

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_2
- VE/VCO_2 slope
- Anaerobic Threshold (AT)

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

RED (urgent evaluation) – any one:

- Peak $\text{VO}_2 < 12 \text{ ml/kg/min}$

- VE/VCO_2 slope ≥ 36
- $AT < 10$ ml/kg/min
- Or clear deterioration vs baseline
 - Peak VO_2 or AT: $\geq 15\%$ decrease
 - VE/VCO_2 slope: $\geq 10\%$ increase or +3

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

- Peak VO_2 or AT: 5–14% decrease vs baseline
- VE/VCO_2 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_2 , VE/ VCO_2 , 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 VO₂ : _____

Current Peak VO₂ : _____ 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)