

## Temporary Epicardial Pacing

### Overview

The scope of this chapter is to cover the basics of perioperative management of epicardial pacing in cardiac theatres and CICU. While there are patients at higher risk of arrhythmias, it is not possible to reliably predict who will require temporary pacing and therefore wires are routinely placed in many cardiac centres.

Whilst commonplace, **epicardial wires are not without risk**, including infection, myocardial damage, perforation, tamponade and disruption of coronary anastomoses. Historically, wires were placed solely on the right ventricle, yet univentricular pacing is inefficient and limits the available pacing modes. Significant mechanical and rhythmical advantage is gained by placing right atrial and right ventricular wires (Dual Chamber) allowing AV sequential pacing. However, this practice is not universal due to the small but serious risks of the additional wire and so a balanced approach is taken.

The major problem with epicardial wires is failure secondary to localised inflammatory reaction which requires progressively larger currents to pace. By post-op Day 5, >60% atrial wires fail to capture, so if it is evident that longer term pacing is required, a definitive plan for permanent pacemaker insertion should be made.

Wires are removed via gentle traction by nursing staff after anticoagulation and clinical status has been reviewed as per local policy (e.g. Heparin off 4 hours, INR <2, non-paced ECG reviewed). There may be resistance due to a tight suture in the epicardium, in which case they may be cut short and left without long term harm. This is the surgical team's responsibility in Bristol. Patients should be observed for arrhythmias and the small but tangible risk of tamponade.

### Pacing Set-up

#### Epicardial Wires

A wire is embedded in the myocardium with the aid of a small needle before being cut off, while a larger needle is used to bring the wire to the surface. Historical convention follows that Ventricular wires are brought out to the skin on the **LEFT** of the sternum and Atrial wires on the **RIGHT**. The wires may be:

- Unipolar (2 wires per chamber paced): Negative anode placed in myocardium, cathode placed in subcutaneous tissue.
- Bipolar (1 wire per chamber): Cathode and anode contained in single wire.

#### Connecting Cable

There are multiple variants and you should familiarise yourself with those in local use and how they connect to the pacing box. There should be **access to emergency back-up wires**.

## Pacing Box/Pulse Generator

These vary greatly, but a diagram of the Biotronik Reacor D (as used in Bristol) is included in Figure 1. Typically, they comprise a battery power source (**back-up batteries should be immediately available**), a connection for the wires, a rate dial, a mode dial and dials for atrial and ventricle sensitivity and amplitude. LEDs indicate when a wire has sensed or paced.

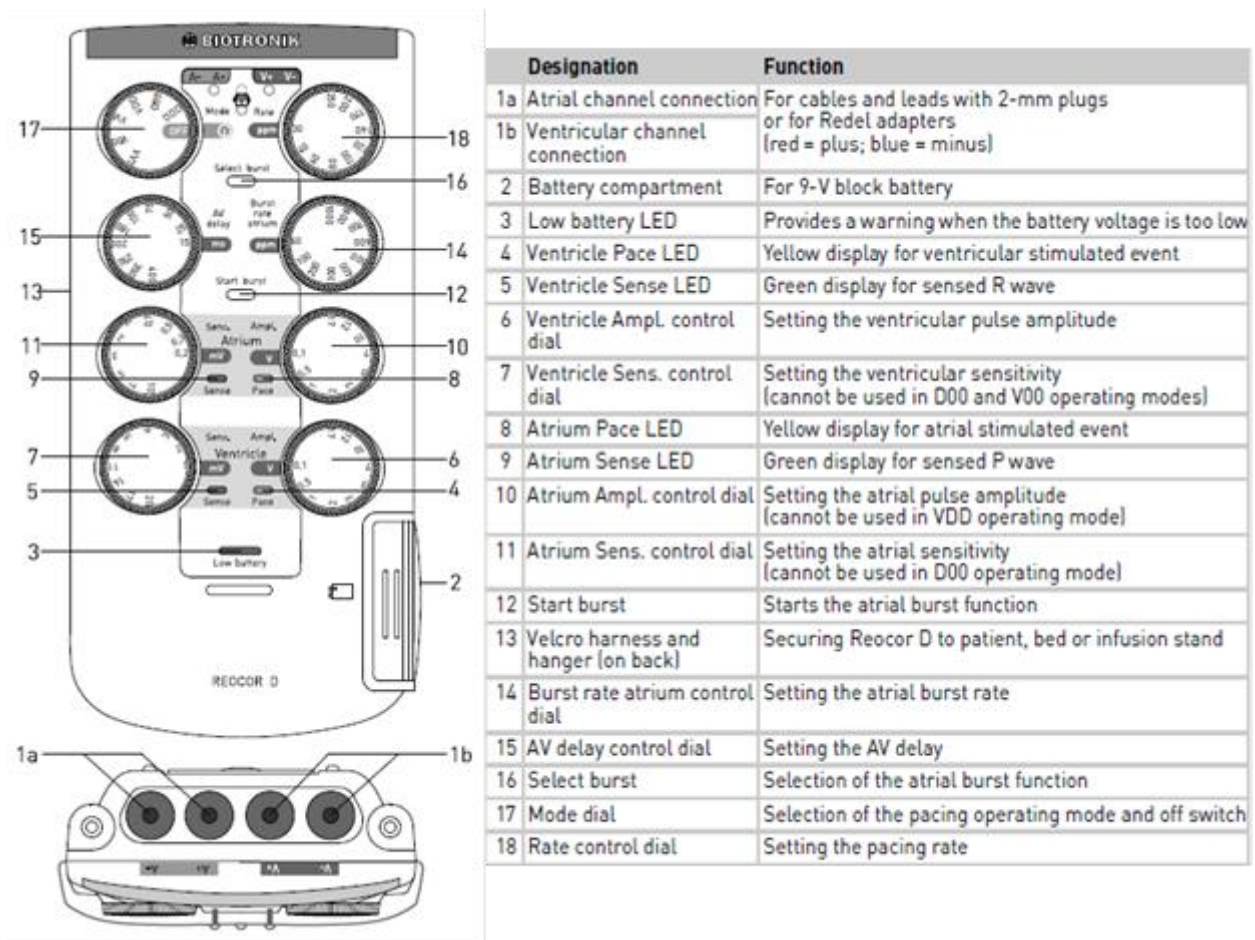


Figure 1 – Features of the Biotronik Reacor D temporary pacing box

## Indications

Indications for perioperative pacing are not universally accepted and so vary between institutions. Broadly, they include:

- 1) **Conduction abnormalities:** AV delay, AV block (2<sup>nd</sup> degree Mobitz Type 2 or 3<sup>rd</sup> degree), Bifascicular 1<sup>st</sup> degree block, prolonged QT
- 2) **Tachycardia:** AV Junctional (common after bypass), re-entrant SVTs, VT, Type 1 Atrial Flutter
- 3) **Prophylactic:** Atrial Fibrillation prophylaxis (not routinely), Bradycardia dependent VT

- 4) **Other:** Sinus bradycardia (with low cardiac output state), to restore AV synchrony, HOCM, post-transplant

### General Care

Daily checks may be more frequently undertaken by nursing staff, but you should be aware how to check the pacing set-up as you will need to troubleshoot in emergencies. These should include examination of the wires for migration, checking the battery of the pacing generator and reviewing the following:

- 1) **Underlying Rhythm:** Turn down rate (Figure 1(18)) to expose endogenous rhythm rather than turning down energy (Figure 1 (6 & 10)) until capture lost
- 2) **Sensitivity:** The minimum current the pacemaker is able to sense (lower = *greater sensitivity*). Set the mode to VVI/DDD (Figure 1(17)) and set rate (Figure 1(18)) to below endogenous rate. Increase the sensitivity (Figure 1(7&11)) until the sensing LED stops flashing (Figure 1(5&9)) and asynchronous pacing is observed. TAKE CARE as this may cause R on T phenomenon.
- 3) **Capture Threshold:** The minimum pacemaker output to stimulate an action potential. Set pacemaker rate above endogenous rate (Figure 1(18)) so chamber is consistently paced. Reduce the energy output (Figure 1 (6 & 10)) until a QRS does NOT follow each pacing spike. This is the capture threshold and should be documented. The output is typically set at TWICE this value as a safety margin.
- 4) **Mechanical Capture:** Evidence of improved/altered cardiac output should be sought by examining arterial line trace, pulse oxygen trace or TTE/TOE.
- 5) **Rate:** Optimal HR depends on individual patient haemodynamics, but in practice 80-90 bpm is used. Back-up modes (e.g. VVI) are usually set to 40bpm.

### Specific Risks

#### Microshock-Induced Arrhythmia

Epicardial wires provide a low resistance connection to the heart and can potentially trigger arrhythmias. The nursing environment should protect against microshock, non-conductive gloves worn and a large metal object (e.g. bed) touched to discharge static before handling the wires.

## R on T Phenomenon

Delivery of a pacing spike during ventricular repolarisation (R on T) can induced ventricular fibrillation. This is MOST likely to occur in the rarely used asynchronous pacing modes (VOO, DOO, AOO). However, it can occur in synchronous modes if the ventricular wire becomes **less** sensitive prohibiting synchronisation (i.e. a higher mV value required to sense). Due to this risk, ventricular sensitivity is often kept <2mV (Figure 1(18)).

## Pacing Modes

Akin to permanent pacemaker (PPMs), temporary epicardial pacing modes are described by the NASPE/BPEG Generic (NBG) Pacemaker Code. Only the first 3 letter are relevant in temporary systems, as detailed in Figure 2.

I	II	III
Chamber paced	Chamber sensed	Response to sensing
O = none	O = none	O = none
A = atrium	A = atrium	T = triggered
V = ventricle	V = ventricle	I = inhibited
D = dual (A + V)	D = dual (A + V)	D = dual (T + I)

*Figure 2 – Abbreviated NBG Pacing Code*

Figure 3 provides a summary of the characteristics of some common temporary pacing modes. If atrial and ventricular wires are available, dual chamber modes are usually preferable.

Code	Description	Indications	Limitations
<b>AOO</b>	<b>Atrial Asynchronous</b> Fixed rate atrial pacing reliant on intact AV node	Bradycardia with intact AVN and synchronous mode contraindicated, e.g. electrocautery	AV block, can cause AF Not for atrial tachycardia
<b>VOO</b>	<b>Ventricular Asynchronous</b> Pacing regardless of underlying rhythm	Bradycardia without AV conduction, where synchronous modes contraindicated. As emergency back-up to preserve cardiac output	High risk R on T
<b>AAI</b>	<b>Atrial Demand</b> Delivers atrial pacing on timed cycle unless endogenous atrial depolarisation sensed	Bradycardia with high endogenous atrial rate	Avoid in atrial tachycardia (cannot capture) and AV block
<b>VVI</b>	<b>Ventricular Demand</b> Pacing on timed cycle unless sufficient endogenous rate	Bradycardia and AV block AF/flutter <b>*DEFAULT IN EMERGENCIES*</b>	Loss of atrial contribution to ventricular preload
<b>DOO</b>	<b>AV Sequential Asynchronous</b> Timed atrial/ventricular pacing	As VOO but cardiac output may be better (atrial kick)	High risk R on T
<b>DDI</b>	<b>AV Sequential, Non-P Synchronous</b> Atrial sensing based pacing with benefit of inhibiting atrial rate if too high	As DDD but better in those prone to paroxysmal atrial tachyarrhythmia	No tracking of increased atrial rate if physiological sinus tachycardia
<b>DDD</b>	<b>AV Universal</b> Most commonly used mode if dual wires present	All indications for pacing, except atrial tachyarrhythmia.	Ventricular tracking of atrial tachycardia
<b>VDD</b>	<b>P wave Synchronous</b> Only ventricle paced, but atrium sensed	Specifically AV block with intact sinus node	Atrial tachyarrhythmia tracking, as per DDD

Figure 3 - Common Epicardial Pacing Modes  
**BLUE= Single chamber**  
**RED=Dual chamber**

## Pacing Emergencies

In the presence of in-situ epicardial wires, use of a pacing box should be the default method of pacing. Please remember however that:

- 1) Pacing wires can (and do) fail

**AND**

- 2) Epicardial wires are only ONE method of cardiac pacing.

The facilities, understanding and practical skills for cardiac rhythm monitoring, transcutaneous pacing and defibrillation should always be immediately available.

Specific sections have been written by One Heart, in conjunction with UHBristol, for the practical management of emergency epicardial pacing. Please see sections entitled “Peri-Operative Complete Heart Block” and “Emergency VVI Epicardial Pacing for Complete Heart Block” within this handbook.

## References

M.C Reade (2007). Temporary epicardial pacing after cardiac surgery: a practical review. Part 1: General considerations in the management of epicardial pacing. *Anaesthesia*, 62:264-271.

M.C Reade (2007). Temporary epicardial pacing after cardiac surgery: a practical review. Part 2. Selection of epicardial pacing modes and troubleshooting. *Anaesthesia*, 62:364-373.

BIOTRONIK SE & Co (2015). *Reocor D Operating Manual*. Revision: J (2015-01-26)  
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