

# CPX-Guided Functional Follow-up After LBBAP

## A 3-Month Baseline Protocol (3–6–12 Months)

### 1. Purpose

To standardize functional follow-up after left bundle branch area pacing (LBBAP) using cardiopulmonary exercise testing (CPX) in order to detect subclinical heart failure, chronotropic incompetence, and pacing-related limitations, and to guide device optimization.

### 2. Target Population

- All patients after LBBAP, regardless of symptoms.

### 3. Timeline (Standard of Care)

- **3 months:** Establish individual baseline CPX
- **6 months:** Change assessment vs 3-month baseline
- **12 months:** Stability assessment & annual plan

#### Triggered CPX (any time)

- New/worsening dyspnea or exercise intolerance
- BNP increase, HF admission, diuretic escalation
- After major device setting changes (for effect confirmation)

### 4. CPX Core Metrics

- Peak VO<sub>2</sub>
- VE/VCO<sub>2</sub> slope
- Anaerobic Threshold (AT)

### 5. Classification (Absolute + Change from 3-Month Baseline)

#### RED (urgent evaluation) – any one:

- Peak VO<sub>2</sub> < 12 ml/kg/min

- VE/VCO<sub>2</sub> slope  $\geq 36$
- AT  $< 10 \text{ ml/kg/min}$
- Or clear deterioration vs baseline
  - Peak VO<sub>2</sub> or AT:  $\geq 15\%$  decrease
  - VE/VCO<sub>2</sub> slope:  $\geq 10\%$  increase or  $+3$

### **YELLOW (optimization candidate) – not RED, but any one:**

- Peak VO<sub>2</sub> or AT: 5–14% decrease vs baseline
- VE/VCO<sub>2</sub> slope: 5–9% increase or +1 to +2
- New/worsening exertion symptoms

### **GREEN**

- Stable or improved vs baseline

## **6. Action Algorithm**

### **GREEN**

- Routine follow-up
- Next CPX at 12 months (then annually or symptom-triggered)

### **YELLOW – Mandatory Device Optimization Bundle (A + B)**

**Before escalation, perform both:**

#### **A) Rate Response Optimization (required)**

- Assess heart-rate rise pattern during activity/CPX
- Sensor sensitivity & response speed
- Alignment between symptoms and HR behavior
- Adjust if inadequate; document before/after

#### **B) Upper Rate / Sensor Max Review (required)**

- Evaluate exercise “plateau” or early headroom limitation
- Review/adjust upper tracking rate and maximum sensor rate
- Consider safety and patient’s habitual activity

Reassess with next scheduled CPX (earlier if symptoms persist).  
If no improvement → manage as RED.

## **RED**

- Prompt Echo + 12-lead ECG + detailed device interrogation
- Correct reversible factors and reprogram
- Repeat CPX in 6–12 weeks to confirm improvement

# **7. Standard Tasks by Visit**

## **3 months (Baseline)**

- CPX (VO<sub>2</sub>, VE/VCO<sub>2</sub>, AT)
- 12-lead ECG
- Device interrogation (save settings as baseline)

## **6 months (Change)**

- CPX
- Classify (Green/Yellow/Red) vs baseline
- Intervene per algorithm

## **12 months (Stability)**

- CPX
- Annual plan (routine vs symptom-triggered)

# Device Optimization Checklist (for YELLOW)

Patient ID : \_\_\_\_\_ Date : \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ Timepoint : 3M / 6M / 12M

Baseline (3M) Peak VO<sub>2</sub> : \_\_\_\_\_

Current Peak VO<sub>2</sub> : \_\_\_\_\_ Δ : \_\_\_\_\_ %

Confounders :  Anemia  Infection  Weight change  Medication change   
Reduced activity

## A) Rate Response Pattern

**HR rise during activity/CPX:**

Slow onset  Mid-level plateau  Minimal rise  Appropriate

**Symptom–HR alignment:**

Mismatch  HR can't keep up  Aligned

**Daily activity level:**

Low  Moderate  High

Action:  Sensitivity ↑  Response speed ↑  No change

Before: \_\_\_\_\_ → After: \_\_\_\_\_

## B) Upper Rate / Sensor Max

Exercise limitation:  Plateau  Palpitations limit  None

Upper tracking / sensor max:

Before: \_\_\_\_\_ bpm → After: \_\_\_\_\_ bpm

## C) Disposition

Expect improvement → reassess by CPX  
 Insufficient → RED pathway (Echo + ECG + detailed device review)