Clinical Guideline

THE MANAGEMENT OF EPICARDIAL AND TRANSVENOUS PACING FOR ADULT PATIENTS

SETTING General Intensive Care Unit (GICU), Cardiac Intensive Care Unit (CICU).

FOR STAFF Staff managing adult patients with epicardial and transvenous pacing.

PATIENTS All adult patients with epicardial and transvenous pacing.

1. Background

Epicardial and transvenous pacing are temporary methods of supporting bradycardia, bradyarrhythmias and tachyarrhythmias until resolution or a definitive treatment is completed, typically by permanent pacemaker insertion (Reade, 2007, Mark, 2021).

In the initial emergency management of bradycardia, management with pharmacological agents is usually sufficient. However, in the peri arrest or cardiac arrest patient where this treatment is insufficient and epicardial/transvenous pacing wires are not already in situ, non-invasive transcutaneous pacing is recommended. This is a temporary measure whilst more definitive temporary transvenous pacing is urgently organised. Transcutaneous pacing will not be discussed in this guideline and guidance can be accessed from the Resuscitation Council UK (Soar *et al.,* 2021).

1.1 Indications for temporary epicardial and transvenous cardiac pacing

- Bradycardia causing haemodynamic instability.
- Bradycardia due to electrolyte disturbance, toxicities and surgery.
- Sinus node disease due to acute myocardial infarction.
- Heart blocks or asystole, causing life threatening haemodynamic instability.
- Syncope at rest.
- Intra and post operatively in cardiac surgery.
- Supressing tachyarrhythmias (e.g. ventricular tachycardia and torsade des pointes).

In addition to the treatment of bradyarrhythmias, overdrive pacing, is used in tachyarrhythmias such as Ventricular Tachycardia or Torsades De Pointes. A rate faster than the tachyarrhythmia is selected and overdrive pacing supresses it, decreasing the rate once the arrhythmia is suppressed.

Epicardial and transvenous pacing are more reliable, durable and better tolerated treatments than transcutaneous pacing, and are consequently implemented (Reade, 2007).

2. Types of temporary cardiac pacing wires

2.1 Epicardial temporary pacing wires

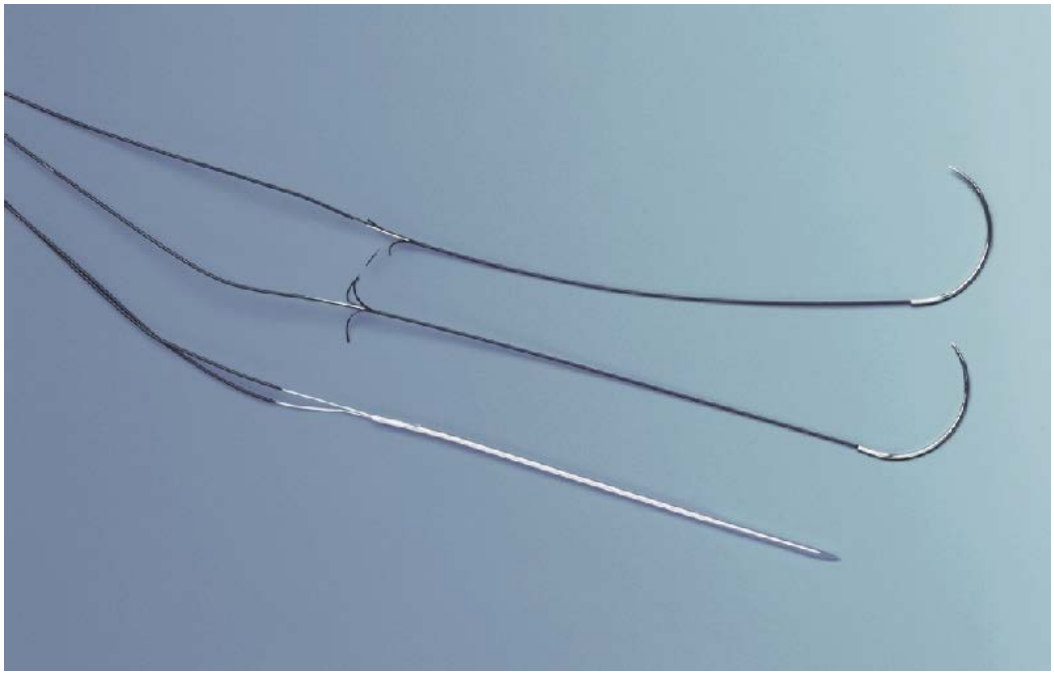


Figure 1. Epicardial pacing wires with insertion needle. These are removed after the wires are sutured to the epicardial surface with dissolvable sutures (Yartsev, 2021).

Temporary epicardial wires are typically inserted by the cardiothoracic surgeons during surgery, where they have been used since the 1960s for the intra and post-operative management of bradycardia, bradyarrhythmias and tachyarrhythmias (Khorsandi *et al.,* 2012).

Temporary pacing wire electrodes are thin stainless-steel wires insulated with Teflon, sutured to the epicardial surface of the right atrium or right ventricle with dissolvable sutures. Either atrial, ventricular or both wires can be inserted. If only one set of wires is present they will always be ventricular. When the chest is closed the pacing, wires are brought onto the chest surface and sutured in place to prevent accidental dislodgement. To determine the location of the epicardial wires, wires to the right ventricle, emerge on the left of the sternum. Wires to the right atrium emerge on the right of the sternum. Ventricular wires are normally white, whereas atrial wires are blue (Reade, 2007).

Epicardial pacing wires can be unipolar or bipolar systems. A unipolar system consists of a single wire (the negative anode) which attaches to the epicardium. A second positive electrode, also referred to as the ground electrode is required to complete the pacing circuit. This could be a second atrial or ventricular pacing wire or a ground electrode placed through the skin with a metal hypodermic needle. Rarely an epicardial wire may be placed through the skin into the subcutaneous tissue (Reade, 2007).

The bipolar system has a single wire with two conductors insulated from each other, which go to the epicardial surface. In the majority of clinical settings pacing wires are now bipolar. Both electrodes are within the heart and the heart muscle and intraventricular blood complete the circuit.

Generally, the spacing between the electrodes on bipolar leads ranges between 2.5mm and 30mm. Importantly the greater the distance between the electrodes, the greater the current that will be required. A higher current causes more inflammation around the wires, decreasing the duration of the systems effectiveness. When the wires are placed too far apart, this can affect the ability to sense electrical activity. Bipolar is beneficial over unipolar as less electrical current is required and less electrical interference occurs (Yartsev, 2021).

The metal end of the pacing wire is then screwed into the patient cable plug. The patient cable plug is attached to the pulse generator box delivering an electrical current to the chamber(s) where the wires have been placed, causing electrical current to be delivered and depolarisation. Epicardial wires have a shorter duration of effectiveness compared to transvenous wires and deteriorate gradually over time. Reliable epicardial pacing and sensing functions are normally lost over five to ten days (Yartsev, 2021).

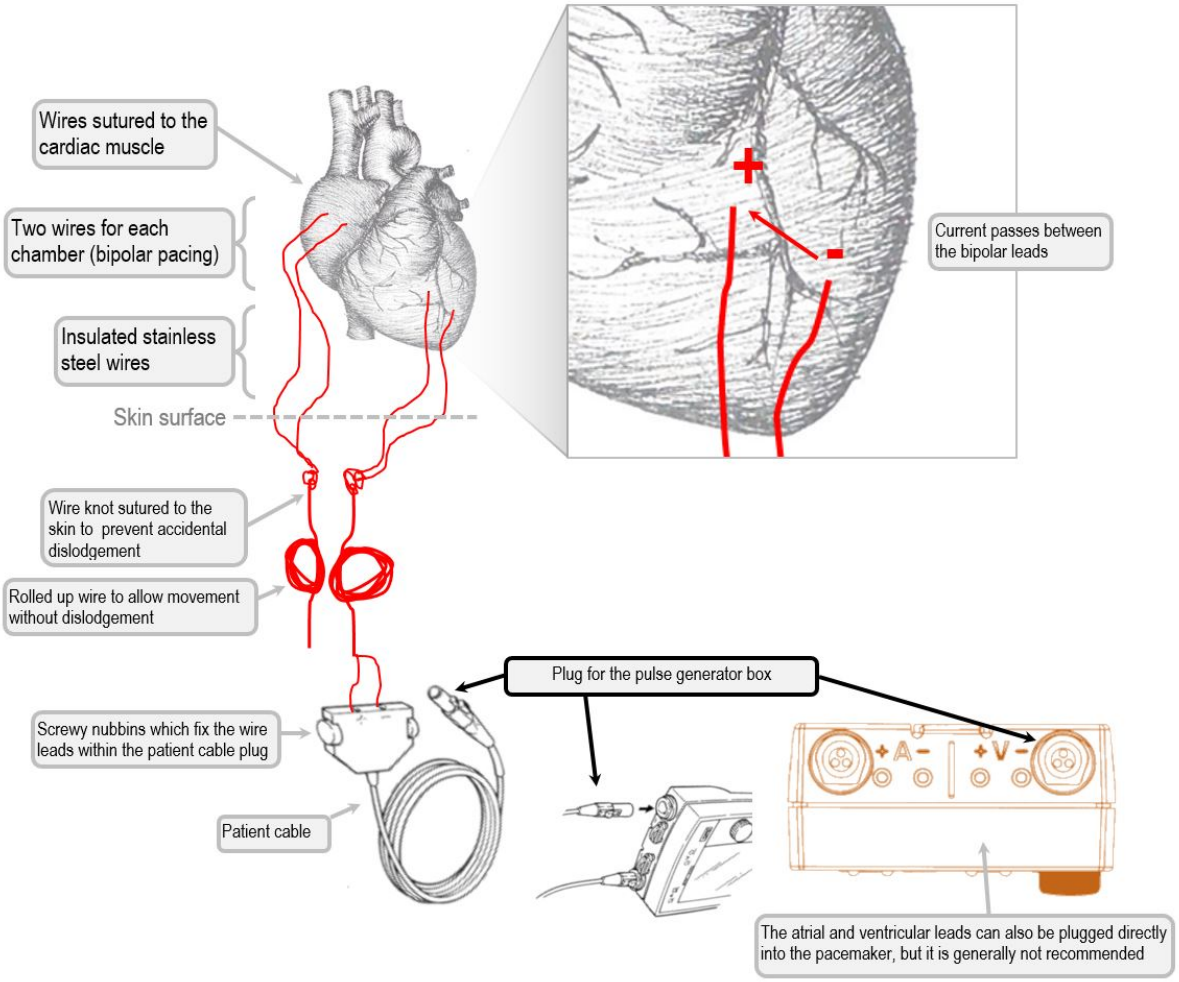


Figure 2. Diagram showing the epicardial pacing wires attached to a patient cable plug, patient cable and pulse generator box (Yartsev, 2021).

2.2 Transvenous cardiac pacing wires

Transvenous temporary cardiac pacing provides lifesaving, emergency therapy for patients with bradycardia and arrhythmias that cause haemodynamic instability. It can be used as a bridging technique when a permanent pace maker insertion is not immediately indicated or available (Tjong *et al*, 2019).

Insertion can be challenging and is completed by a skilled trained operator. Within the hospital setting the procedure is normally inserted within a fully equipped temporary pacing room, using a trained team. Central venous access is obtained with a Seldinger technique, with operators preferring the right internal jugular, and left subclavian, allowing a more direct anatomical route. Sites of potential permanent pacemakers are best avoided, normally the left subclavian and left cephalic vein. A venous sheath is inserted, allowing the bipolar pacing wire to be inserted through this. The venous sheath allows blood samples to be taken and the insertion of drugs, via the side arm (Royal College Physicians).

A bipolar single temporary transvenous catheter is then floated under fluoroscopic guidance through the right side of the heart while the patient is monitored on an ECG. The wire containing a deflated balloon passes through the right atrium, tricuspid annulus and into the right ventricle, with the tip pointing down into the right ventricular apex. The balloon is then inflated, where it sits against the right ventricular wall protecting it from damage, and keeping it in place during deep inspiration. The transvenous pacing electrodes are in close proximity at the end of the catheter tip. Its placement is confirmed by chest x-ray and a successful attempt at pacing. Complications of insertion include damage or perforation to the valves or ventricle. Transient ventricular arrhythmias on insertion are normal. Pneumothorax should be excluded on the return to critical care by completing a chest x ray (Royal College Physicians).

This single bipolar temporary pacing wire can be attached to a pulse generator (pacing box) for transvenous pacing. An electrical stimulus is delivered to the ventricle resulting in depolarisation and contraction (Mark, 2021).

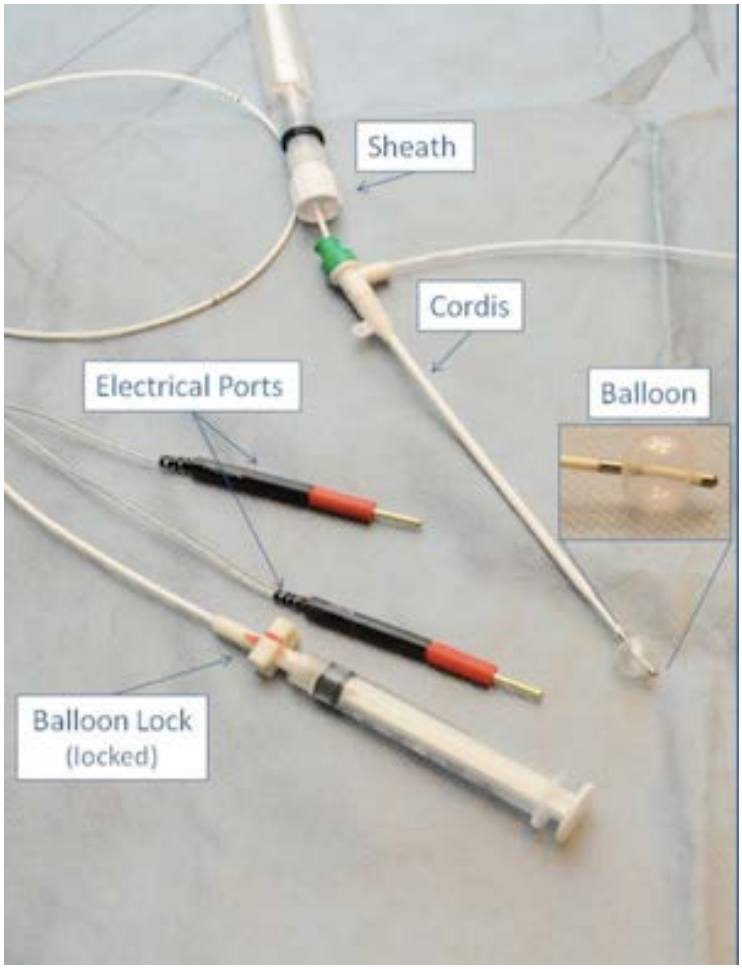


Figure 3. Photo showing the different parts of a transvenous pacing wire (Hill, 2015).

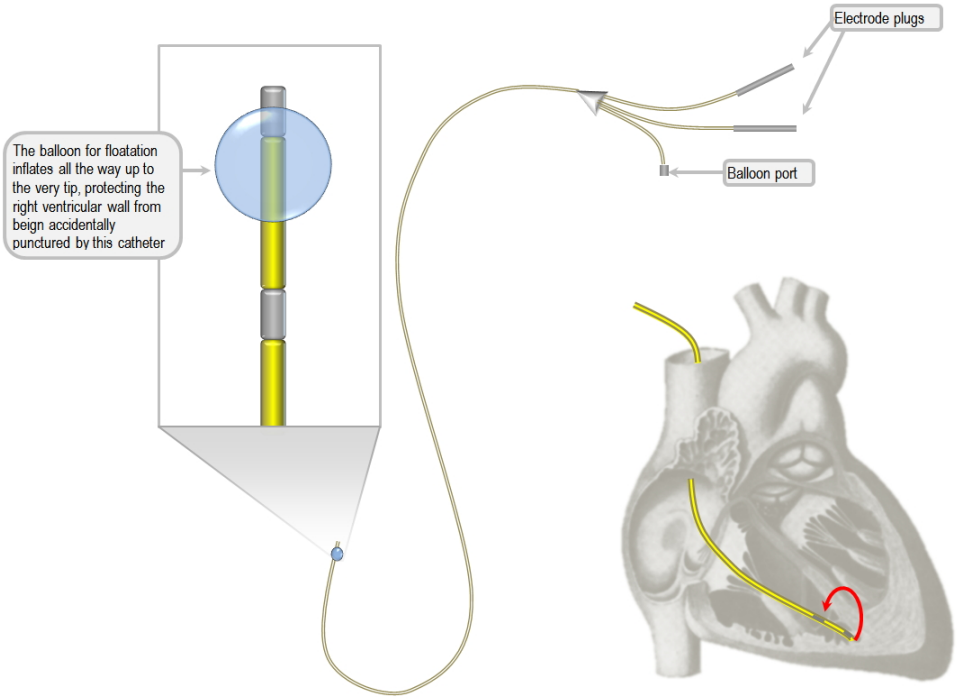


Figure 4. Diagram of a transvenous pacing wire in the correct position. The tip and balloon inflated within the apex of the right ventricle (Yartsev, 2021).

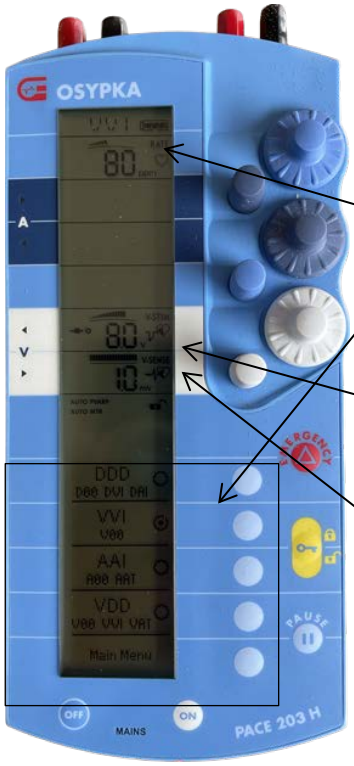
3. Understanding cardiac pacing

3.1 Pulse generator (pacing box)

The pulse generator is commonly referred to as a pacing box in clinical practice. The term pulse generator will be used within the remainder of this document. The pulse generator is battery operated, and attached to epicardial or transvenous pacing wires supplying them with an electrical current. Several companies manufacture pulse generators but the basic important functions are similar in all the devices.

The pulse generator (pacing box) allows adjustment of the pacing mode, pacing rate, pacing output and sensitivity to intrinsic activity. Within this document the aforementioned settings are explained, of which it is crucial that the operator understands to provide safe temporary pacing to patients (Yartsev, 2021).

3.2 A basic overview of the pulse generator pacing settings



3.2.1 Mode

Mode determines which leads are paced and how the pacer responds to intrinsic cardiac activity.

3.2.2 Rate

Rate determines how often the pulse generator will deliver an electrical impulse in the absence of intrinsic activity. This determines the pulse rate assuming there is mechanical capture.

3.2.3 Output – (V-Stim and A-Stim)

Output determines how much energy is delivered to each pacing lead. Threshold is how much energy is required to trigger depolarisation (electrical capture) in the paced chamber and a pulse (mechanical capture).

3.2.4 Sensitivity- (V-sense and A-sense)

Sensitivity determines how much current must be detected to identify intrinsic activity in the paced chamber.

Figure 5. Above is a pulse generator (pacing box) the Osypka pace 203H. This is the device commonly used within acute areas of the Bristol Royal Infirmary (BRI). This device can be attached to epicardial and transvenous pacing wires.

3.2.1 Mode

Mode determines which leads are paced and how the pacer responds to intrinsic cardiac activity.

Pacing modes are selected on the pulse generator by the operator. The mode determines which leads are paced and how the pulse generator responds to the intrinsic cardiac activity.

One of the following two modes is selected:

Fixed: The pacemaker paces at a fixed, constant rate. This is the mode used for overdrive pacing when a higher rate is set to supress tachyarrhythmias.

Demand: The pulse generator will not pace if intrinsic activity is sensed. This is the more commonly used pacing mode (Royal College Physicians).

Single chamber modes
If pacing wires are leading to only a single chamber (atrium or ventricle), then the pulse generator can be set to one of the following four modes: (Reade, 2007).

Atrial
AAI (Atrial demand pacing)
AOO (Asynchronous atrial pacing)

Ventricular

VOO (Asynchronous ventricular pacing)
VVI (Ventricular demand pacing)

Dual chamber pacing mode

In dual chamber modes, pacing wires must be present in both the atrial and ventricular chambers. The pacemaker can be used in one of the single chamber pacing modes (see previous section) or the following additional dual chamber pacing modes:

DDD (Dual chamber demand pacing)
DOO (AV sequential asynchronous pacing)
DVI (AV sequential, ventricular inhibited)
DDI (AV sequential, non-P-synchronous, with dual chamber sensing)

DDD and DOO are the most commonly used dual chamber modes, and the others will not be discussed in more detail, as they are beyond the scope of this document.

The advantage of pacing both chambers is that you can improve cardiac output by the addition of atrial systolic volume to the diastolic filling of the ventricle, improving haemodynamic stability (Yartsev, 2018).

If the pulse generator is switched to OOO this means that the pulse generator is turned off.

The pacing modes used most commonly within the general intensive care (GICU) and cardiac intensive care unit (CICU) are VVI and DDD. VVI is the most common and is the focus of this guideline. However occasionally different modes may be seen which are not mentioned in this document (e.g. VOO and AOO).

If the pacing mode is set to VOO/AOO or the pulse generator box is left in 'emergency mode' please escalate this to a senior member of the medical team immediately. These are typically only used in theatre or temporarily in emergencies.

Below is a reference table explaining the specifics of these common pacing modes**.**

Table 1. Reference table of commonly used epicardial and transvenous pacing modes (VVI and DDD) (Mark, 2021, Reade, 2007, Yartsev, 2021).

Mode	Single or dual chamber	Description of the mode	Indications to use the mode	Positives of the mode	Limitations of the mode
VVI (Ventricular demand pacing)	Single	The ventricle is sensed and if a QRS is produced the pacemaker will not deliver an electrical impulse. The VVI pacemaker will only deliver an electrical impulse if there has been no electrical activity within the interval specified by the set pacing rate.	On demand ventricular pacing, with ventricular backup. Common mode used in trans venous pacing. Overdrive pacing for the suppression of ectopic beats.	On demand ventricular pacing. Only paces when the intrinsic rate is not high enough. Good for backup pacing.	Difficult to assess QRS morphology as LBBB like QRS morphology.
DDD (dual chamber demand pacing)	Dual	In normal intrinsic atrial and ventricular conduction no pacing response is required. If there is a loss of atrial or ventricular intrinsic conduction, the pacemaker will deliver an electrical stimulus. If there is loss of both atrial and ventricular conduction the pacemaker will deliver an electrical stimulus to the atrium and then the ventricles, with a pre-determined gap in between, similar to a normal PR interval.	All indications for pacing, with the exception of atrial tachyarrhythmias. Commonly used in epicardial pacing.	Maintains atrial kick. A versatile mode regardless of the patients conduction system. Haemodynamic benefit from the atria and ventricles both contracting in synchrony.	Risk of endless loop tachycardia.

Table 2. British Pacing and Electrophysiology Group (BPEG) pacemaker code. Adapted from Burns *et al.* 2022.

The following table can be used to interpret settings selected on the pulse generator in clinical practice.

Chamber(s) paced	Chamber(s) sensed	Response to sensing
Refers to the chambers paced.	Refers to the location where the pacemaker senses intrinsic cardiac electrical activity.	Refers to pacemaker response to sensed intrinsic cardiac activity. T = Sensed activity results in triggering of paced activity. I = Sensed activity results in inhibition of pacing activity.
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)

3.2.2 Rate

Rate controls the number of times per minute that the pulse generator will deliver an electrical impulse causing a pulse rate.

Setting the pulse rate (beats per minute) on the pulse generator, will control the cardiac output. Cardiac output is a result of heart rate and stroke volume (HR X SV = CO). After a point, as the heart rate increases, stroke volume falls and so will cardiac output. Consequently, each patient will have an optimal heart rate for cardiac output. When the heart rate drives increased cardiac output, this comes at the expense of increased oxygen consumption. In clinical practice, the optimal heart rate is rarely calculated and the pulse generator is usually left at 80-90 bpm (Reade, 2007).

A back up rate can be set and this rate is determined by the operator. Normally around 50 bpm but some patients may require a higher rate. In patients who are transitioning to being reliant on their own intrinsic rhythm, this allows a safety back up. The patient will remain in their own intrinsic rate and rhythm till the heart rate decreases to below the set back up rate (e.g. 50 bpm). At this point, if the patient becomes haemodynamically compromised the backup rate will be triggered (Yartsev, 2020).

3.2.3 Output

The output of the pulse generator is the current (measured in milliamperes, mA) which is delivered to each pacing lead. This then produces a brief pulse.

The energy is delivered in a brief burst, over about 0.6 milliseconds. In this short period of time the pulse generator discharges a capacitator into the leads. This means that electricity is briefly stored within the pacing leads. Voltage between the electrodes increases suddenly to 5V. The voltage then decreases over this short period of time, and the level it reduces to is determined by the lead impedance. Impedance is the opposition to alternating current given by the effect of resistance and reactance in a circuit (Yartsev, 2020).

Capture

Capture is a commonly used term in cardiac pacing and refers to effective stimulation of cardiac depolarisation by the pacemaker. Simply, if the pacemaker delivers an electrical impulse and the myocardium responds displaying a QRS or P wave, then there is successful capture (Yartsev, 2020).

Capture threshold

Capture threshold is defined as the minimum pacemaker output required, producing a depolarisation of the paced chamber (Reade, 2007). The capture threshold is important as the higher the output and current delivered to the pacing wires the more quickly these will become encrusted, degrading them and reducing their effectiveness to pace. Consequently it is important to keep the output current as low as safely possible (Yartsev, 2020). Staff should pay close attention to monitor for the development of occasional missed beats, which can mean a rise in capture threshold, requiring an increase in pacing output (Reade, 2007).

Finding the capture threshold

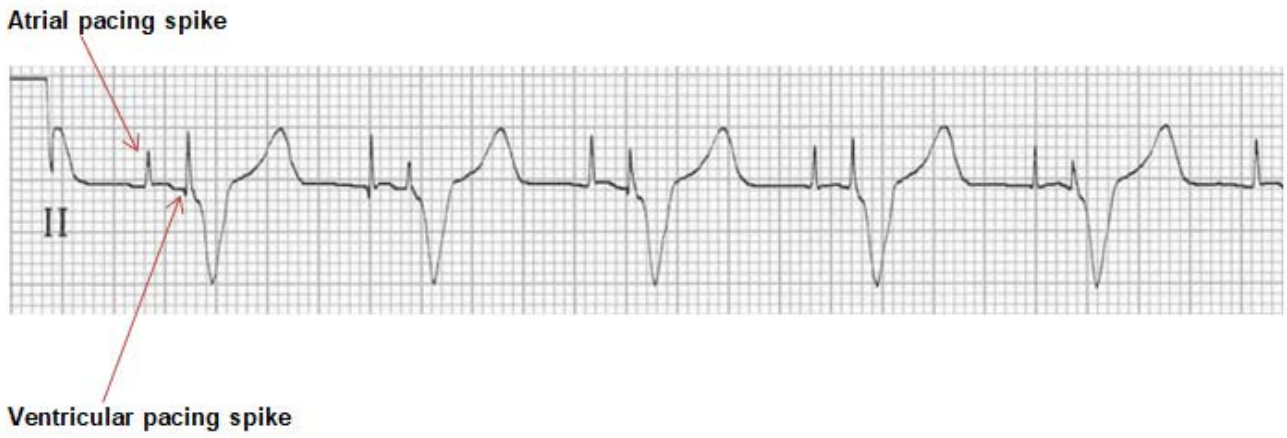
To find the minimum current (mA), the following instructions can be followed.

- Set the pulse generator rate well above the intrinsic rate, so the chamber of interest is continuously paced.
- Start reducing the output until a QRS no longer follows each pacing spike.
- **The minimum output at which there is still consistent capture is the capture threshold.**
- The output is typically set at twice the capture threshold, allowing a margin of safety. If the electrodes then become encrusted they will still continue to pace successfully (Reade, 2007).

Electrocardiographic features in temporary pacing

Patients who have atrial pacing will have pacing spikes before the P wave.
In ventricular pacing the pacing spike is before the QRS complex.
When the pacing lead is placed in the right ventricle this results in QRS morphology similar to LBBB.
When the pacing lead is placed in the left ventricle in epicardial pacing this results in QRS morphology similar to RBBB (Burns *et al.* 2022).

Figure 6. Atrial and ventricular pacing spikes in a paced rhythm (Burns *et al.,* 2022).



Dual chamber pacing electrocardiographic features may demonstrate features of atrial, ventricular pacing or both. In the absence of paced complexes this may indicate satisfactory intrinsic conduction or failure of the pacemaker.

3.2.4 Sensitivity

Pacing wires deliver electricity, but they also sense electrical activity at the myocardial surface. The sensitivity of the pacing electrode is defined as the minimum myocardial voltage (mV) needed to be detected as a P wave or R wave.

The sensitivity of the pacemaker can be adjusted on the pulse generator. A lower number corresponds to a greater sensitivity and a higher number a lower sensitivity. This is important to note as it commonly causes confusion.

When the pacing electrodes are initially inserted the maximum sensitivity is really high, causing it to detect very subtle changes in atrial and ventricular activity. The range of sensitivity is 0.4-10 millivolts (mV) for the atria and 0.8-20 mV for the ventricles (Yartsev, 2020). The sensitivity is commonly set at 2 mV when pacing is initiated (Reade, 2007).

If the sensitivity is too low causing the pulse generator to be too sensitive, this can cause inappropriate sensing of signals, including R on T waves. This can inappropriately prevent pacing.

Importantly if there is no significant underlying rhythm then it is not possible to assess the electrode sensitivity.

Checking the sensitivity threshold

To check the sensitivity threshold the following instructions can be completed. **It will not be possible to safely check sensitivity threshold in patients with no haemodynamically stable underlying rhythm.**

- Put the pulse generator in VVI or DDD mode. Intrinsic electrical activity should inhibit the pulse generator.
- Change the rate to a lower rate than the patient's intrinsic rate.
- Change the output to the minimum setting. Capture is not required, only the pacing indicator LED
- Observe the sense indicator.
- Increase the mV dial which will decrease the sensitivity.
- Eventually, the sensitivity will be so low that any intrinsic electrical activity of the myocardium will no longer be sensed by the pacemaker. The pacemaker will be unable to detect electrical activity and the patient will be paced at the set rate, demonstrated by flashing pacing indicator LED at the set rate.
- The mV dial can now be decreased, increasing the pacemaker sensitivity.
- Eventually, there will be a sensitivity value where the pacemaker senses every p-wave or QRS interval.
- **This sensitivity value is the sensitivity threshold.**
- The sensitivity is typically left at half to one third of the sensitivity threshold.

Setting the sensitivity threshold

The commonly used Osypka pace 203H pulse generator can identify the amplitude of the native P and R waves. This can then be used to set the sensitivity as follows.

Ensure the patient is supine in bed in case of haemodynamic changes associated with change in rhythm. **This method cannot be used if the patient has no haemodynamically stable underlying rhythm.**

- Press "Pause" button. Observe the lower screen for the P wave and R wave amplitude.
- Set Atrial sensitivity to 1/3 P wave amplitude or as low as it will go, whichever is higher (only relevant in atrial or dual pacing mode).
- Set Ventricular sensitivity to 1/3 R wave amplitude or as low as it will go, whichever is higher.
- If in doubt, set the sensitivity to as low as it will go and seek senior help.

3.2.5 Assessing the underlying rhythm

The ongoing requirement of temporary cardiac pacing should be frequently reassessed. **This should be completed by a consultant or senior doctor on the medical ward round.**

Ensure the patient is supine in bed in case of haemodynamic changes associated with change in rhythm. If significant haemodynamic compromise develops before the underlying rhythm is detected the procedure should be abandoned.

- Turn down the pacing rate slowly until the underlying rhythm is revealed and can be assessed.
- It may not be possible to identify any underlying rhythm if there is haemodynamic instability associated with reducing the pacing rate below the intrinsic rate.
- A 12 lead ECG may be completed if the patient has a stable underlying rhythm.

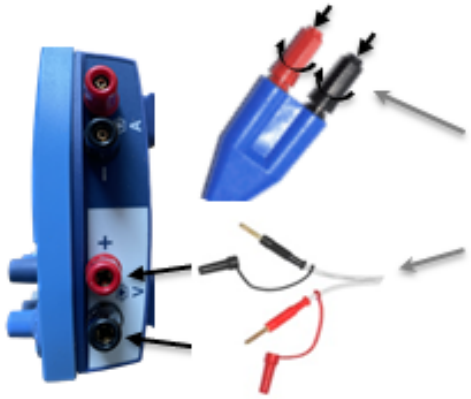
4. Emergency actions

4.1 Emergency set up of VVI pacing

Emergency VVI pacing can be instituted in severe bradycardia in patients with epicardial pacing wires in situ following cardiac surgery.

Seek help immediately from a senior member of the medical team.

If there is haemodynamic compromise pull emergency buzzer.



1. Screw tighten the grey leads to the patient's ventricular wires
2. Screw tighten the pins of the grey leads into the **Ventricle (V)** ports on the pacing box
3. Turn on
4. Unlock
5. Check the box has defaulted to the following settings, if not, select them as follows:
   - **a)** Ensure **unlocked**
   - **b)** Select **VVI** mode
   - **c)** Set the **RATE** dial to **80ppm**
   - **d)** Set the **V-SENSE** dial to **1.0mV**
   - **e)** Set the **V-STIM** dial to **8.0V** and increase until capture
6. Monitor for consistent capture at 80bpm, **then seek help immediately**

Ensure senior medical team assessment of patient after instituting emergency pacing and cardiology input considered.

4.2 Loss of paced rhythm

Loss of pacing can be recognised by the return of a patients underlying rhythm and may be associated with severe bradycardia and haemodynamic instability.

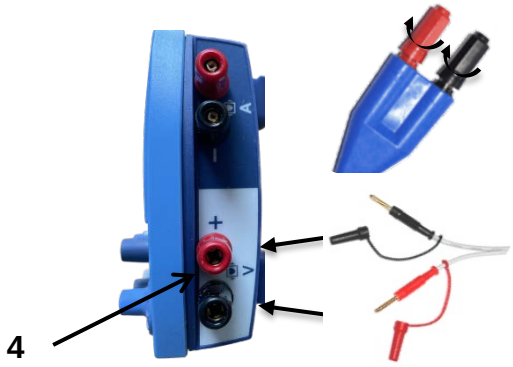
Seek help immediately from a senior member of the medical team.

- **GICU Consultant or airway resident.**
- **CICU Consultant or registrar.**

If there is haemodynamic compromise pull emergency buzzer.

If the patient is unresponsive ensure ALS is followed while pacing issues addressed.

Ensure cardiology +/- cardiac surgery registrar contacted and coming to review.



1 Set ventricular amplitude (V-Stim) to maximum output

Pacing Restored

No pacing capture

2 Check all connections from patient to pacing box

No pacing capture

3 Check battery indicator and replace if depleted

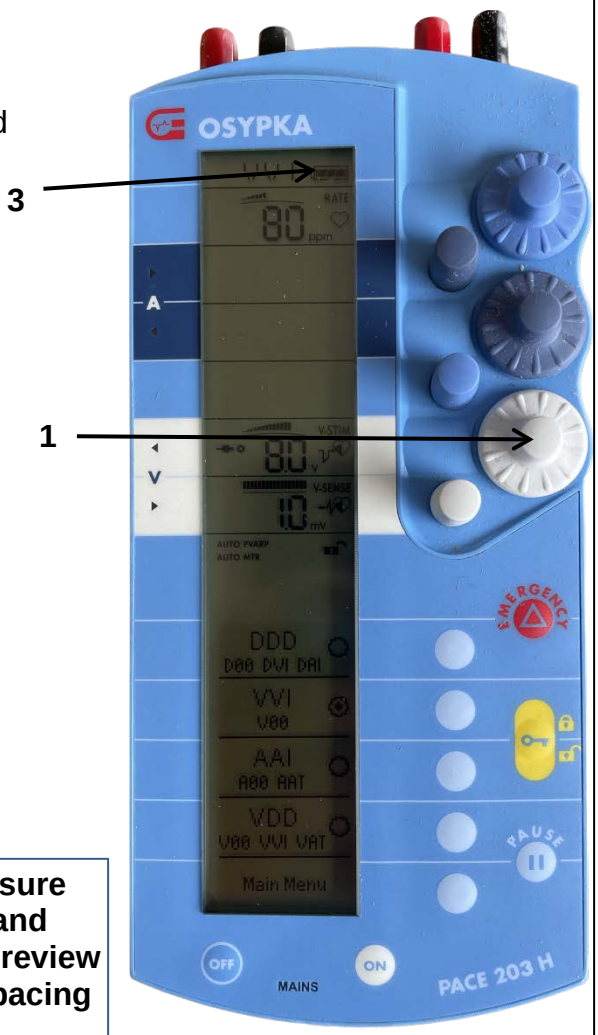
No pacing capture

4 Trial switching polarity by swapping the positive and negative terminals of the ventricular wires at the pulse generator

No pacing capture

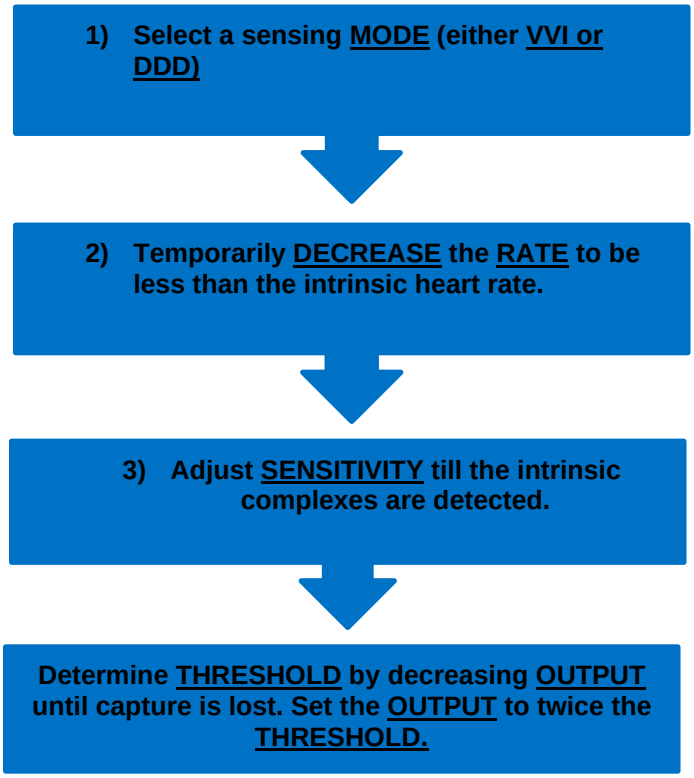
Consider transcutaneous pacing

Reassess and ensure senior medical and cardiology input to review safety of ongoing pacing



5. Setting the pulse generator (pacing box) with a back up rate

Follow the below instructions to set up the pulse generator (pacing box) with a backup rate.



6. Daily nursing care of the patient with temporary cardiac pacing

Registered nurses caring for patients with epicardial or transvenous pacing wires should complete the following procedures at the required frequency.

Table 3. Nursing procedures for the patient with epicardial or transvenous pacing wires and a pulse generator (pacing box).

Procedure	Required frequency of completion	Rationale	Additional information
Check the battery status of the pulse generator (pacing box) on the screen. Ensure the pulse generator has sufficient battery.	Complete once at the start of the shift with the safety checks.	To prevent pulse generator and pacing failure (Reade, 2007).	
Battery change (e.g. 9 V battery in the Osypka 203H).	As required, when the low battery symbol is displayed on the screen.	To prevent pulse generator and pacing failure.	Osypka 203H pulse generator can be changed promptly during pacing, as it has 30 seconds back up when the battery is removed.
Ensure that a spare battery (e.g. 9 V battery in the Osypka 203H pulse generator), is present in the patients bed space. This should be taped to the top of the equipment cabinet.	Complete once at the start of the shift with the safety checks.	To ensure a spare battery is immediately available in the event of battery failure. To ensure the battery is easily identifiable if required urgently.	
Ensure continuous ECG monitoring for all paced patients. Check ECG, BP, Sa02% monitor alarm settings are ON and correctly set. Ensure the pacemaker mode is turned ON, and pacing spikes are seen on the ECG monitor.	Complete once at the start of the shift with the safety checks.	To ensure pacing failure or arrhythmias are promptly detected. Electrical interference from the environment can affect the ability to see pacing spikes clearly. Pacemaker mode applies a high frequency filter, allowing clearer rhythm and pacing analysis (Reade, 2007).	
Carefully check all the connections are tightly secured from the pacing wires to the pulse generator.	Complete once at the start of the shift with the safety checks. Check each time the patient is moved.	To prevent accidental disconnection and pacing failure.	
Inspect the pacing wires entry site for signs of infection. Inform a senior member of the medical or nursing team if signs of infection are found.	Complete once at the start of the shift with the safety checks.	To monitor for signs of infection.	
Ensure that a registered nurse is in charge of the safe movement of the pulse generator during repositioning within the bed or mobilising. Check all the connections of the pacing system are correctly secured after repositioning.	Each time the patient is repositioned within the bed or mobilised.	To prevent accidental disconnection and pacing failure.	
Record pacing observations under vital signs on the computer information service (CIS).	Complete hourly pacing observations. Include mode, rate, output, sensing and pacing activity.	To accurately record the pacing requirements of the patient.	

7. Daily medical care of the patient with temporary cardiac pacing

The medical team caring for patients with epicardial or transvenous pacing wires should complete the following checks at the required frequency and document in the patient record. Checks should be performed by a member of the medical team trained to perform pacing checks or pacing technicians.

Table 4. Medical team procedures for the patient with epicardial or transvenous pacing wires and a pulse generator (pacing box).

Procedure	Required frequency of completion	Rationale
Assess and record the underlying cardiac rhythm.	Daily on consultant ward round If the patient is pacing dependent then the consultant should be present on the unit when these checks are performed.	To assess for the ongoing need for temporary pacing and to record the underlying rhythm to inform need for permanent pacing.
Review pacing mode, rate and need for ongoing pacing.	Daily on consultant ward round.	To optimise pacing mode and rate to patient condition.
Check output threshold and set amplitude with a margin of safety above the threshold (typically 25-50% above the threshold). **If threshold is rising above 10V consider referral to cardiology** to explore need for alternative methods of pacing.	Daily on consultant ward round. If the patient is pacing dependent then the consultant should be present on the unit when these checks are performed.	To monitor for rising output threshold and ensure margin of safety in set pacing output to avoid loss of capture.
Check the sensitivity settings. This should typically be set at 1mV. Consider checking the R wave amplitude and setting the ventricular sensitivity (V-sense) to 1/3 of the R wave amplitude. **This will not be possible if there is no underlying rhythm**. In this case set the sensitivity to 1mV.	Daily on consultant ward round.	To provide margin of safety to avoid under-sensing and risk of R-T

8. Removal of epicardial pacing wires

When removing epicardial pacing wires please see the Clinical Standard Operating Procedure (SOP) Removal of epicardial pacing wires post cardiac surgery. This can be found on the GICU share point. For further advice discuss with a senior nurse or member of the medical team.

9. Transitioning to a permanent pacemaker

Patients receiving temporary pacing through epicardial or transvenous wires may remain pacing dependent, requiring insertion of a permanent pacemaker. The timings of this insertion will be determined by the clinical course of the patient. Epicardial pacing wires will often begin to fail after four to five days and transvenous wires may be effective for longer (Reade, 2007). Patients with clinical signs of infection and/or fever must be afebrile for at least 24 hours prior to permanent pacemaker insertion (European Society Cardiology, 2021).

10. Safety

10.1 Magnetic Resonance Imaging (MRI) and Computerised Tomography (CT)

Patients with epicardial or transvenous wires who are temporary pacing dependent via a pulse generator are unsuitable for magnetic resonance imaging (MRI). Temporary pulse generators contain too much ferrous material to be allowed into the magnetic field with a patient (Reade, 2007). Patients with epicardial or transvenous wires who are temporary pacing dependent via a pulse generator can safely receive computerised tomography (CT) scanning.

10.2 Pacing wire storage and environmental safety

Epicardial and transvenous temporary pacing wires should be nursed in a cardiac-protected electrical environment (e.g. isolated electrical appliances and the absence of carpeted floors).

As a minimum all patients should have continuous ECG monitoring with pacing monitoring activated, monitoring for temporary pacing failure and associated arrhythmias. Consequently immediate access to a defibrillator with the ability to complete transcutaneous pacing is essential.

Wires should be handled with non -conductive gloves, to reduce static electricity. Epicardial wires when not in use should be stored in a non-conductive container (e.g. a plastic syringe barrel) (Reade, 2007).

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RELATED DOCUMENTS AND PAGES	Quick Reference Guideline: The Management of Epicardial and Transvenous Pacing for Adult Patents. Clinical Standard Operating Procedure (SOP) Removal of epicardial pacing wires post cardiac surgery. Standard Operating Procedure (SOP). Competency assessment for Registered Nurses in the removal of temporary pacing wires following cardiac surgery.
AUTHORISING BODY	Surgery Governance Body.
SAFETY	See safety section.

QUERIES AND CONTACT	Nurse in charge, General Intensive Care (A600) Extension 27238.
AUDIT REQUIREMNTS	Re-audit of completion of pacing checks following implementation of the guideline.

Plan Elements	**Plan Details**
The Dissemination Lead is:	Geoff Ball
Is this document: A – replacing the same titled, expired guideline, B – replacing an alternative guideline, C – a new Guideline:	New guideline.
If answer above is B: Alternative documentation this guideline will replace (if applicable):	N/A
This document is to be disseminated to:	Medical and nursing staff GICU and CICU via Sharepoint and Mystaff
Method of dissemination:	Email, governance meeting and teaching topic of the month on GICU.
Is training required and how will this be delivered:	Training already undertaken

Document Change Control

Date of Version	Version Number	Lead for Revisions	Type of Revision	Description of Revision
4/7/2024	1.00	Geoff Ball	Major	New document