Indications for CRT in patients with heart failure and low ejection fraction in sinus rhythm

- CRT is recommended in chronic HF patients and LVEF ≤35% who remain symptomatic in NYHA functional class II, III and ambulatory IV despite adequate medical treatment and who have **LBBB with QRS duration >120 ms on ECG.**
- CRT should be considered in chronic HF patients and LVEF ≤35% who remain in NYHA functional class II, III and ambulatory IV despite adequate medical treatment and who have **non-LBBB with QRS duration >150 ms.** If QRS duration is 120-150ms, the benefits are uncertain.
- CRT in patients with chronic HF with **QRS duration <120 ms** is not recommended.

Indications for CRT in patients in atrial fibrillation

1. **Patients with HF, wide QRS and reduced LVEF:**
   1A. CRT should be considered in chronic HF patients, intrinsic QRS ≥120 ms and LVEF ≤35% who remain in NYHA functional class III and ambulatory IV despite adequate medical treatment, provided that a biventricular pacing as close to 100% as possible can be achieved.
   1B. AV junction ablation should be added in case of incomplete biventricular pacing.
2. **Patients with uncontrolled heart rate who are candidates for AV junction ablation** CRT should be considered in patients with reduced LVEF.

Indications for upgraded or *"de novo"* CRT in patients with conventional pacemaker indications and heart failure

- **Upgrade from conventional PM or ICD.** CRT is indicated in HF patients with LVEF <35% and high percentage of ventricular pacing who remaining NYHA class III and ambulatory IV despite adequate medical treatment.
- ***"De novo"* CRT implantation.** CRT may be considered in HF patients, reduced EF and expected high percentage of ventricular pacing in order to decrease the risk of worsening HF.

Clinical guidance to the choice of CRT-P or CRT-D in primary prevention

Factors favouring CRT-D	Factors favouring CRT-P
Life expectancy >1 year	Advanced heart failure
Stable heart failure, NYHA II	Severe renal insufficiency or dialysis
Ischaemic heart disease	
(low and intermediate MADIT risk score)	Other major co-morbidities
Lack of comorbidities	Frailty
	Cachexia

CRT-D = cardiac resynchronization therapy and defibrillator; CRT-P = cardiac resynchronization therapy and pacemaker.

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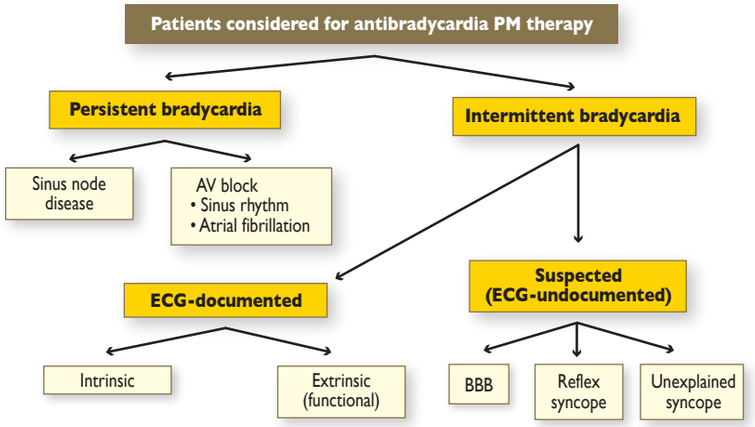
The diagnosis of bradyarrhythmia is usually made from a standard ECG when persistent, and from a standard ECG or more prolonged ECG recordings [ambulatory monitoring or implantable loop recorder (ILR)] when intermittent. Provocative testing or an electrophysiological study (EPS) may be required when a bradycardia is suspected but not documented.

Since there is no defined heart rate below which treatment is indicated, correlation between symptoms and bradyarrhythmia is essential when deciding on the need for cardiac pacing therapy. This can be difficult to establish in patients with competing mechanisms for their symptoms. In general, an attempt to obtain ECG documentation during syncope (symptom-arrhythmia correlation) is warranted (see below).



Patients with persistent bradycardia (sinus bradycardia or AV block)

- Pacing is indicated when symptoms can clearly be attributed to bradycardia due to sinus arrest or AV block.
- Pacing is indicated in patients with third- or second-degree type 2 AV block irrespective of symptoms.
- Pacing may be indicated when symptoms are likely to be due to bradycardia, even if the evidence is not conclusive.

From the 2013 ESC Guidelines on Cardiac Pacing and Cardiac Resynchronization Therapy (European Heart Journal 2013; 34:2281-2329 -doi:10.1093/eurheartj/eht150).

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Special thanks to Christi Deaton and Arno W. Hoes for their contribution.

Patients with intermittent documented bradycardia (sinus bradycardia or AV block)

- Pacing is indicated in patients who have documented symptomatic bradycardia due to sinus arrest or AV block.
- Pacing is indicated in patients with third- or second-degree type 2 AV block irrespective of symptoms.
- **Reflex asystolic syncope.** Pacing should be considered in patients ≥40 years with recurrent, unpredictable reflex syncopes and documented symptomatic pause/s due to sinus arrest or AV block or the combination of the two.

Patients with syncope and suspected (undocumented) bradycardia

- **Bundle branch block (BBB).** Pacing is indicated in patients with alternating BBB and in patients with BBB and positive EPS defined as HV interval of ≥70 ms, or second- or third-degree His-Purkinje block demonstrated during incremental atrial pacing or with pharmacological challenge.
- **Bundle branch block (BBB).** Pacing may be considered in selected patients with unexplained syncope and BBB.
- **Carotid sinus syncope.** Pacing is indicated in patients with dominant cardioinhibitory carotid sinus syndrome and recurrent unpredictable syncope.
- **Tilt-induced cardioinhibitory syncope.** Pacing may be indicated in patients with tilt-induced cardioinhibitory response with recurrent frequent unpredictable syncope and age >40 years afteralternative therapy has failed

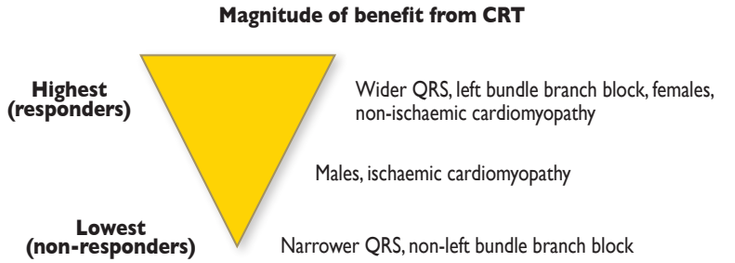
Part 2. Indications for cardiac resynchronization therapy (CRT) in patients with heart failure or low ejection fraction

Based on current guideline criteria only a small proportion of patients with heart failure (HF) (perhaps 5–10%) have cardiac dyssynchrony and are therefore indicated for CRT but this is still a large number of patients.

Cardiac dyssynchrony is complex and multifaceted. Prolongation of the AV interval delays systolic contraction, inter- and intra-ventricular conduction delays lead to asynchronous contraction of LV wall regions (ventricular dyssynchrony). Cardiac resynchronization therapy (CRT) helps to restore AV, inter- and intra-ventricular synchrony, improving LV function, reducing functional mitral regurgitation and inducing LV reverse remodelling.

Key evidence supporting recommendations:

- Patients with both mild (NYHA class II) and more severe symptoms (NYHA class III) and severely depressed LVEF (<35%) are recommended to receive CRT as the benefits for both groups are similar in terms of mortality, hospitalization, and cardiac function. The evidence for recommending CRT in patients with NYHA class I is in conclusive due to the low number of patients enrolled in RCTs.
- The evidence for recommending CRT in patients with NYHA class IV is inconclusive due to the low number of patients enrolled in RCTs. However, an individual situation should be taken in account especially for NYHA class IV patients who have had no scheduled or unscheduled HF hospitalizations during the last month (termed "ambulatory" Class IV) in order to reduce hospitalizations and to improve symptoms
- LBBB morphology is required in class I recommendation. Sub-analyses of randomized clinical trials and meta-analyses have shown that the beneficial effects of CRT were observed in patients with typical LBBB.
- Sub-analyses from randomized clinical trials suggest that the beneficial effects of CRT on morbidity and mortality and LV function may be greater in females, patients with non-ischaemic cardiomyopathy and patients with QRS duration >150 ms (the longer the QRS duration, the greater the benefit).
- The evidence of benefit in patients with non-LBBB configuration is weak particularly in patients with QRS <150 ms and NYHA class I and II.
- RBBB most often implies worse disease state than LBBB and is generally expected not be benefit from CRT. For these patients the decision to implant a CRT should be individualized based on other clinical/ imaging criteria.
- There is no evidence of benefit from CRT for patients with QRS <120 msec.



Clinical factors influencing the likelihood to respond to CRT