

Table 1. ACC/AHA/HRS 2018 GL on bradycardia. Atrioventricular block

- *First-degree atrioventricular block*: P waves associated with 1:1 atrioventricular conduction and a PR interval >200 ms (this is more accurately defined as atrioventricular delay because no P waves are blocked)
- *Second-degree atrioventricular block*: P waves with a constant rate (<100 bpm) where atrioventricular conduction is present but not 1:1
 - Mobitz type I: P waves with a constant rate (<100 bpm) with a periodic single nonconducted P wave associated with P waves before and after the nonconducted P wave with inconstant PR intervals
 - Mobitz type II: P waves with a constant rate (< 100 bpm) with a periodic single nonconducted P wave associated with other P waves before and after the nonconducted P wave with constant PR intervals (excluding 2:1 atrioventricular block)
 - 2:1 atrioventricular block: P waves with a constant rate (or near constant rate because of ventriculophasic sinus arrhythmia) rate (<100 bpm) where every other P wave conducts to the ventricles
 - Advanced, high-grade or high-degree atrioventricular block: ≥2 consecutive P waves at a constant physiologic rate that do not conduct to the ventricles with evidence for some atrioventricular conduction
- *Third-degree atrioventricular block (complete heart block)*: No evidence of atrioventricular conduction
- *Vagally mediated atrioventricular block*: Any type of atrioventricular block mediated by heightened parasympathetic tone
- *Infranodal block*: Atrioventricular conduction block where clinical evidence or electrophysiologic evidence suggests that the conduction block occurs distal to the atrioventricular node

Table 2. ACC/AHA/HRS 2018 GL on bradycardia. Aetiology of atrioventricular block

Congenital/genetic
• Congenital AV block (associated with maternal systemic lupus erythematosus) • Congenital heart defects (e.g., L-TGA) • Genetic (e.g., SCN5A mutations)
Infectious
• Lyme carditis • Bacterial endocarditis with perivalvar abscess • Acute rheumatic fever • Chagas disease • Toxoplasmosis
Inflammatory/infiltrative
• Myocarditis • Amyloidosis • Cardiac sarcoidosis • Rheumatologic disease: Systemic sclerosis, SLE, RA, reactive arthritis (Reiter's syndrome) • Other cardiomyopathy-idiopathic, valvular
Ischemic
• Acute MI • Coronary ischemia without infarction—unstable angina, variant angina • Chronic ischemic cardiomyopathy
Degenerative
• Lev's and Lenegre's diseases
Vagotonic-associated with increased vagal tone
• Sleep, obstructive sleep apnea • High-level athletic conditioning • Neurocardiogenic
Metabolic/endocrine
• Acid-base disorders • Poisoning/overdose (e.g., mercury, cyanide, carbon monoxide, mad honey) • Thyroid disease (both hypothyroidism and hyperthyroidism) • Adrenal disease (e.g., pheochromocytoma, hypoaldosteronism)
Other diseases
• Neuromuscular diseases (e.g., myotonic dystrophy, Kearns-Sayre syndrome, Erb's dystrophy) • Lymphoma
Iatrogenic
• Medication related ◦ Beta blockers, verapamil, diltiazem, digoxin ◦ Antiarrhythmic drugs ◦ Neutraceuticals • Catheter ablation • Cardiac surgery, especially valve surgery • TAVR, alcohol septal ablation

RA indicates rheumatoid arthritis; MI, myocardial infarction; SLE, systemic lupus erythematosus; and TAVR, transcatheter aortic valve replacement.

Table 3. EHRA/HRS/APHRs/LAHRs 2022 Consensus Statement on genetic testing.
Genes implicated in CCD/PCCD.

Gene	Locus	Phenotype—syndrome	Protein (functional effect)	Frequency	ClinGen classification
Genes for isolated SND					
SCN5A	3p22.2	BrS1, SND, ASS, (LQT3) ^{194–196,203,204}	Cardiac Na channel α subunit (Nav1.5) Loss-of-function, $I_{Na} \downarrow$	>10%	NA/major gene; definite for LQTS, BrS1
TRPM4	19q13.33	^{205,206}	Transient receptor potential melastatin 4 channel Gain-of-function	1–10%	NA/major gene
Genes for syndromal disorders with CCD/PCCD					
LMNA	1q22	DCM (CMD1A), AFib, SND (Emery-Dreifuss muscular dystrophy 2/3, congenital muscular dystrophy, limb- girdle myopathy, familial lipodystrophy type 2, Hutchinson-Gilford proge- ria, and various other disorders) ^{197,199,200}	Lamin A/C	>10%	NA/major gene; definite for DCM
DES	2q35	DCM (CMD1I), ACM, Myofibrillar myopathy (MFM1)	Desmin	()	NA/rare gene; Definite for DCM, mod- erate for ACM
DMD	Xp21.2-p21.1	DCM (CMD3B), muscular dystrophy (Becker or Duchenne type) ²⁰⁷	Dystrophin	()	NA/rare gene
DMPK	19q13.32	DCM, myotonic dystrophy (DM1) ²⁰⁸	Myotonic dystrophy protein kinase	()	NA/rare gene
EMD	Xq28	DCM, LVNC, SND, Emery- Dreifuss muscular dystro- phy (EMD) ^{209,210}	Emerin	()	NA/rare gene
LAMP2	Xq24	HCM, DCM, LVNCDanon disease (glycogen storage disease), skeletal muscle in- volvement, mental retardation ²¹¹	Lysosomal-associated membrane protein 2	()	NA/rare gene; Definite for HCM
ZNF9	3q21.3	DCM, myotonic dystrophy (DM2) ²¹²	Zink finger protein 9 (CZNP)	()	NA/rare gene
GLA	Xq22.1	Fabry disease (HCM, RCM, acral paresthesia, PNP, kidney insufficiency, angio- keratoma, anhydrosis, cor- nea verticillata, etc.)	Galactosidase α	()	NA/rare gene; definite for HCM
PRKAG2	7q36.1	Cardiac preexcitation (WPW), LVH/HCM, ²¹³	AMP-activated protein kinase γ 2-subunit	()	NA/rare gene; definite for HCM
TNNI3K	1p31.1	DCM, AFib ²¹⁴	Troponin I-interacting MAP kinase	()	NA/rare gene
NKX2-5	5q35.1	ASD7, (VSD7, TOF)	Transcription factor Nkx2.5	()	NA/rare gene
GJC1	17q21.31	Bone malformations (brachy- facial pattern, finger defor- mity, and dental dysplasia) ²¹⁵	Connexin 45	()	NA/rare gene

<i>TBX5</i>	12q24.21	Holt-Oram syndrome (HOS) (hand-heart syndrome): ASD, hand and limb malformation (e.g., triphalang thumb), other CHD	Transcription factor <i>TBX5</i>	()	NA/rare gene
<i>MYL4</i>	17q21.32	AFib/conduction disease	atrial-specific myosin light chain	()	NA, rare gene
<i>mtDNA</i>	Mitochondrial DNA	Kearns-Sayre syndrome (KSS): Ptosis, progressive external ophthalmoplegia, ataxia, retinitis pigmentosa; Chronic progressive external ophthalmoplegia (CPEO), ptosis ²¹⁶	(37 mitochondrial genes)	()	NA/rare gene

Frequency: refers to mutation detection rate; core genes: major (>10%) or minor (1–10%); rare gene (<1%); (): mutation rate unknown and/or single reports.

Other phenotypes: [. . .], phenotype associated with gene, but unlinked with CCD/PCCD.

ClinGen: Clinical Genome Resource of NCBI; <https://clinicalgenome.org>, NA: not available = not yet curated.

ACM, arrhythmogenic cardiomyopathy; AFib, atrial fibrillation; ASD, atrial septal defect; ASS, atrial stand still; BrS, Brugada syndrome, CHD, congenital heart disease, DCM, dilated cardiomyopathy; HCM, hypertrophic cardiomyopathy; LQT, long-QT syndrome subtype; LVH, left ventricular hypertrophy; LVNC, left ventricular non-compaction cardiomyopathy; PNP, polyneuropathy; WPW, Wolff–Parkinson–White syndrome; RCM, restrictive cardiomyopathy; SND, sinus node dysfunction; TOF, Tetralogy of Fallot; VSD, ventricular septal defect; X-chr., X-chromosome

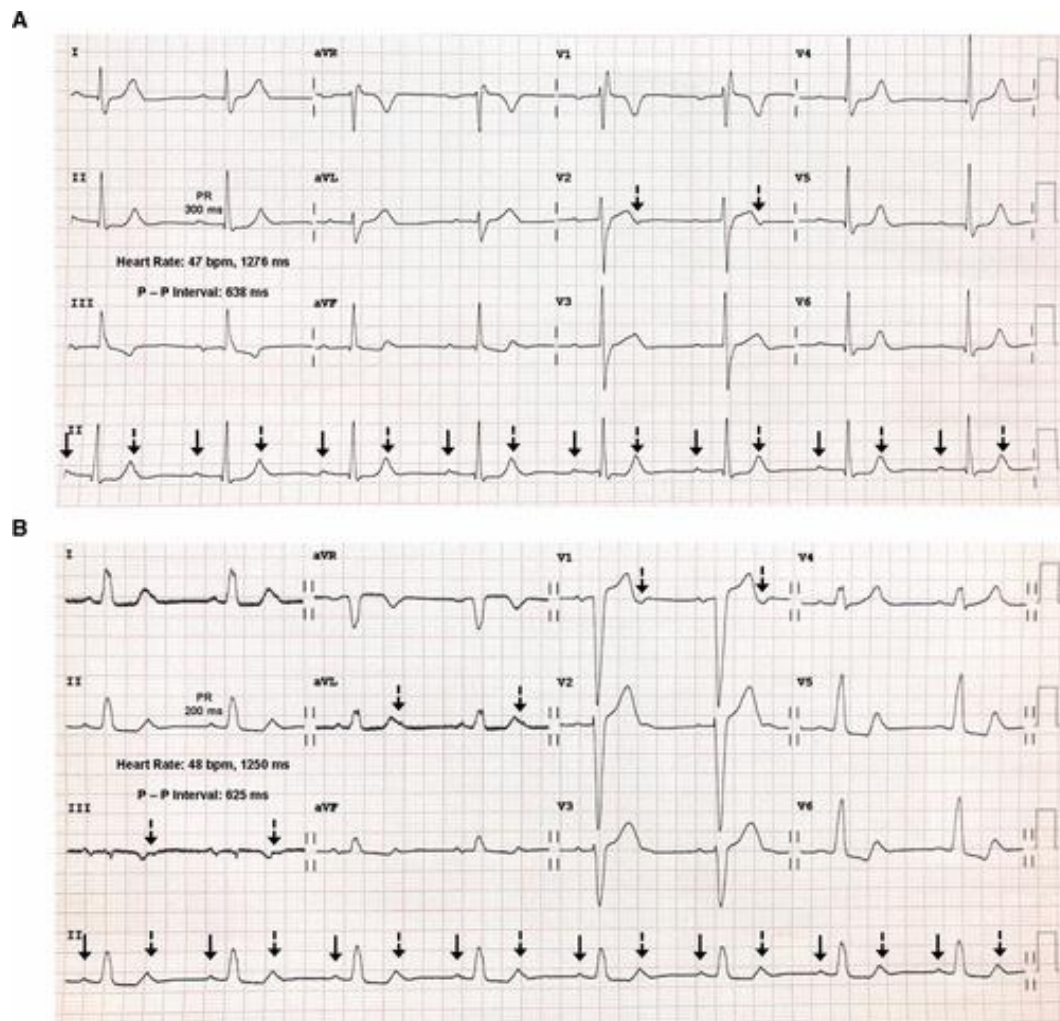


Figure 1. A. The ECG displays a prolonged PR interval and right bundle-branch block. **B.** ECG with a shorter PR interval and left bundle-branch block. Solid black arrows point to clearly visible P-waves, and dashed black arrows point to the P-waves buried in the T-waves. Note that the P-P interval is exactly double the heart rate in both ECGs.

Arias MA, Martínez-Cámara A, Pachón M. Syncope and Alternating QRS Morphology. *Circulation*. 2020;141:1819-1822.

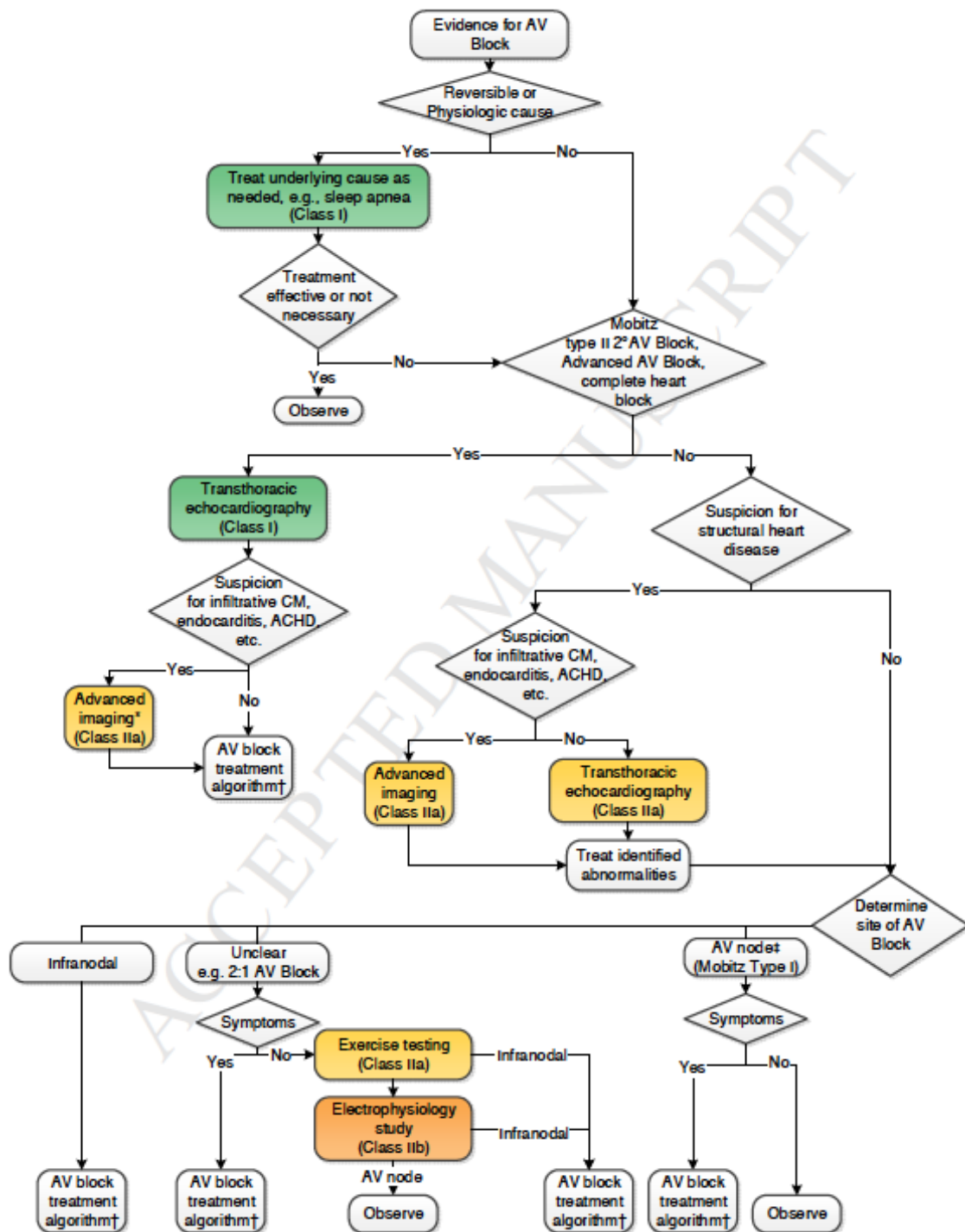


Figure 2. ACC/AHA/HRS 2018 GL on bradycardia. Initial Evaluation of Suspected AV block Algorithm

*Targeted Advanced Imaging—

Magnetic Resonance Imaging (MRI): Amyloidosis, myocarditis, hemochromatosis, sarcoidosis, CHD, sinus of Valsalva aneurysm, aortic dissection, arrhythmogenic right ventricular cardiomyopathy;

Fluoro-deoxy-glucose (fludeoxyglucose)-positron emission tomography (FDG PET): sarcoidosis;

^{99m}Tc Technetium pyrophosphate (Tc PYP) or ^{99m}Tc 3,3-diphosphono-1,2-propanodicarboxylic acid (Tc-DPD): Transthyretin (TTR) amyloidosis;

Cardiac computed tomography (CT): CHD, sinus of Valsalva aneurysm, aortic dissection, arrhythmogenic right ventricular cardiomyopathy; echo longitudinal strain: Amyloidosis;

Transesophageal echocardiogram (TEE): Endocarditis, sinus of Valsalva aneurysm, aortic dissection, CHD.

‡The atrioventricular node is more likely the site of block with second-degree Mobitz type I atrioventricular block and a narrow QRS complex or severe first-degree atrioventricular block (>0.30 s) with a narrow QRS complex.

AV indicates atrioventricular; ACHD, adult congenital heart disease; CHD, congenital heart disease; and CM, cardiomyopathy.

Table 4. Indications for electrophysiology study of atrioventricular block

1. Suspicion of concealed AV junctional extrasystoles.
2. Asymptomatic type I second-degree AV block with bundle branch block.
3. Asymptomatic second-degree AV block with bundle branch block.
4. Questionable diagnosis of type II block with a narrow QRS complex.
5. Suspicion of bradycardia-dependent (phase 4) infranodal block.
6. Transient second-degree AV block with bundle branch block in patients with inferior myocardial infarction where the site of block is suspected to be in the His-Purkinje system rather than the AV node.
7. Third degree AV block with a fast ventricular rate.
8. Progressive conduction disease due to neuromuscular disorders or suspected *SCN5A* mutations.

Katrakis DG, Josephson ME. AV conduction abnormalities and AV blocks: role of EP testing. In: Camm AJ, Lüscher T, Maurer G, Serruys P: European Society of Cardiology Textbook. 3rd Edition. 2018

Table 5. EHRA/HRS/APHRS/LAHRs 2022 Consensus Statement on genetic testing.**Impact of genetic testing for the index case**

Disease	Diagnostic	Prognostic	Therapeutic
Cardiac conduction disease	+	+	+

Recommendations**Should do**

Targeted genetic testing as part of the diagnostic evaluation for index patients with isolated cardiac conduction disease (CCD/PCCD) or with concomitant structural heart disease or extracardiac disease, when there is early age of diagnosis or a suspicion of laminopathy, especially when there is documentation of a positive family history of CCD/PCCD.

Variant-specific genetic testing for family members and appropriate relatives following the identification of the disease-causative variant.

May do

Predictive genetic testing in related children from birth onward (any age) in specific settings.

Targeted genetic testing as part of the diagnostic evaluation for index patients with isolated cardiac conduction disease (CCD/PCCD) or with concomitant structural heart disease or extracardiac disease, especially in the setting of a positive family history.

Table 6. ACC/AHA/HRS 2018 GL on bradycardia. Acute Management of Reversible Causes of Bradycardia Attributable to AV Block

Patients with transient or reversible causes of AV block, such as Lyme carditis or drug toxicity, should have medical therapy and supportive care, including temporary transvenous pacing if necessary, before determination of need for permanent pacing	I-B-NR
Permanent pacing without further observation for drug washout or reversibility in patients with symptomatic second-degree or third-degree AV block who are on chronic stable doses of medically necessary antiarrhythmic or beta-blocker therapy	IIa-B-NR
In second-degree or third-degree AV block associated with cardiac sarcoidosis, permanent pacing, with additional defibrillator capability if needed and meaningful survival of greater than 1 year is expected, without further observation for reversibility.	IIa-B-NR
In symptomatic second-degree or third-degree AV block associated with thyroid function.	IIb-C-LD
Abnormalities but without clinical myxedema, permanent pacing without further observation for reversibility.	

Table 7. ACC/AHA/HRS 2018 GL on bradycardia. Acute Medical Therapy for Bradycardia Attributable to AV Block

Atropine for second-degree or third-degree AVblock believed to be at the atrioventricular nodal level associated with symptoms or hemodynamic compromise	Ila-C-LD
Beta-adrenergic agonists, such as isoproterenol, dopamine, dobutamine, or epinephrine, in second-degree or third-degree atrioventricular block associated with symptoms or hemodynamic compromise and low likelihood for coronary ischemia	Ilb-B-NR
Intravenous aminophylline in second-degree or third-degree atrioventricular block associated with symptoms or hemodynamic compromise in the setting of acute inferior MI	Ilb-C-LD

Table 8. ACC/AHA/HRS 2018 GL on bradycardia. Temporary pacing for AV Block

Second-degree or third-degree atrioventricular block associated with symptoms or hemodynamic compromise that is refractory to medical therapy, to increase heart rate and improve symptoms	Ila-B-NR
Externalized permanent active fixation lead over a standard passive fixation temporary pacing lead for prolonged temporary transvenous pacing	Ila-B-NR
In second-degree or third-degree atrioventricular block and hemodynamic compromise refractory to antibradycardic medical therapy, temporary transcutaneous pacing until a temporary transvenous or PPM is placed or the bradyarrhythmia resolves	Ilb-B-NR

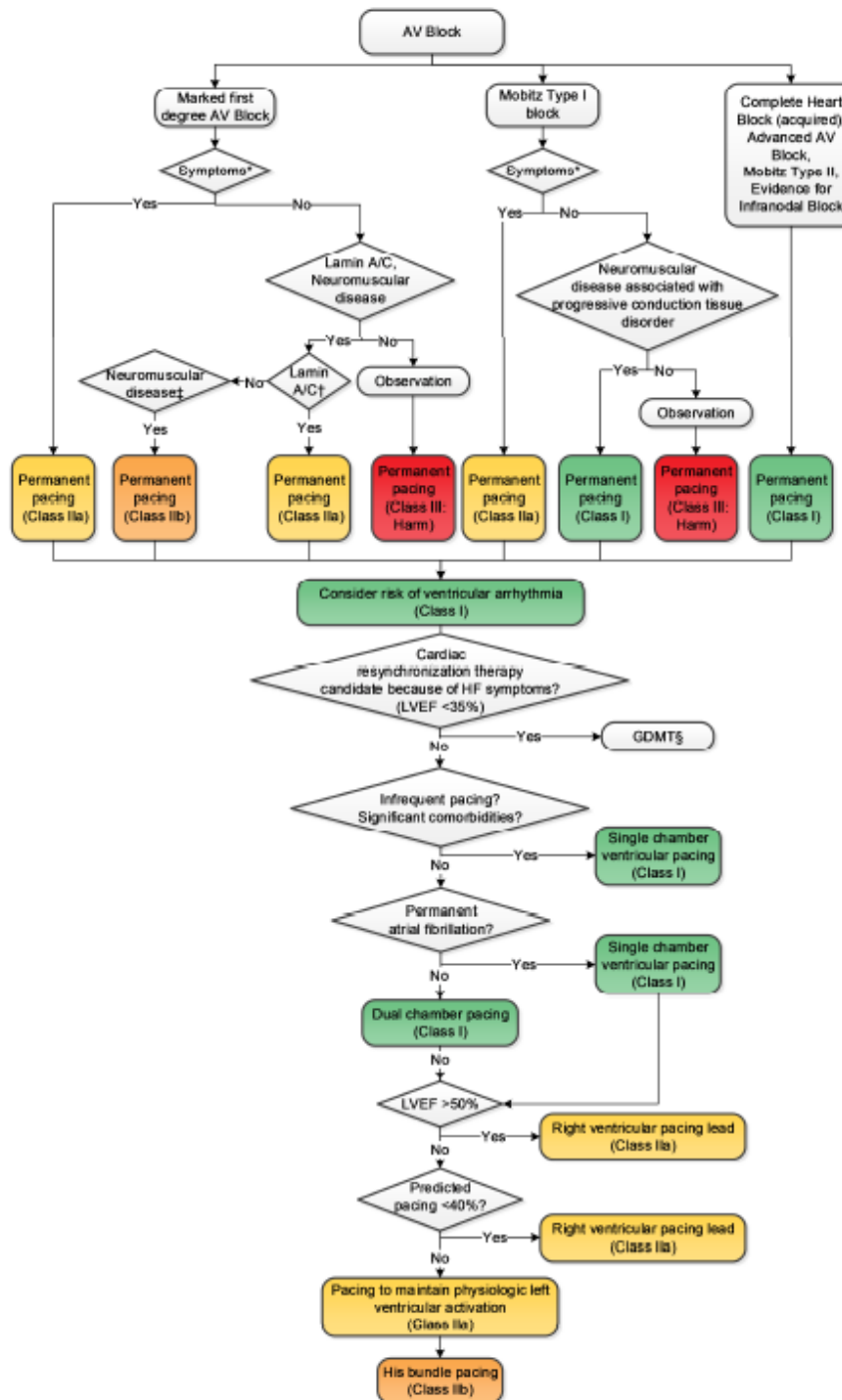


Figure 3. ACC/AHA/HRS 2018 GL on bradycardia. Management of Bradycardia or Pauses Attributable to Chronic Atrioventricular Block Algorithm

*Symptoms correlate with AV block.

†PR interval >240 ms, LBBB.

‡PR interval >240 ms, QRS >120 ms or fascicular block.

§Refer to heart failure guidelines (S6.4-1, S6.4-2).

AV indicates atrioventricular; GDMT, guideline-directed management and therapy; HF, heart failure; LBBB, left bundle branch block; and LVEF, left ventricular ejection fraction.

Table 9. ACC/AHA/HRS 2018 GL on bradycardia. General Principles of Chronic Therapy/Management of Bradycardia Attributable to AV Block

In first-degree AV block or second-degree Mobitz type I (Wenckebach) or 2:1 atrioventricular block which is believed to be at the level of the atrioventricular node, (Harm) with symptoms that do not temporally correspond to the AV block, permanent pacing should not be performed	III-C-LD
In asymptomatic first-degree AV block or second-degree Mobitz type I (Wenckebach) or 2:1 AV block which is believed to be at the level of the atrioventricular node, permanent pacing should not be performed	III-C-LD (Harm)

Table 10. ACC/AHA/HRS 2018 GL on bradycardia. Transient/Potentially Reversible Causes of AV Block

Permanent pacing for symptomatic AV block attributable to a known reversible cause when the AV block does not resolve despite treatment of the underlying cause.	I-C-LD
In acute AVblock attributable to a known reversible and nonrecurrent cause, and complete resolution of the AV block with treatment of the underlying cause, permanent pacing should not be performed	III-C-LD (Harm)
In asymptomatic vagally mediated AV block, permanent pacing should not be performed	III-C-LD (Harm)

Table 11. ACC/AHA/HRS 2018 GL on bradycardia. Additional Testing for Chronic Therapy/Management of Bradycardia attributable to AV block

Ambulatory electrocardiographic monitoring to establish correlation between symptoms and rhythm abnormalities, in symptoms (e.g., lightheadedness, dizziness) of unclear etiology and first-degree AVblock or second-degree Mobitz type I AV block on ECG	Ila-B-R
Exercise treadmill test to determine whether they may benefit from permanent pacing in exertional symptoms (e.g., chest pain, shortness of breath) and first-degree or second-degree Mobitz type I AV block at rest	Ila-C-LD
EPS to determine the level of the block and to determine whether they may benefit from permanent pacing in second-degree AV block	Iib-B-NR
Carotid sinus massage and/or pharmacological challenge with atropine, isoproterenol, or procainamide to determine the level of the block and to determine whether they may benefit from permanent pacing in second-degree AV block	Iib-C-LD

Table 12. Indications for permanent pacing**ACC/AHA/HRS 2018 GL on bradycardia. Permanent pacing**

Regardless of symptoms in acquired second-degree Mobitz type II AV block, high-grade AV, or third-degree AVblock not attributable to reversible or physiologic causes.	I-B-NR
Regardless of symptoms in neuromuscular diseases associated with conduction disorders, including muscular dystrophy (e.g., myotonic dystrophy type 1) or Kearns-Sayre syndrome, with evidence of second-degree AV block, third-degree AV block, or an HV interval ≥ 70 ms, with additional defibrillator capability if needed.*	I-B-NR
In permanent AF and symptomatic bradycardia	I-C-LD
In symptomatic AV block as a consequence of guideline-directed management and therapy for which there is no alternative treatment and continued treatment is clinically necessary	I-C-LD
In infiltrative cardiomyopathy, such as cardiac sarcoidosis or amyloidosis, and second-degree Mobitz type II AV block, high-grade AV block, or third-degree AV block, with additional defibrillator capability if needed.*	IIa-B-NR
In lamin A/C gene mutations, including limb-girdle and Emery Dreifuss muscular dystrophies, with a PR interval > 240 ms and LBBB, with additional defibrillator capability if needed.*	IIa-B-NR
In marked first-degree or second-degree Mobitz type I (Wenckebach) AVblock with symptoms that are clearly attributable to the AV block	IIa-C-LD
In neuromuscular diseases, such as myotonic dystrophy type 1, with a PR interval > 240 ms, a QRS duration > 120 ms, or fascicular block, with additional defibrillator capability if needed.*	IIb-C-LD

*: if meaningful survival > 1 year is expected

ESC 2021 GL on pacing and CRT. Recommendations for pacing for atrioventricular block

Pacing in patients in SR with permanent or paroxysmal third- or second-degree type 2, infranodal 2:1, or high-degree AVB, irrespective of symptoms. ^a	I C
Pacing in patients with atrial arrhythmia (mainly AF) and permanent or paroxysmal third- or high-degree AVB irrespective of symptoms.	I C
Ventricular pacing with rate response function in patients with permanent AF in need of a pacemaker	I C
Pacing in patients with second-degree type 1 AVB that causes symptoms or is found to be located at intra- or infra-His levels at EPS.	IIa C

In patients with AVB, DDD preferred over single-chamber ventricular pacing to avoid pacemaker syndrome and to improve quality of life. IIa A

Permanent pacemaker implantation for patients with persistent symptoms similar to those of pacemaker syndrome and clearly attributable to first-degree AVB (PR >0.3 s). IIa C

Pacing is not recommended in patients with AVB due to transient causes that can be corrected and prevented. III C

AF = atrial fibrillation; AVB = atrioventricular block; DDD = dual-chamber, atrioventricular pacing; EPS = electrophysiology study; SR = sinus rhythm.

a In asymptomatic narrow QRS complex and 2:1 AVB, pacing may be avoided if supra-Hisian block is clinically suspected (concomitant Wenckebach is observed and block disappears with exercise) or demonstrated at EPS.

Table 13. Mode of pacing in AV block

ACC/AHA/HRS 2018 GL on bradycardia. Permanent Pacing Techniques and Methods for Chronic Therapy/Management of Bradycardia Attributable to AV Block

In patients with SND and AV block who require permanent pacing, dual chamber pacing over single chamber ventricular pacing	I-A
In patients with AV block who require permanent pacing in whom frequent ventricular pacing is not expected, or who have significant comorbidities that are likely to determine clinical outcomes and that may limit the benefit of dual chamber pacing, single chamber ventricular pacing is effective	I-A
For patients in sinus rhythm with a single chamber ventricular pacemaker who develop pacemaker syndrome, revising to a dual chamber pacemaker	I-B-R
In patients with AV block who have an indication for permanent pacing with a LVEF 36-50% and are expected to require ventricular pacing more than 40% of the time, choose pacing methods that maintain physiologic ventricular activation (e.g., CRT or His bundle pacing) over right ventricular pacing	IIa-B-R ^{SR}
In patients with AV block who have an indication for permanent pacing with a LVEF 36-50% and are expected to require ventricular pacing less than 40% of the time, choose right ventricular pacing over pacing methods that maintain physiologic ventricular activation (e.g., CRT or His bundle pacing)	IIa-B-R
In AV block at the level of the atrioventricular node and an indication for permanent pacing, His bundle pacing to maintain physiologic ventricular activation	IIb-B-R ^{SR}
In patients with permanent or persistent AF in whom a rhythm control strategy is not planned, implantation of an atrial lead should not be performed	III-C-LD (Harm)

SR indicates systematic review

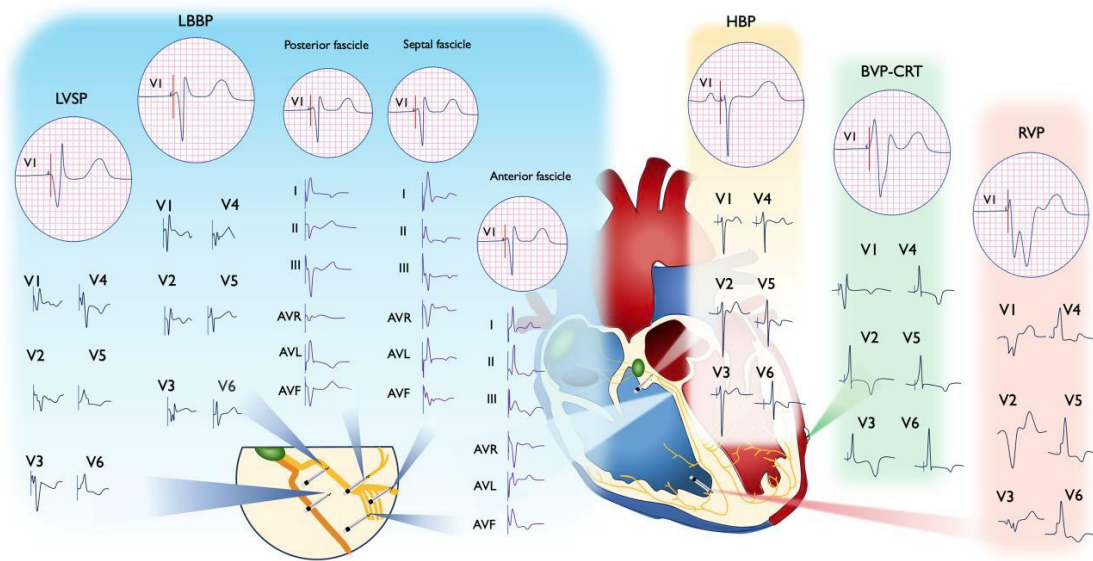


Figure 4. Paced ECGs of available pacing approaches.

HBP, His-bundle pacing; LBBP, left bundle branch pacing; LVSP, left ventricular septal pacing; BVP-CRT, biventricular pacing cardiac resynchronization therapy; RVP, right ventricular pacing

Whinnett Z, et al. Physiological pacing: mechanisms, clinical indications, and perspectives. *Eur Heart J*. 2025.

Table 14. ESC 2021 GL on pacing and CRT. Recommendations for using His bundle pacing

In patients treated with HBP, device programming tailored to specific requirements of HBP is recommended.	I C
In CRT candidates in whom coronary sinus lead implantation is unsuccessful, HBP as a treatment option along with other techniques such as surgical epicardial lead.	IIa B
In patients treated with HBP, implantation of an RV lead used as ‘backup’ for pacing should be considered in specific situations (e.g. pacemaker dependency, high-grade AVB, infranodal block, high pacing threshold, planned AVJ ablation) or for sensing in the case of issues with detection (e.g. risk of ventricular undersensing or oversensing of atrial/His potentials).	IIa C
HBP with a ventricular backup lead in patients in whom a ‘pace-and-ablate’ strategy for rapidly conducted supraventricular arrhythmia is indicated, particularly when the intrinsic QRS is narrow.	IIb C
HBP as an alternative to RV pacing in patients with AVB and LVEF >40%, who are anticipated to have >20% ventricular pacing.	IIb C

AVB = atrioventricular block; AVJ = atrioventricular junction; CRT = cardiac resynchronization therapy; HBP = His bundle pacing; LVEF = left ventricular ejection fraction; RV = right ventricular.

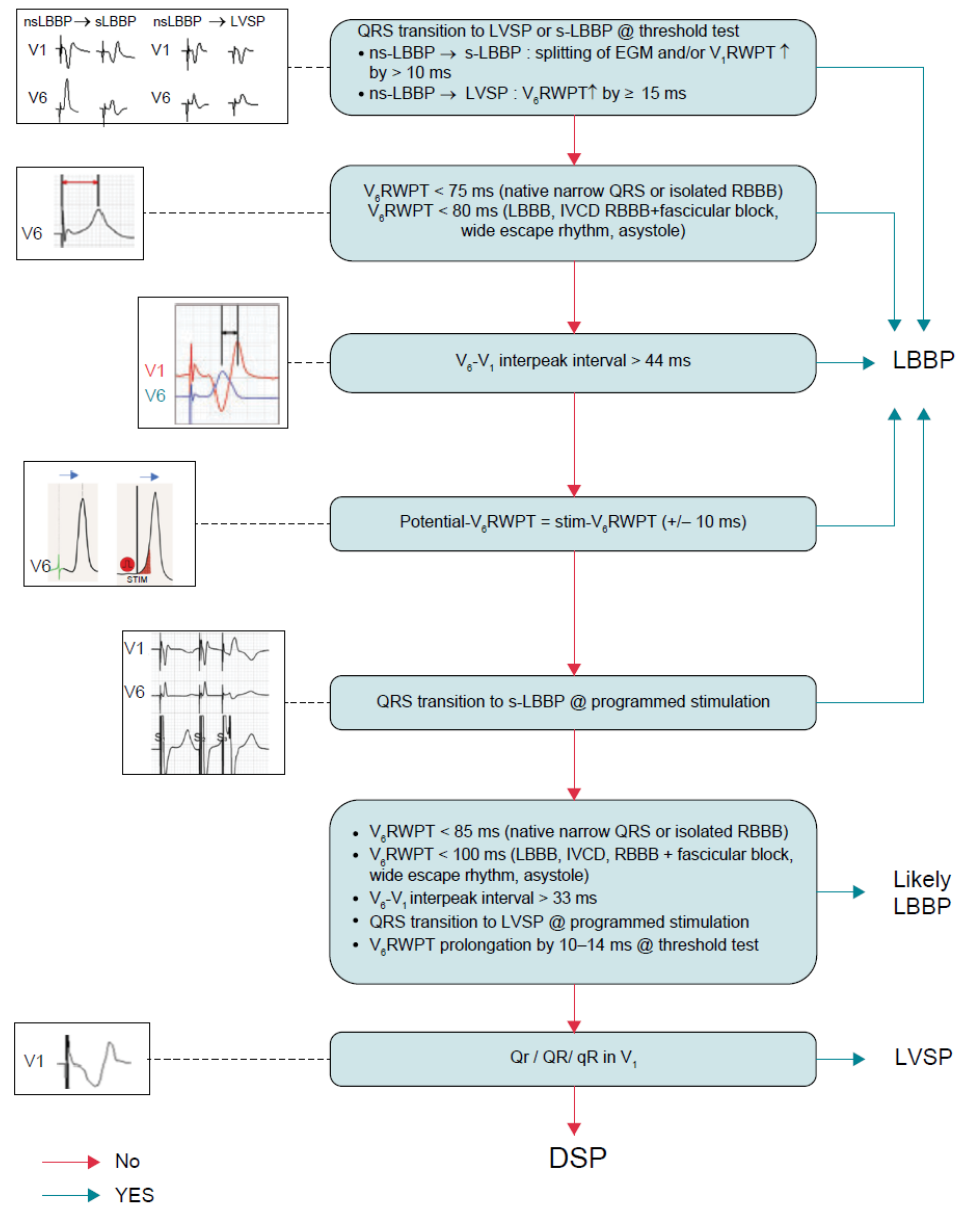


Figure 5. Algorithm for confirming conduction system capture with LBBAP. Some of the steps may be skipped according to operator preference, experience or feasibility to perform particular measurements/maneuvers.

Burri H, et al. EHRA clinical consensus statement on conduction system pacing implantation: executive summary. Endorsed by the Asia-Pacific Heart Rhythm Society (APHRS), Canadian Heart Rhythm Society (CHRS) and Latin-American Heart Rhythm Society (LAHRS). *Europace*. 2023;25:1237-1248.

Table 15. ACC/AHA/HRS 2018 GL on bradycardia. Conduction tissue disease

- RBBB (as defined in adults):
 - Complete RBBB:
 1. QRS duration ≥ 120 ms
 2. rsr' , rsR' , rSR' , or rarely a qR in leads V_1 or V_2 . The R' or r' deflection is usually wider than the initial R wave. In a minority of patients, a wide and often notched R wave pattern may be seen in lead V_1 and/or V_2 .
 3. S wave of greater duration than R wave or >40 ms in leads I and V_6 in adults
 4. Normal R peak time in leads V_5 and V_6 but >50 ms in lead V_1
 - Incomplete RBBB: Same QRS morphology criteria as complete RBBB but with a QRS duration between 110 and 119 ms
 - LBBB (as defined in adults):
 - Complete LBBB:
 1. QRS duration ≥ 120 ms in adults
 2. Broad notched or slurred R wave in leads I, aVL, V_5 , and V_6 and an occasional RS pattern in V_5 and V_6 attributed to displaced transition of QRS complex
 3. Absent Q waves in leads I, V_5 , and V_6 , but in the lead aVL, a narrow Q wave may be present in the absence of myocardial pathology
 4. R peak time >60 ms in leads V_5 and V_6 but normal in leads V_1 , V_2 , and V_3 , when small initial R waves can be discerned in the precordial leads
 5. ST and T waves usually opposite in direction to QRS
 - Incomplete LBBB:
 1. QRS duration between 110 and 119 ms in adults
 2. Presence of left ventricular hypertrophy pattern
 3. R peak time >60 ms in leads V_4 , V_5 , and V_6
 4. Absence of Q wave in leads I, V_5 , and V_6
 - Nonspecific intraventricular conduction delay (as defined in adults): QRS duration >110 ms where morphology criteria for RBBB or LBBB are not present
 - Left anterior fascicular block:
 - QRS duration <120 ms
 - Frontal plane axis between -45° and -90°
 - qR (small r, tall R) pattern in lead aVL
 - R-peak time in lead aVL of ≥ 45 ms
 - rS pattern (small r, deep S) in leads II, III, and aVF
 - Left posterior fascicular block:
 - QRS duration <120 ms
 - Frontal plane axis between 90° and 180° in adults. Because of the more rightward axis in children up to 16 years of age, this criterion should only be applied to them when a distinct rightward change in axis is documented.
- | |
|--|
| <ul style="list-style-type: none"> ○ rS (small r, deep S) pattern in leads I and aVL ○ qR (small q, tall R) pattern in leads III and aVF |
|--|

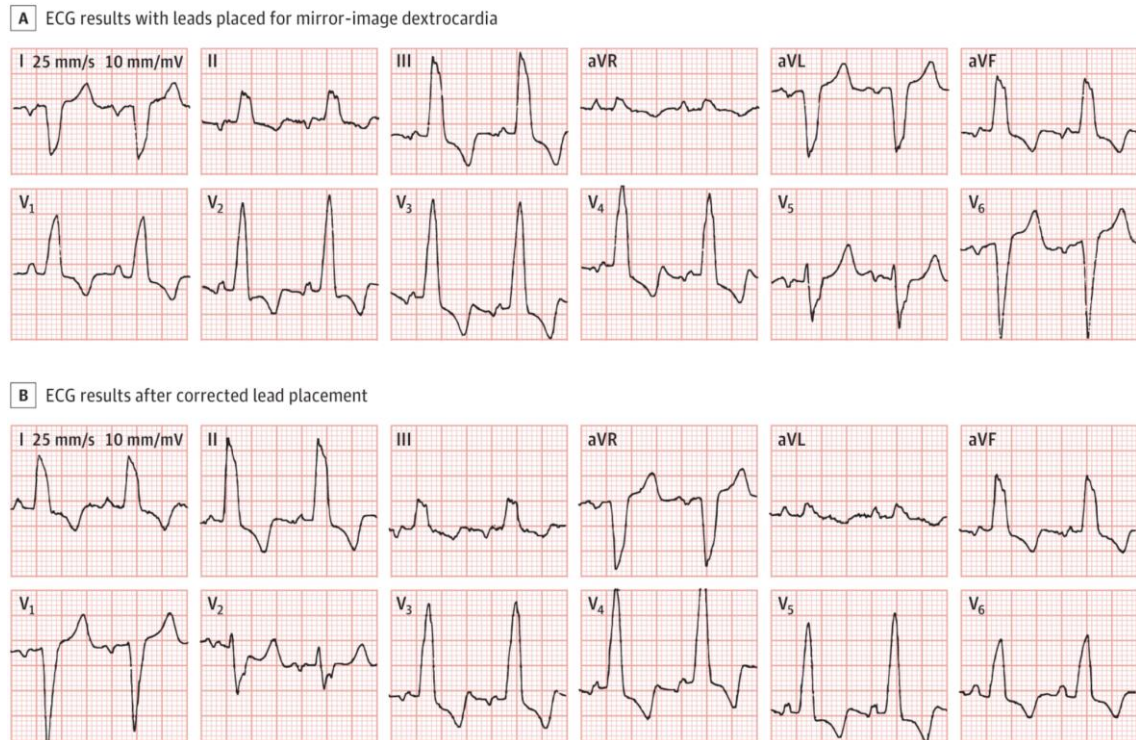


Figure 6. Electrocardiogram after correction in dextrocardia

A, A 12-lead electrocardiogram (ECG) was obtained with the lead electrodes placed according to the anatomic condition of mirror-image dextrocardia. B, The ECG leads were relocated, with the V₁ through V₆ leads placed in the V_{6R} through V_{3R}, V₁, and V₂ positions. The corrected 12-lead ECG shows an rS pattern in lead V₁ and slurred R waves in leads V₅ and V₆.

Chang Q and al. e. Bundle Branch Block Site in a Patient With a Right-Lying Heart and Wide QRS Complex. *JAMA Intern Med.* 2018.

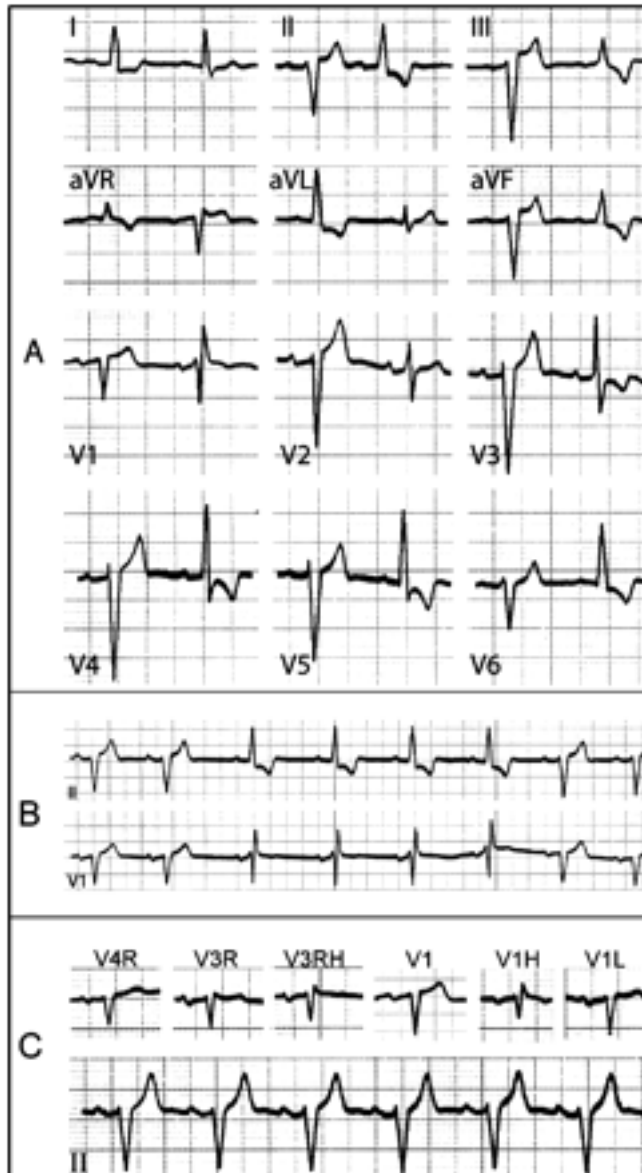


Figure 7. Permanent RBBB with intermittent left anterior hemiblock (LAH). The LAH conceals the signs of RBBB. A, In every lead, the first beat shows LAH (plus RBBB), and the second beat shows RBBB alone. B, Simultaneous recording of leads II and V1. LAH is seen only in the first 2 beats and the last 2 beats. When LAH is absent, a typical RBBB pattern is uncovered. C, The precordial chest leads recorded at the time when LAH was present (as seen in lead II) show the pattern of RBBB when V3R and V1 were recorded 1 intercostal space above the normal level (V3RH and V1H).

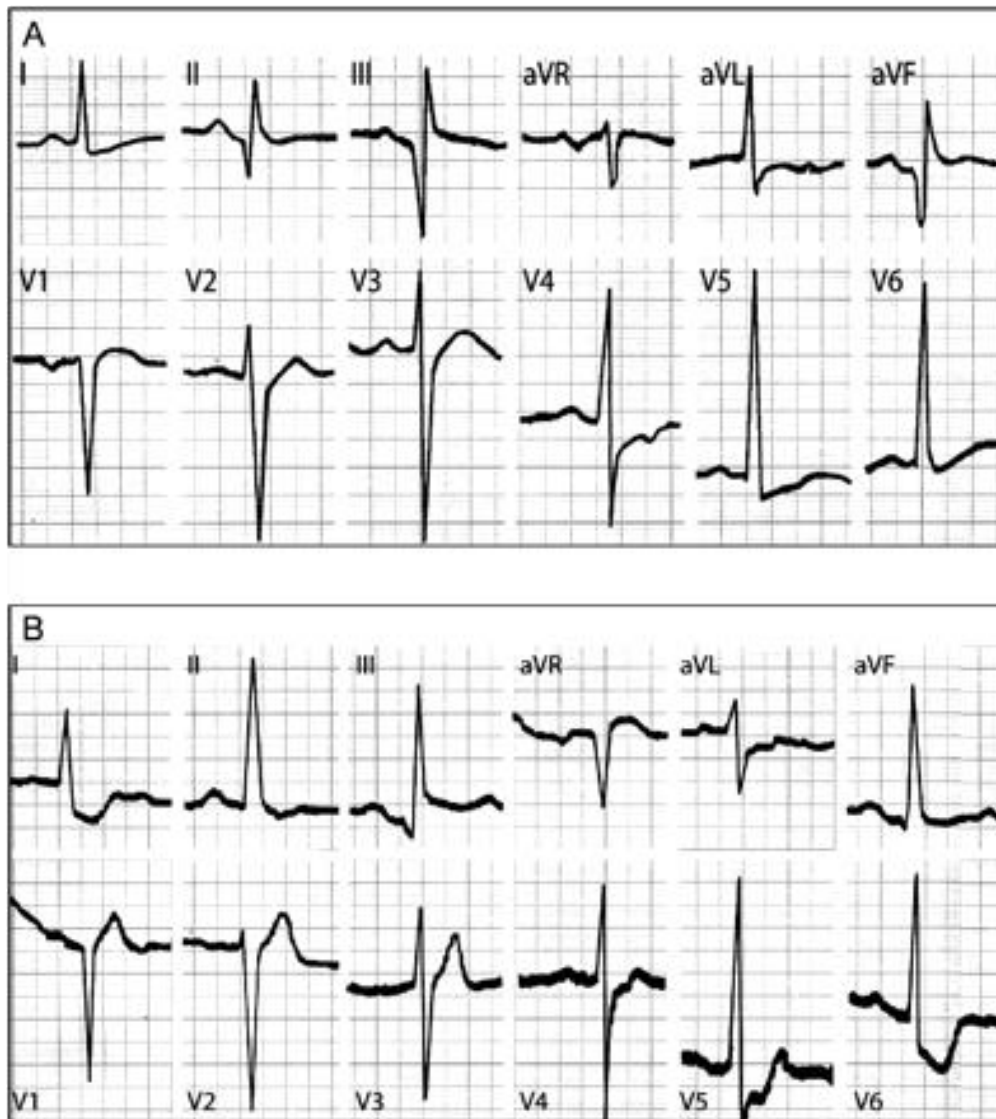


Figure 8. Transient left posterior hemiblock (LPH) caused by subepicardial inferior wall injury greatly conceals the pattern of inferior wall myocardial infarction in a 62-year-old patient with unstable angina. A, Clear-cut signs of inferior infarction. B, During an episode of angina, the ECG shows a transient LPH, which almost completely conceals the signs of the inferior wall myocardial infarction.

Elizari MV, Acunzo RS, Ferreiro M. Hemiblocks revisited. *Circulation*. 2007;115:1154-63.

Table 16. ACC/AHA/HRS 2018 GL on bradycardia. Evaluation of conduction disorders (With 1:1 Atrioventricular Conduction and Normal PR Interval)

Transthoracic echocardiogram to exclude structural heart disease in patients with newly detected LBBB	I-B-NR
Ambulatory electrocardiographic monitoring in symptomatic patients with conduction system disease, in whom AV block is suspected	I-C-LD
Transthoracic echocardiography if structural heart disease is suspected in patients presenting with intraventricular conduction disorders other than LBBB	IIa-B-NR
EPS in symptoms suggestive of intermittent bradycardia (e.g., lightheadedness, syncope), with conduction system disease identified by ECG and no demonstrated atrioventricular block	IIa-B-NR
Advanced imaging (e.g., cardiac MRI, computed tomography, or nuclear studies) in patients with LBBB in whom structural heart disease is suspected and echocardiogram is unrevealing	IIa-C-LD
Ambulatory electrocardiographic recording to document suspected higher degree of AV block in patients with extensive conduction system disease (bifascicular or trifascicular block).	IIb-C-LD
Stress testing with imaging in asymptomatic patients with LBBB in whom ischemic heart disease is suspected	IIb-C-LD

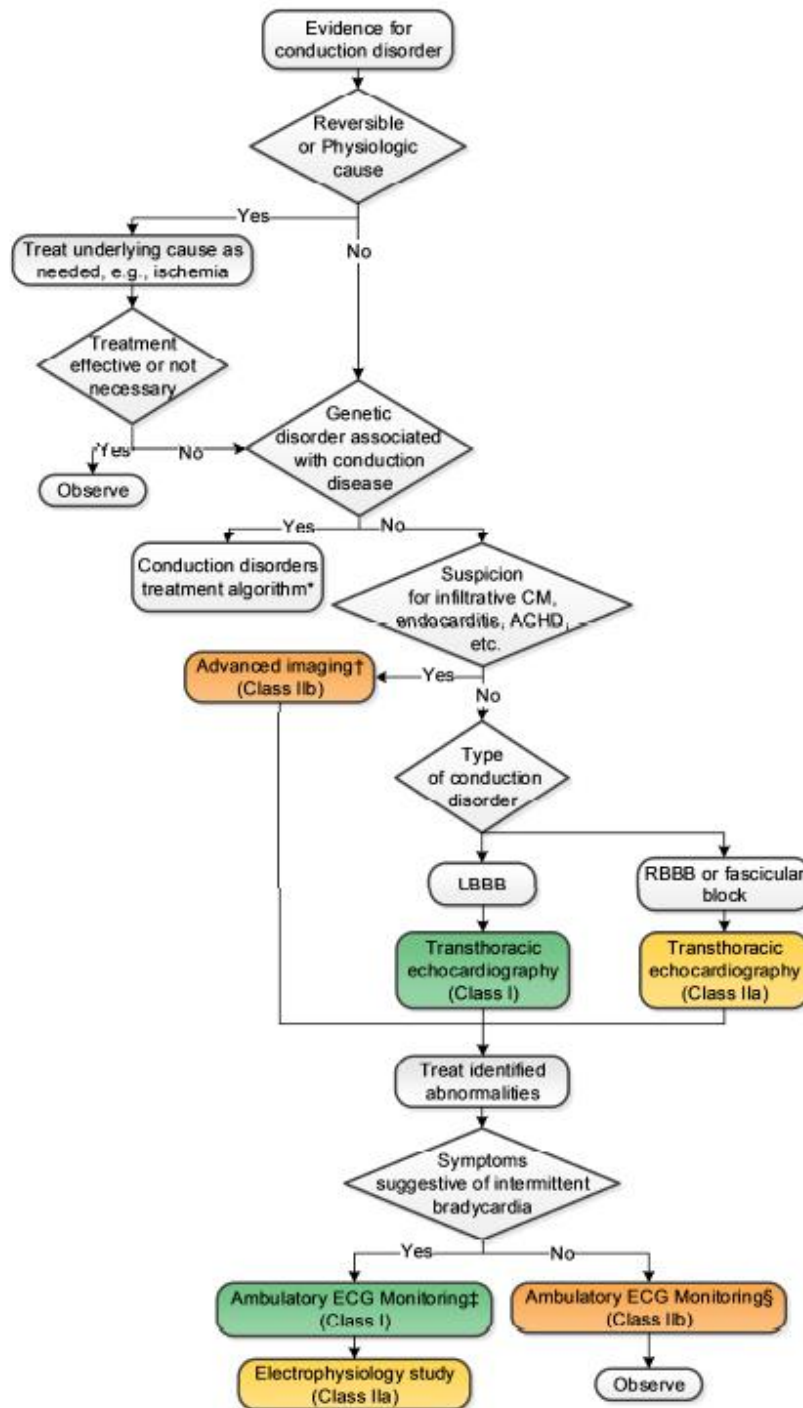


Figure 9. ACC/AHA/HRS 2018 GL on bradycardia. Evaluation of conduction disorders algorithm

†Advanced imaging could include magnetic resonance imaging, computed tomography, or transesophageal echocardiography.

‡Monitor choice based on the frequency of symptoms.

§Extensive conduction disease (e.g., first-degree atrioventricular block combined with LBBB).

ACHD indicates adult congenital heart disease; CM, cardiomyopathy; ECG, electrocardiogram/electrocardiographic; LBBB, left bundle branch block; and RBBB, right bundle branch block.

Table 17. Pacing in conduction disorders**ACC/AHA/HRS 2018 GL on bradycardia. Permanent Pacing in Conduction Disorders (With 1:1 Atrioventricular Conduction and Normal PR Intervals)**

Syncope and bundle branch block and an HV interval ≥ 70 ms or I-C-LD infranodal evidence of block at EPS	I C-LD
Alternating bundle branch block	I-C-LD
In Kearns-Sayre syndrome and conduction disorders, with additional defibrillator capability.*	IIa-C-LD
In with Anderson-Fabry disease and QRS prolongation >10 ms, with additional defibrillator capability*	IIb-C-LD
CRT in heart failure, a mildly to moderately reduced LVEF (36%-50%), and LBBB (QRS ≥ 150 ms)	IIb-C-LD
In asymptomatic patients with isolated conduction disease and 1:1 AV conduction, permanent pacing is not indicated (in the absence of other indications for pacing)	III-B-NR (Harm)

*: if meaningful survival > 1 year is expected

ESC 2021 GL on pacing and CRT. Recommendations for pacing in patients with bundle branch block

Pacing in patients with unexplained syncope and bifascicular block, in the presence of either a baseline HV of ≥ 70 ms, second- or third-degree intra- or infra-Hisian block during incremental atrial pacing, or an abnormal response to pharmacological challenge.	I B
Pacing in patients with alternating BBB with or without symptoms.	I C
Pacing in selected patients with unexplained syncope and bifascicular block without EPS (elderly, frail patients, high-risk and/or recurrent syncope).	IIb B
Pacing is not recommended for asymptomatic BBB or bifascicular block.	III B

BBB = bundle branch block; EPS = electrophysiology study; HV = His-ventricular interval.

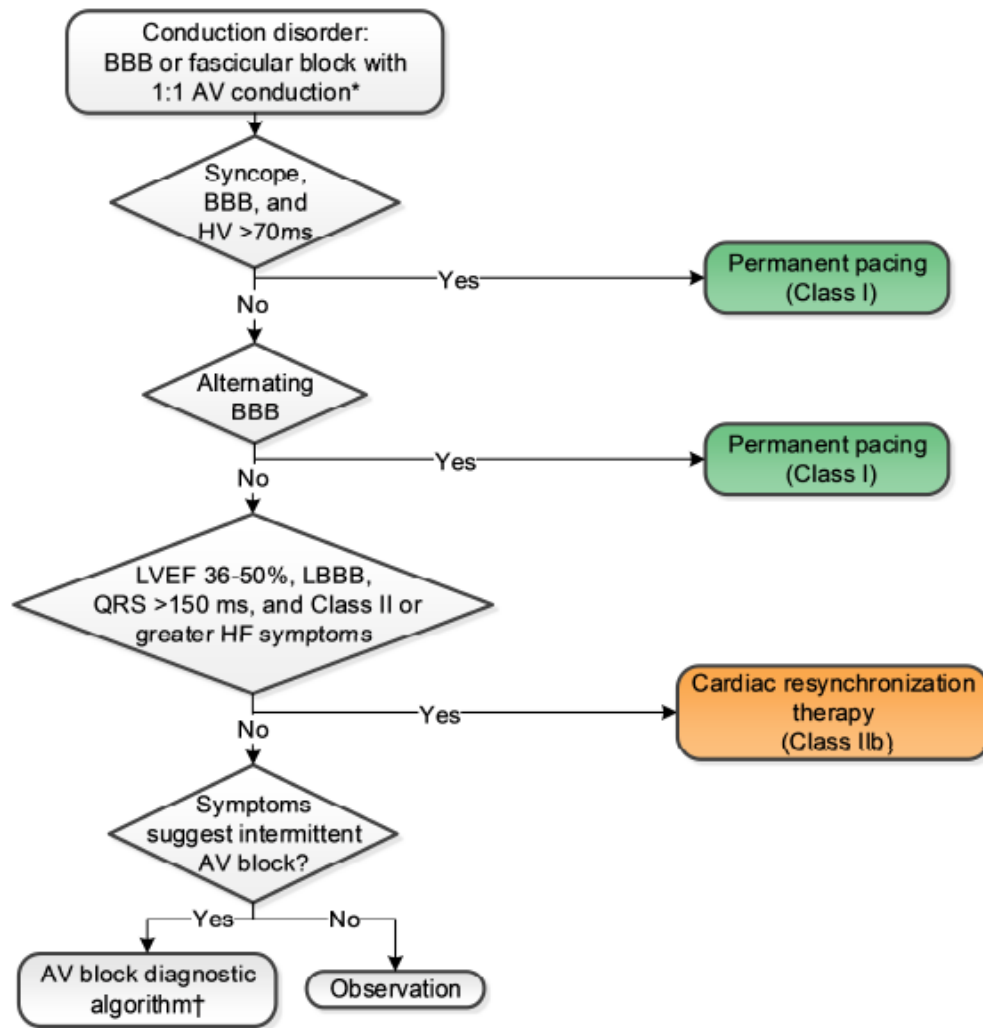


Figure 10. ACC/AHA/HRS 2018 GL on bradycardia. Management of Conduction Disorders Algorithm

*For severe first-degree atrioventricular block or first-degree atrioventricular block with an accompanying neuromuscular disease, also refer to the atrioventricular block algorithm.

AV indicates atrioventricular; BBB, bundle branch block; HF, heart failure; LBBB, left bundle branch block; and LVEF, left ventricular ejection fraction.

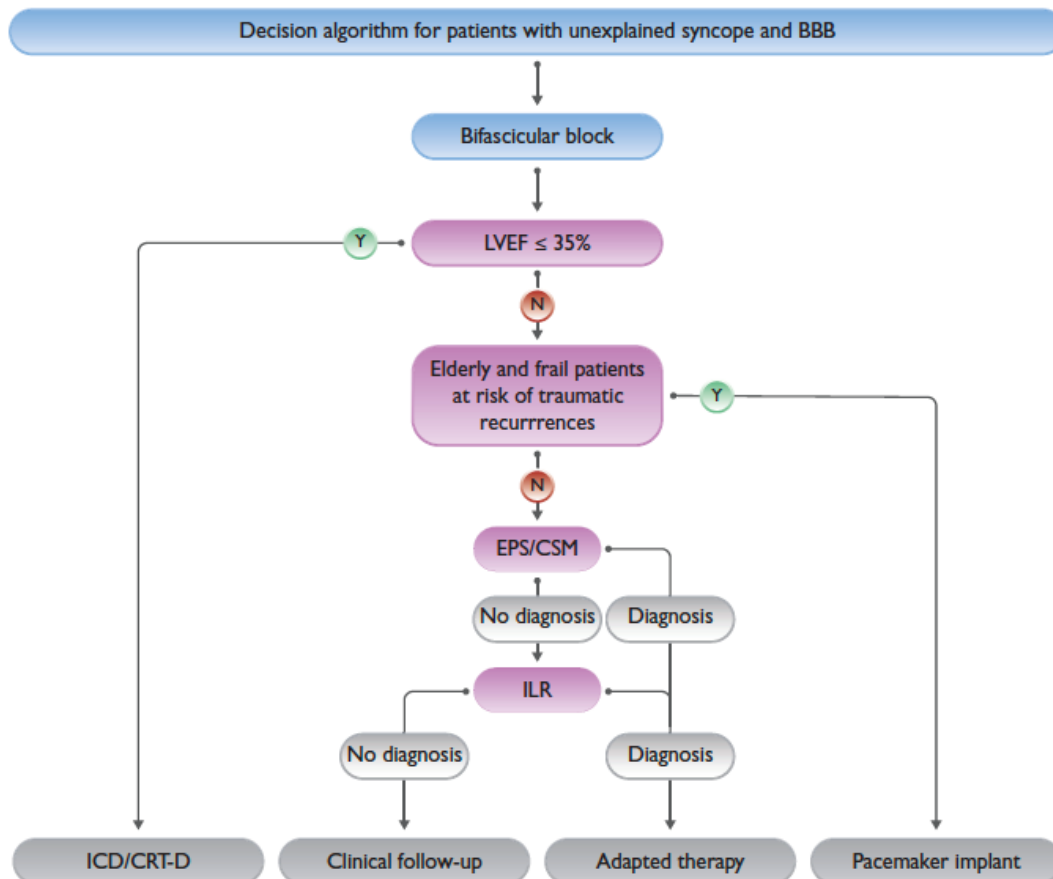


Figure 11. ESC 2021 GL on pacing and CRT. Decision algorithm for patients with unexplained syncope and bundle branch block.

BBB = bundle branch block; CRT-D = defibrillator with cardiac resynchronization therapy; CSM = carotid sinus massage; EPS = electrophysiology study; ICD = implantable cardioverter-defibrillator; ILR = implantable loop recorder; LVEF = left ventricular ejection fraction.