8 2017;70(6):776-803. doi:10.1016/j.jacc.2017.04.025

ADDITIONAL RESOURCES

1. Curtis AB, Worley SJ, Adamson PB, et al. Biventricular pacing for atrioventricular block and systolic dysfunction. *N Engl J Med*. Apr 25 2013;368(17):1585-93. doi:10.1056/NEJMoa1210356
2. Kotecha D, Flather MD, Altman DG, et al. Heart Rate and Rhythm and the Benefit of Beta-Blockers in Patients With Heart Failure. *J Am Coll Cardiol*. Jun 20 2017;69(24):2885-2896. doi:10.1016/j.jacc.2017.04.001
3. Kusumoto FM, Schoenfeld MH, Barrett C, et al. 2018 ACC/AHA/HRS Guideline on the Evaluation and Management of Patients With Bradycardia and Cardiac Conduction Delay: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines, and the Heart Rhythm Society. *J Am Coll Cardiol.* Aug 20 2019;74(7):932-987. doi:10.1016/j.jacc.2018.10.043

4. Motonaga KS, Dubin AM. Cardiac resynchronization therapy for pediatric patients with heart failure and congenital heart disease: a reappraisal of results. *Circulation*. May 6 2014;129(18):1879-91. doi:10.1161/circulationaha.113.001383
5. Shen WK, Sheldon RS, Benditt DG, et al. 2017 ACC/AHA/HRS Guideline for the Evaluation and Management of Patients With Syncope: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. *Circulation*. Aug 1 2017;136(5):e60-e122. doi:10.1161/cir.0000000000000499
6. Stevenson WG, Hernandez AF, Carson PE, et al. Indications for cardiac resynchronization therapy: 2011 update from the Heart Failure Society of America Guideline Committee. *J Card Fail.* Feb 2012;18(2):94-106. doi:10.1016/j.cardfail.2011.12.004

Reviewed / Approved by NIA Clinical Guideline Committee