

# CARDIAC PACING: PATIENT MANAGEMENT PRACTICE GUIDELINE<sup>®</sup>

## DOCUMENT SUMMARY/KEY POINTS

**Focus of practice guideline is on temporary pacing but does include some information on permanent pacemakers at end of document.**

**Note:** At all times, whenever possible, all patients with external pacing should be managed within a “cardiac protected” patient treatment area. A "cardiac protected" patient treatment area is one identified by a green sign with a white heart symbol in a white box.

At all times, when handling pacing wires, gloves should be worn to avoid the potential for static electricity to cause a micro-electrocution.



- Cardiac pacing is a means of delivering an electrical stimulus to the heart muscle to treat low cardiac output state (LCOS) caused by an arrhythmia to optimize cardiac output.
- Patients with temporary pacing devices require cardiac monitoring in Paediatric Intensive Care Unit (PICU), Grace Centre for Newborn Care (GCNC), Edgar Stephen Ward (ESW), Emergency Department (ED), or Operating Theatre (OT) at Westmead campus and Children’s intensive care unit (CICU), Children’s 1 South (C1S), ED, or OT at Randwick campus.
- A patient who is dependent on temporary pacing, with no underlying rhythm is unsuitable for transfer to the ward. The patient needs to have a safe underlying rhythm with adequate cardiac output prior to transfer.
- There are 4 types of temporary cardiac pacing:
  1. Epicardial pacing
  2. Transthoracic pacing
  3. Transvenous pacing
  4. Transoesophageal pacing
- A patient’s coagulation profile must be checked and reviewed by the cardiac team prior to removal of pacing wires.
- General guide is an INR of <1.6 and platelets >100 000 for removal of wires. Some patients who are receiving anticoagulant therapy may have a higher INR; consult with cardiac team.

This document reflects what is currently regarded as safe practice. However, as in any clinical situation, there may be factors which cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

<b>Approved by:</b>	Director, Clinical Governance	<b>Review Period:</b> 3 years
<b>Date effective:</b>	1 <sup>st</sup> April 2017	<b>Area/Dept:</b> Edgar Stephens Ward CHW
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## CHANGE SUMMARY

- Due for mandatory review –Network document created and name changed slightly.
- No major changes made however the entire document should be re-read as minor changes have been made throughout.
- A search of the literature was performed and no new evidence was found.

## READ ACKNOWLEDGEMENT

- All registered nurses involved in caring for patients requiring pacing must be deemed competent in the nursing management of cardiac pacing. See local NE/CNE for appropriate accreditation process.
- All clinical staff in PICU, ESW, CICU, C1S, ED, and OT must read and acknowledge the practice guideline.

This document reflects what are currently regarded as safe practice. However, as in any clinical situation there may be factors that cannot be covered by a single set of guidelines. This document does not replace the need for the application of clinical judgement to each individual presentation.

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## Introduction

The management of paediatric patients requiring temporary cardiac pacing is restricted to the following clinical areas:

- PICU, GCNC, ESW, CICU, C1S, ED, and OT

A patient who is dependent on temporary pacing, with no underlying rhythm is unsuitable for transfer to the ward. The patient needs to have a safe underlying rhythm with adequate cardiac output prior to transfer.

## Rationale for Cardiac Pacing

- Cardiac pacing is a means of delivering an electrical stimulus to the heart muscle to treat low cardiac output state (LCOS) caused by an arrhythmia.<sup>1</sup> The aim of this treatment is to optimise cardiac output.

## Temporary Pacing

### Indications<sup>2</sup>

- Atrioventricular (AV) Block - second degree or third degree (complete heart block)
- As an adjunctive therapy to establish AV synchrony in postoperative arrhythmias such as junctional and Junctional Ectopic tachycardia (JET)
- Overdrive pacing may be indicated for the termination of tachyarrhythmias, such as atrial flutter and supraventricular tachycardia (SVT)
- Any bradycardia with reduced cardiac output
- Support management of a patient prior to permanent pacemaker implantation

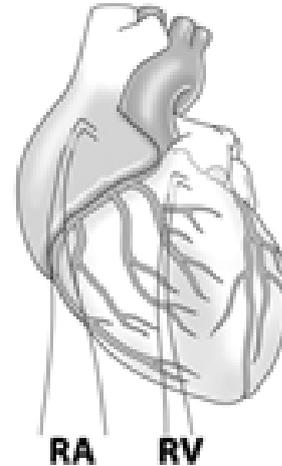
## Methods or Routes Used for temporary pacing

### Four types of temporary pacing:

#### 1. Epicardial pacing

Arrhythmias are a common complication following cardiac surgery therefore some patients may require support from a temporary pacemaker.<sup>3,4</sup> Epicardial wires are the preferred method if pacing is required post operatively and are routinely inserted during cardiac surgery. Epicardial pacing wires are insulated multifilament stainless steel wires that are stitched to the epicardium and brought through the chest wall before closing the sternotomy.<sup>5,6</sup> Usually two pairs of wires are attached, one pair attached to the right atrium (exiting the thorax on the right side of the sternum) and one pair attached to the right

ventricle (exiting on the left side of the sternum) (regardless of the underlying cardiac anatomy) unless labelled otherwise by the surgeon.<sup>4,5,6</sup> When there are two epicardial leads they can be used as either pole (positive or negative).



Epicardial pacing is the most common method of temporary pacing used at Sydney Children's' Hospitals Network (SCHN).

### **General Principles for Epicardial Pacing**

**Note:** At all times, whenever possible, all patients with external pacing should be managed within a "cardiac protected" patient treatment area. A "cardiac protected" patient treatment area is one identified by a green sign with a white heart symbol in a white box. This is to reduce the risk of micro-electrocution.<sup>1,7</sup>



- The pacing device should be visible at all times and the wires secured to the patient. The device must be locked to prevent the patient accessing the pacing box and inadvertently altering the pacemaker settings.<sup>2</sup>
- A spare identical pacing device, including spare battery, should be readily available at the patient's bedside on the ward or on the unit in the ICU setting.<sup>4</sup> A spare device can be found as follows:
  - PICU store room
  - ESW arrest trolley
  - Cardiology Department.
  - CICU
- When epicardial pacing wires are not in use they should have their tips insulated. This is done by curling the wire, wrapping it in gauze and adhering to the chest wall with an occlusive dressing.<sup>5,6</sup>
- Rubber gloves should always be used when handling epicardial pacing wires to prevent static electricity passing down the wires and causing micro-shocks.<sup>1,7</sup>
- Epicardial pacing wires may lose their ability to accurately sense and pace over time due to the tissue scarring that occurs at the point of the electrical impulse. This is described as increasing resistance. Pacing and sensing thresholds need to be checked daily (or more often if the patient is "pacemaker dependant" with no underlying or intrinsic rhythm)

and pacemaker settings adjusted accordingly by medical officer or accredited registered nurse in PICU/CICU.<sup>2,7</sup>

- Complication of epicardial wires include:
  - Infection
  - Myocardial damage
  - Arrhythmias
  - Perforation
  - Cardiac tamponade
- For a detailed table of potential complications post epicardial wire removal, see table on page 18.

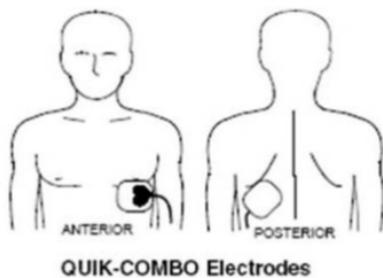
## 2. Transthoracic (non-invasive) pacing

**Transthoracic (non invasive) pacing** is accomplished by using an external defibrillator with a pacing function.<sup>5</sup>

A spare defibrillator capable of delivering transthoracic pacing can be found in PICU and CICU.

### Pad placement

The anterior pad is placed just left of the sternum, and the posterior pad is placed just left of the spine creating a 'heart sandwich', and a pathway for the electrical current.<sup>1,7</sup> For patients with dextrocardia, place the anterior pad on the right side of the sternum and the posterior pad on the right side of the spine.



**Pad size according to weight**  
<15kg- paediatric pads  
>15kg – adult pads



Do not place defibrillator pads over ECG dots, internal automated implantable cardioverter defibrillators (ICDs) or permanent pacemakers (PPM), wet skin, or bony areas such as the sternum or scapula.<sup>7</sup>

### **General Principles for Non-Invasive Transthoracic Pacing**

- Temporary transthoracic pacing is used primarily during emergency situations for the treatment of haemodynamically significant bradyarrhythmia or cardiac arrest that is unresponsive to resuscitative measures and pharmacology.<sup>7</sup>
- It is important to ensure the patient is administered analgesia and sedation.<sup>7</sup>

- As an effect of transthoracic pacing, the patient may experience muscular contraction of the chest and abdominal muscles.<sup>7</sup>

### 3. Transvenous pacing

**Transvenous pacing** - an electrode catheter is threaded through a vein (normally femoral or jugular vein) into the patient's right atrium or right ventricle.<sup>5,7</sup> The pacing lead is a self contained bipolar system with two pins at the proximal end for connection to the bridging lead and pacing box.<sup>7</sup>

#### ***General Principles for Transvenous Pacing***

- The puncture site should be covered in a transparent dressing to facilitate assessment of the site. The lead should be appropriately secured to the patient.<sup>7</sup>
- If the transvenous catheter is placed in the femoral vein the affected limb should be stabilised (kept as immobile and straight as comfortably possible). This is to avoid leg flexion, which may result in movement/dislodgement of the pacing lead. If there is any suspicion of lead movement, an xray must be performed.
- Circulation observations should also be performed on the affected limb. Refer to Post-Operative Management section in the [‘Cardiac Catheterisation: Interventional, Non-interventional and Electrophysiological Studies’ practice guideline](#).
- Transvenous pacing catheters positioned in the apex of the heart are prone to move or drift out of position.<sup>5</sup> This can result in failure to capture (see [Trouble-shooting guide](#)).
- The pacing device should be visible at all times and the wires secured to the patient with occlusive dressing. Make sure the device is locked to prevent the patient accessing the pacing box and inadvertently altering the pacemaker settings.<sup>2</sup>
- A spare identical pacing device should be readily available at the patient's bedside.<sup>7</sup>

### 4. Transoesophageal pacing

Transoesophageal pacing is an electrode attached to an oesophageal probe inserted to the oesophagus just behind the left atrium to permit temporary atrial pacing.<sup>6,7</sup> The patient is to remain sedated for the duration of this type of pacing.<sup>7</sup> This system may also be used in the diagnosis (electrophysiological study) and termination of arrhythmias including SVT.<sup>4</sup> However, as this pacing only captures the atrium, it cannot usually be used to treat AV block.

#### ***General Principles for Transoesophageal Pacing***

- The bipolar lead is inserted by cardiologist via the nose or mouth, and is secured to the face with tape.
- The transoesophageal pacing lead is attached to an electrocardiographic (ECG) machine. The lead is then advanced and positioned behind the left atrium. This is indicated by the largest atrial signal as recorded on the ECG trace.
- When pacing is discontinued, the lead can be removed after consultation with cardiac team.
- The lead should be placed in a plastic bag and returned for re-sterilisation.

- Oesophageal injury and burns can be caused by long term oesophageal pacing.

## Components of pacing system

A temporary pacing system consists of three main components

- Pulse generator/pacing box
- Bridging or connecting cable/s
- Pacing wires/leads/electrodes

The Medtronic 5392 (as pictured below) is commonly used at both Westmead and Randwick campus but different models may be used on occasion.



## Modes of Pacing

Modern pacemakers offer several features in an effort to replicate physiologic cardiac rhythm and provide rhythm modulation as clinically indicated. To facilitate common understanding among health care providers a generic pacemaker code has been developed to describe the types and function of different devices (see table below). In practice, the temporary pacing mode is abbreviated as the 3 letter acronym.<sup>7,8</sup>

## Pacemaker Nomenclature \*NASPE/BPEG\*\* GENERIC

### PACEMAKER (NBG) CODE

\*North American Society of Pacing & Electrophysiology

\*\*British Pacing & Electrophysiology Group

Temporary Pacemakers		
I	II	III
Chamber Paced	Chamber Sensed	Response to Sensing
	O = None	O = None
A = Atrium	A = Atrium	I = Inhibited
V = Ventricle	V = Ventricle	T = Triggered
D = Dual	D = Dual	D = Triggered & Inhibited

For example, AAI indicates that the atrium is paced, the atrium is sensed and the generator/pacemaker is inhibited if it senses intrinsic atrial activity. <sup>5,7,8,9</sup>

## Nursing Management of Temporarily Paced Children

### Assessing & Recording Vital Signs

All patients receiving temporary pacing therapy require continuous ECG monitoring; ensuring that the bedside monitor is set up appropriately for a paced patient. Regular assessment of hemodynamic stability is required, including the recording of **hourly** vital sign observations, or more frequently if required, including; <sup>1</sup>

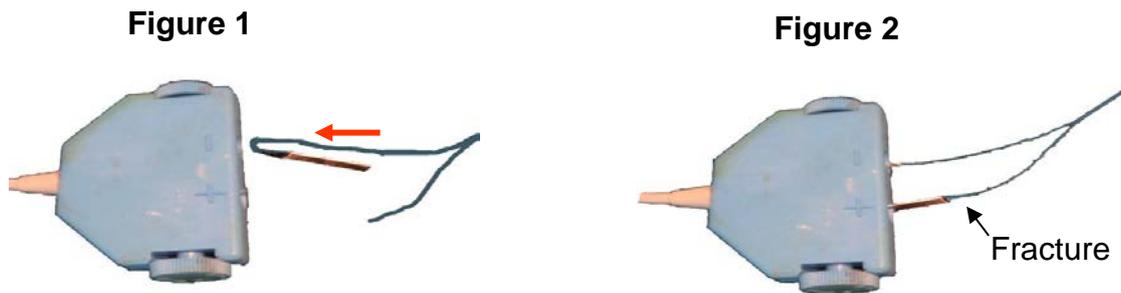
- Heart rate
- Blood pressure
- Perfusion (skin colour, warmth, capillary refill, peripheral pulse strength)

Print a rhythm strip from bedside monitoring once per shift and place in patient notes.

## How to Connect Pacing Wires

At Westmead campus It is recommended that the pacing wires should be connected by folding the wire electrode as shown (figure 1), prior to tightening the screw knobs. This will reduce the risk of the wire fracturing where the wire joins the exposed pin as shown in figure 2.

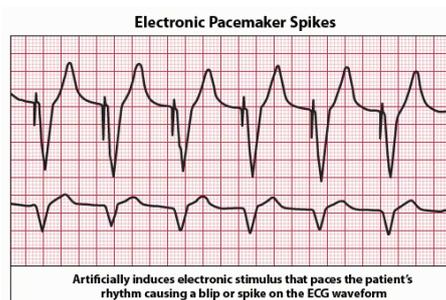
In some circumstances the fractured wire can be rendered useful again by removing a 2cm section of insulation cover from the wire and inserting it into the pacing box.



## Assessing & Recording Pacemaker Function

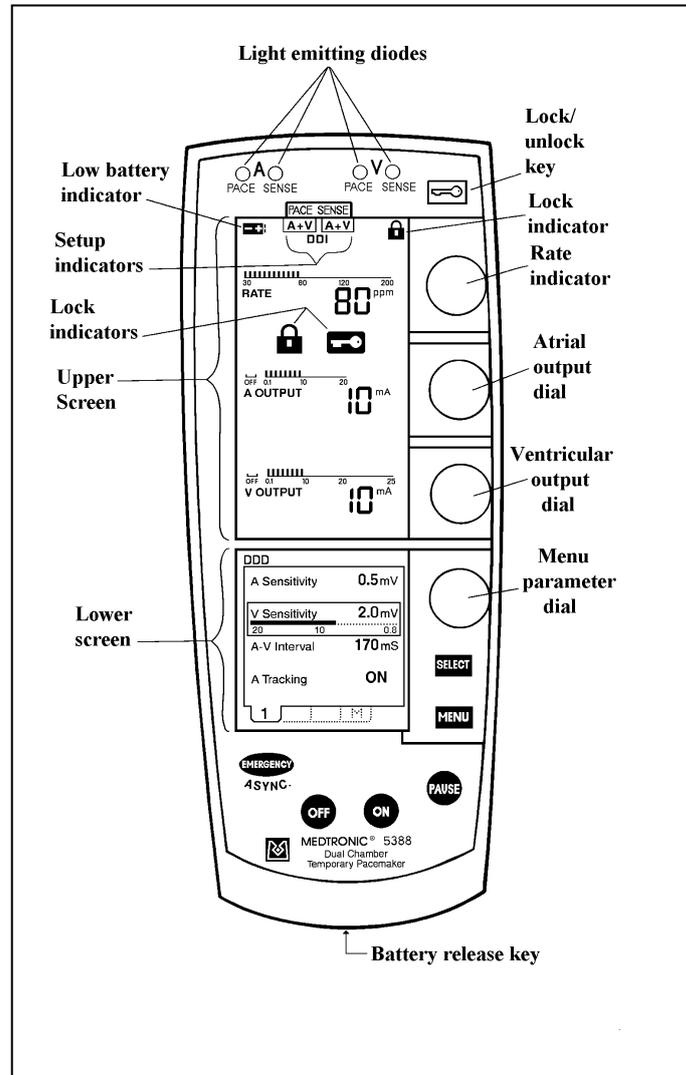
All infants and children receiving temporary pacing therapy require regular assessment and **hourly** documentation of pacemaker function, or more frequently if required, including

- Pacing mode. Ensure to check that the mode as well as the rate and output are programmed as have been prescribed.
- Pacemaker capture - the pacing spike is followed by appropriate electrical activity, (i.e. an atrial pacing spike followed by a P-wave or a ventricular pacing spike followed by a QRS complex). Mechanical response to pacing can be supported through the palpation of the patient's pulse or correlating with the monitored pulse rate.<sup>1</sup>



- Pacemaker sense - the pacemaker is detecting the patient's own electrical output only (the patient's intrinsic electrical activity) and inhibits pacing appropriately in demand modes.<sup>1</sup>

- If the low battery indicator is displayed on the pacing device, immediate battery change is required. See 'Method for changing battery' section for further instructions.



- Check insertion sites of pacing wires into the patient's chest and ensure pacing wires are secured and no evidence of dislodgement.<sup>1</sup>
- Check all connections between the patient's chest and the pacing device.<sup>1,7</sup>
- Record observations according to local policy.

See the link for the [Temporary Pacemaker Observation Chart](#):

**The following pacemaker checks need to be documented every 12-24 hours<sup>1</sup>, or as the patient's condition warrants, and is to be performed by trained medical staff or in some circumstances by accredited RNs in the intensive care setting**

- Threshold checks for capture
- Sensitivity threshold
- Determination of underlying rhythm
- Correlation between pacemaker order and pacemaker settings<sup>1,7</sup>
- Changes to the pacemaker order should be documented on each occasion a change occurs (the original order will be documented on the commencement of pacing)
- Additional pacemaker checking may be required if the patient has a breakthrough rhythm (an intrinsic rate that is faster than the rate set by the pacing device). Unless indicated by the patient's clinical condition, the underlying rate need not be checked more often than once per shift as this may cause a syncopal event if there is no underlying rhythm.<sup>7</sup>

The following section on output and sensitivity was taken from the [Congenital heart disease: PICU Peri-operative management Practice Guideline – CHW](#). Refer to this document for further information:

### **Output**<sup>4,10</sup>

The threshold is the minimum current necessary to capture & stimulate the heart. To test for this:

- Atrial and ventricular output is generated in milliamperes (mA). The typical atrial output is 5 mA and typical ventricular output is 8-10 mA. Set pacer rate 10 ppm faster than patient's heart rate
- Decrease mA until capture is lost (change in ECG)
- Increase output until capture is regained (threshold capture)
- Output setting to be 2mA above the threshold capture (example: set output at 7mA if capture was regained at 5mA)

### **Sensitivity**<sup>4,10</sup>

The sensitivity is the minimum level of intrinsic electric activity generated by the heart detectable by the pacemaker. ONLY test for sensitivity if cardiovascularly stable in their intrinsic rhythm. To test for this follow:

- Atrial and ventricular sensitivity is measured in millivolts (mV). The typical atrial sensitivity is 0.5 mV and typical ventricular sensitivity is 2.0 – 5.0mV
- Set pacer rate 10 ppm slower than patient's HR
- Increase sensitivity to chamber being tested to minimum level (0.4mV)
- Decrease sensitivity of the pacer (↑mV) to the chamber being tested until pacer stops sensing patient (orange light stops flashing)
- Increase sensitivity of the pacer (↓mV) until the pacer senses the patient (orange light begins flashing). This is the threshold for sensitivity.

- Set the sensitivity at  $\frac{1}{2}$  the threshold value (example: set sensitivity at 1mV if the threshold was 2mV)

## Method for Changing Battery

- A battery should last about 3-7 days depending on the pacemaker settings.
- Change of battery is required when the low battery indicator is shown. It is recommended to change the battery as soon as the low battery indicator is noticed.
- Battery change to be performed by Registered nurse who has completed the pacemaker accreditation.
- The pacemaker will operate for approximately 15 seconds after the battery is removed. There is a diagram inside the battery drawer to show correct orientation of battery when changing it.
- A second pacemaker should be available.
- Check settings prior to changing battery.
- Always replace with a new battery/ batteries.
- Leave pacemaker operating.
- Press battery release button, pull out drawer, insert new battery/ batteries, close drawer.
- Check that the pacing is functional after changing battery. Low battery indicator should now be inactive.
- Assess the patient, their vital signs, and assess and record the pacemaker function.

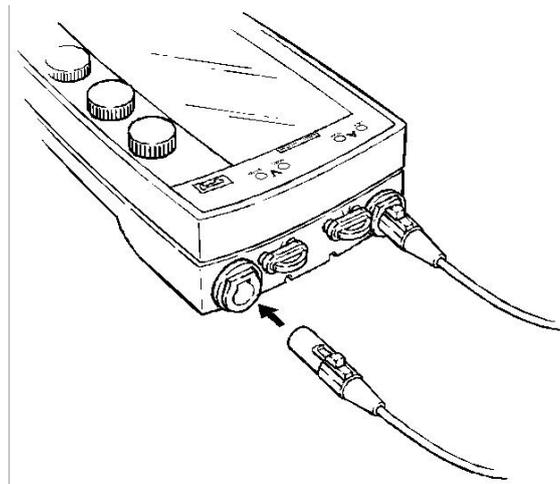
Note: Depending on the pacemaker model, the pacemaker may require 2 AA batteries while others may require a 9volt battery. Ensure correct spare battery is ready before commencing battery change.

## Method for Change of Device

If device thought to be faulty or malfunctioning (see troubleshooting table on page 15 for some common causes), notify the nurse in charge and medical team, and contact a cardiac technician if available, medical officer, or accredited Registered Nurse who is competent in changing a pacing device. At Westmead the PICU outreach service can be paged on #6664 for assistance.

If patient noted to be deteriorating due to suspected pacemaker malfunction, follow emergency protocols immediately.

- To change pacing box, preset the desired value on spare pacing device.
- Press the release button, unplug the cables from the old one and connected to the new pacing device (See diagram below).
- It is recommended for both cables to be unplugged and connected to the new device at the same time.
- The entire pacing device, including the battery, should be returned to biomedical department.



## Temporary Pacing Trouble Shooting Guide<sup>1,2,5,7</sup>

<b>FAILURE TO PACE: unable to pace patient despite appropriate pacemaker settings</b>			
<b>Signs &amp; Symptoms</b>	<b>Cause</b>	<b>Management</b>	<b>Responsibility</b>
No pacing activity Bradycardia Hypotension Loss of consciousness	Electrode displacement (transvenous)	Reposition patient, & reassess for pacing	Immediate RN Contact RMO
	Electrode displacement (epicardial)	Emergency management for loss of cardiac output . Trained medical officer or accredited PICU RN to increase output to maximum setting on pacemaker if wire still in patient.	Emergency bell
			Page cardiac RMO
	Lead fracture	Strip insulation & reinsert wire into cable or replace wire in Op Suite	RN if able, or contact RMO
	Lead disconnection	Reconnect lead	
	Fibrotic tip or oedema/scar tissue at electrode tip	Swap polarity of electrodes	RN/contact cardiac technician
		Increase output	
Flat battery Pacemaker malfunction	Change pacemaker	RN/contact cardiac technician	
Electrolyte disturbance	Correct Electrolytes	RMO	
<b>FAILURE TO CAPTURE: when the pacemaker output fails to depolarise the myocardium</b>			
<b>Signs &amp; Symptoms</b>	<b>Cause</b>	<b>Management</b>	<b>Responsibility</b>
No P-wave/QRS complex after pacing spike Loss of atrial kick in atrially-paced patients Bradycardia Hypotension Syncope	Electrode displacement (transvenous)	Reposition patient & reassess for capture	Immediate RN Contact RMO
	Low output setting	Reassess threshold	RN if able, or Contact RMO
	Increase in pacing threshold due to oedema/scar tissue or fibrosis at electrode tip	Swap polarity of electrodes	
		Increase output	
	Lead fracture	Strip insulation & reinsert wire into cable	
	Lead disconnection	Reconnect lead	RN/contact cardiac technician
	Flat battery Pacemaker malfunction	Change pacemaker	
Myocardial perforation from transvenous wire	Surgical emergency, treat haemodynamic instability	Call RMO & T/L Contact cardiac team	
<b>UNDERSENSING: when the pacemaker fails to detect intrinsic cardiac depolarisation</b>			
<b>Signs &amp; Symptoms</b>	<b>Cause</b>	<b>Management</b>	<b>Responsibility</b>
Pacing spike occurs prematurely or inappropriately Pacing spike may/may not produce a QRS complex depending on where it occurs in the cardiac cycle Palpitations, skipped beats Lethal arrhythmias can result from competition, or R-on-T phenomenon	Sensitivity too low (high mV number on sensitivity dial)	Increase sensitivity (reduce mV number on dial)	RN if able, or RMO
	Lead fracture	Strip insulation & reinsert wire into cable	
	Lead disconnection	Reconnect lead	RN if able
	Battery depletion Pacing box malfunction	Replace pacing box	
	Electromagnetic interference	Identify & remove cause	Cardiac technician
	Fixed rate pacing	Reassess pacing modality	RMO
<b>OVERSENSING: when the pacemaker detects non-cardiac electrical events</b>			
<b>Signs &amp; Symptoms</b>	<b>Cause</b>	<b>Management</b>	<b>Responsibility</b>
No pacing activity on ECG despite pacemaker being set at higher pulse rate than patient's intrinsic HR Sense light flashing at higher rate than patient's intrinsic pulse rate	Pacemaker sensing atrial or T wave activity in patient's intrinsic rhythm because sensitivity level is not set at appropriate level	Adjust sensitivity level	RN if able, or RMO
	Pacemaker sensing skeletal muscle contraction		
<b>CHEST WALL OR DIAPHRAGMATIC STIMULATION:</b>			
<b>Signs &amp; Symptoms</b>	<b>Cause</b>	<b>Management</b>	<b>Responsibility</b>
Hiccups Muscle twitching Abdominal pain/discomfort	Output too high	Reassess threshold Reduce output	RN if able, or contact RMO
	Stimulation of phrenic nerve by electrode tip (transvenous lead)	Reposition patient & reassess for result	RN, contact RMO if no response to positioning

## Removal of Epicardial Pacing Wires

**Note:** A patient's coagulation profile must be checked and reviewed by the cardiac team prior to removal of pacing wires. General guide is an INR of <1.6 and platelets >100 000 for removal of wires. Some patients who are receiving anticoagulant therapy may have a higher INR; consult with cardiac team.

### **Equipment:**

- Dressing pack
- Gloves (non-sterile)
- Aqueous Chlorhexidine 0.5% / 0.9% Sodium chloride
- Stitch cutter
- Appropriate dressing

### **Timing of wire removal**

- Pacing wires are only to be removed after discussion with Cardiologist and Cardiothoracic Surgeon as well as the intensivist if the patient is in the intensive care.
- The patient is to be in sinus rhythm for a minimum 24 hours prior to removal.
- It is the responsibility of the person removing the wires to ensure that the nurse in charge and a member of the cardiothoracic team are aware and available at the time of the wire removal.

### **Pre-procedural tests and documentation**

- Most patients require a recent ECG or printed rhythm strip from bedside monitoring, and coagulation profile. INR < 1.6 and platelets >100 000.
- Consult with cardiac team for the need of establishment of IV access prior to wire removal
- It is the responsibility of the person performing the procedure to ensure all necessary tests are performed, that the results have been assessed by the medical staff and the decision to remove the wires documented.

### **Person performing the procedure**

- The procedure will be performed by either a doctor or nurse with the relevant training and experience. Whoever undertakes the procedure must be competent or supervised in the procedure.
- Obtain assistance from another nurse or member of the medical team.

### **Preparation of the patient and carers**

- Psychological preparation is to be given to the patient and/or parents at an appropriate level; a verbal explanation should be given of the possible complications of wires removal. The use of the child life therapist for preparation and/or distraction therapy is encouraged.

- It is not necessary to keep the patient fasted prior to pacing wire removal, but this will be determined by policy, especially where sedation is used. An assessment of the level of analgesia +/- sedation will be made on an individual patient basis

### **Chest Drains**

- If chest drains are present they should be tapped/manipulated (in accordance with local policy for chest drain management), to ensure patency of drains thereby providing a pathway for bleeding and reducing potential for cardiac tamponade. Refer to the following [SCHN chest drain practice guideline](#) for further nursing management of patients with chest drains:

### **Important to remember:**

- Notify the cardiothoracic registrar prior to procedure.
- The atrial pacing wire should be removed first as this allows for ventricular pacing to be undertaken should the patient's clinical status become unstable.
- Pacing wires should be removed by constant gentle traction, allowing the motion of the heart to assist dislodgment from the epicardial surface. Excessive traction should not be applied. <sup>2,3</sup>
- If the wires are unable to be removed due to excessive tension, stop and notify cardiothoracic nurse practitioner or fellow.

### ***Procedure***

1. Perform baseline vital signs and cardiac assessment and ensure patient is attached to a cardiac monitor
2. Print pre-wire removal rhythm strip from bedside monitoring
3. Don gloves
4. Remove any dressings from pacing wires
5. Clean wires and skin around puncture site with Aqueous Chlorhexidine 0.5% / 0.9% Sodium chloride
6. Cut suture holding the atrial wire
7. Place folded sterile gauze swab over atrial puncture site and wire and pull wire gently until it slides from the chest
8. Check the wire and wire tip are intact
9. Assess rhythm on cardiac monitor and assess patient
10. Assess chest tube drainage if applicable. If there is a sudden increase in drainage that does not resolve, contact cardiothoracic team before removing ventricular wire.
11. If rhythm and patient is stable, repeat previous steps to remove ventricular wire
12. Cover pacing wire sites with appropriate dressings as necessary

13. Perform vital signs and patient cardiac assessment

14. Dispose of equipment appropriately

15. Print post-wire removal rhythm strip from bedside monitoring and paste both strips on appropriate form and placed in patient notes.

**Alert:** Be alert for tamponade acutely or slowly evolving. Notify cardiothoracic team and cardiology fellow (who should perform immediate echocardiogram) if concerned.

### **Observations and Tests**

- The RN should check the vital signs and perform a cardiac assessment immediately post-procedure and again every 30 minutes for 2 hours, or as the patient's condition warrants, to detect potential complications. Patient should remain on continuous cardiac monitoring until instructed to cease by team.
- Observe chest drain losses (if insitu) for signs of tamponade, eg: increased drain losses and haemoserous drainage.
- The patient should remain in the ward/unit for at least two hours post procedure. The patient (if age-appropriate) and parents should be aware of signs and symptoms of possible complications and to report any concerns to staff immediately.
- In some cases, an echocardiogram may be requested post-procedure.

### **Complications associated with removal of epicardial pacing wires:**

<b>Complication</b>	<b>Signs and Symptoms</b>	<b>Management</b>
Cardiac tamponade <sup>2</sup>	Tachycardia, hypotension, cool peripheries with delayed capillary refill, reduced level of consciousness (LOC), arrhythmia, cardiac arrest	Notify RMO/Nursing team leader (TL) & Cardiac surgeon Tap chest drains vigorously (if insitu) Assess vital signs and perform cardiac assessment Prepare Chest Opening Tray Follow emergency protocol for campus
Excessive Bleeding	Obvious bleeding from site, tachycardia, hypotension, pallor, poor peripheral perfusion, reducing LOC, shock	Notify RMO & Nursing T/L Assess vital signs and perform cardiac assessment Measure blood loss Prepare IV fluids to replace losses (blood products/4% NSA as available)
Arrhythmias <sup>2</sup>	Evident on cardiac monitor with or without change in hemodynamic status Irregular pulse rate	Notify RMO/Nursing T/L & Consultant Assess vital signs and perform cardiac assessment
Wires become wedged in chest	Hard to pull the wires	Do not use force to remove, Abandon the procedure and inform the cardiothoracic surgical registrar/cardiac team

## Removal of Transvenous Pacing Lead

Transvenous Pacing Leads should be managed using the same principles as those for percutaneous Central Venous Access Devices (CVADs) outlined in the hospital guideline on CVADs. Once it has been deemed by the medical team that the patient's underlying rhythm is safe and reliable, the transvenous pacing lead can be removed. The steps taken to remove a transvenous pacing lead should be the same as those taken to remove a non-tunnelled CVAD as per [SCHN CVADs practice guideline](#):

Watch for arrhythmia when removing pacing lead as lead is intracardiac and can stimulate ectopic beats or arrhythmias.

## Indications for Insertion of a Permanent Pacemaker

The following list is not exhaustive, but does include some typical indications for the insertion of a permanent pacemaker. The indications for permanent pacing are relative and not absolute. The overall clinical condition of the patient is considered rather than using this list as a definitive indication for insertion of a permanent pacemaker (for example, the rates specified for complete heart block in neonates).

- Second- or third-degree AV block with symptomatic bradycardia
- Sinus node dysfunction with symptomatic bradycardia
- An asymptomatic neonate with congenital third degree AV block and wide complex escape rhythm
- Asymptomatic patients after cardiac surgery with advanced second- or third-degree AV block who's conducted sinus rhythm did not spontaneously recover after ten days post operatively <sup>11</sup>

## Permanent Pacemaker Nomenclature \*NASPE/\*\*BPEG

### GENERIC PACEMAKER (NBG) CODE

\*North American Society of Pacing & Electrophysiology

\*\*British Pacing & Electrophysiology Group

Permanent Pacemakers				
I	II	III	IV	V
Chamber Paced	Chamber Sensed	Response to Sensing	Programmable Functions	Antiarrhythmia Function
	O = None	O = None	O = None	O = None
A = Atrium	A = Atrium	I = Inhibited	P = Simple Programmable	P = Pacing
V = Ventricle	V = Ventricle	T = Triggered	M = Multi-Programmable	S = Shock
D = Dual	D = Dual	D = Triggered & Inhibited	C = Communicating R = Rate Modulated	D = Dual (pace & sense)

5,7,8,9

## Indications for Insertion of automated Implantable Cardioverter Defibrillator (ICD)

The American Heart Association (AHA) has guidelines on the indications for an ICD.<sup>12</sup>

Some typical indications for insertion of an implantable defibrillator include.<sup>12</sup>

- Cardiac arrest due to ventricular fibrillation (VF) or ventricular tachycardia (VT) not due to a transient or reversible cause
- Syncope of undetermined origin with clinically relevant, haemodynamically significant sustained VT or VF induced at electrophysiological study when drug therapy is ineffective, not tolerated or not preferred

For a full list of indications for an ICD, refer to the AHA guidelines.<sup>12</sup>

**Alert** - If patient with an ICD or PPM experiences cardiac arrest, the placement of external defibrillation pads/paddles in the anterior-posterior configuration is preferable to avoid damage to the device. Ensure pads are not placed directly over the ICD/PPM. Implantable cardioverter defibrillator shocks do not pose a danger to others during CPR; an unpleasant tingle has been described but can be prevented by wearing gloves while performing external cardiac compressions.<sup>13</sup>

## Emergency Procedure for Malfunctioning automated Implantable Defibrillation Device (ICD)/ Permanent Pacemaker (PPM)

In the circumstance of an ICD delivering a shock inappropriately, the Medtronic® Pulse Generator Magnet can be used to disable the defibrillator mode. In the event of a malfunctioning PPM, the Medtronic® Pulse Generator Magnet can be used to remove the PPM's sensing ability and places the PPM in an asynchronous pacing mode. The following information should be utilised in conjunction with the emergency protocol for each local area.

### **General Description**

The magnet is a blue-coated, ring-shaped magnet used to verify proper operation of Medtronic® pulse generators. They are available across the hospital as follows:

- PICU (resuscitation trolley opposite bed 13)
- ESW (resuscitation trolley and medication room)
- Cardiac department - Westmead
- CICU (resuscitation trolley)
- OT
- ED (mobile arrest trolley)

**The following information is provided by Medtronic® in the Pulse Generator Magnet product information sheet.<sup>14</sup>**

### ***Use of the Magnet***

The patient needs to be ECG monitored when using the magnet as it will interfere with normal ICD function.

Holding the magnet against the skin directly over the implanted device will convert the device to asynchronous operation and interrupt automatic defibrillation. This means that the ICD pacing component will pace the heart at a preset heart rate as set in the pacemaker programming, regardless of the heart's own activity (intrinsic activity). Fundamentally, it will inhibit the defibrillation function but not the pacing function.

*Note:* the magnet needs to be left against the skin for the defibrillation function to remain deactivated.

When the magnet is used on a patient to interrupt inappropriate ICD defibrillator activity, this should be treated as a medical emergency as inappropriate ICD therapy can precipitate fatal arrhythmias. Appropriate medical staff should be contacted urgently and the Medtronic representative (or relevant industry technician) should be contacted as soon as possible to run diagnostics on the implanted device.

### ***Care of the patient with an ICD or PPM***

#### ***Warnings***

- Magnetic conversion of an implanted device to asynchronous operation may result in competitive pacing.
- MRI scans needs to be avoided.
- An implanted device may be inadvertently reprogrammed if the magnet is applied in the presence of pulsed energy sources (i.e. radio and radar transmitters, some electric razors and household appliances, ECG telemetry, arc welders, anti-theft devices and other spark-producing devices).

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