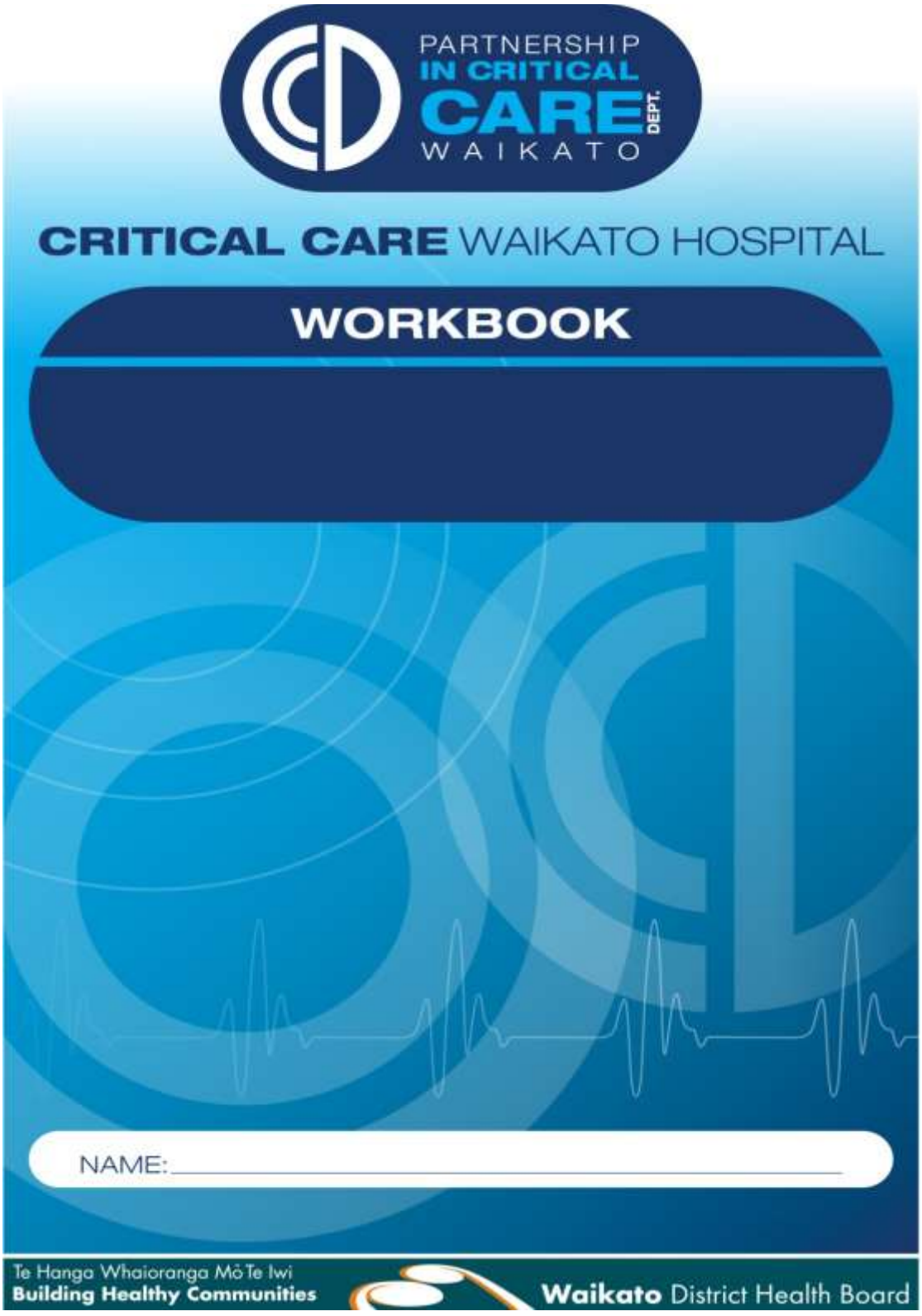


Section 4

Temporary Cardiac Pacing

Temporary Epicardial Pacing

Introduction

Temporary cardiac pacing involves sending an electrical signal from the pacing unit to generate a depolarisation in the myocardium, which in turn creates a ventricular or atrial response.

Indications for Pacing After Cardiac Surgery

Temporary cardiac pacing is indicated where there is failure of the inherent pacemakers to initiate an adequate rhythm or where the normal conduction pathways fail to conduct the impulse properly.
For example:

- To augment cardiac output post-operatively by increasing the heart rate
- As a precautionary measure post cardiac surgery
- Following adverse effects from anti-arrhythmic drugs
- Override pacing of atrial flutter as an alternative to DC reversion
- Post-myocardial infarction (e.g. in heart block)

Epicardial Pacing Wires

Epicardial pacing wires are placed at the time of open-heart surgery. The wires can either be lightly sutured to the epicardial surface of the right atria and right ventricle, or they may simply lie against the right atria and ventricle, depending on the pacing wire used and the preference of the surgeon. They then protrude subcostally and are sutured at the skin. They are tested prior to closure.

Atrial *wires exit the chest wall on the* ***patient's right****.*
Ventricular *wires exit the chest wall on the* ***patient's left****.*

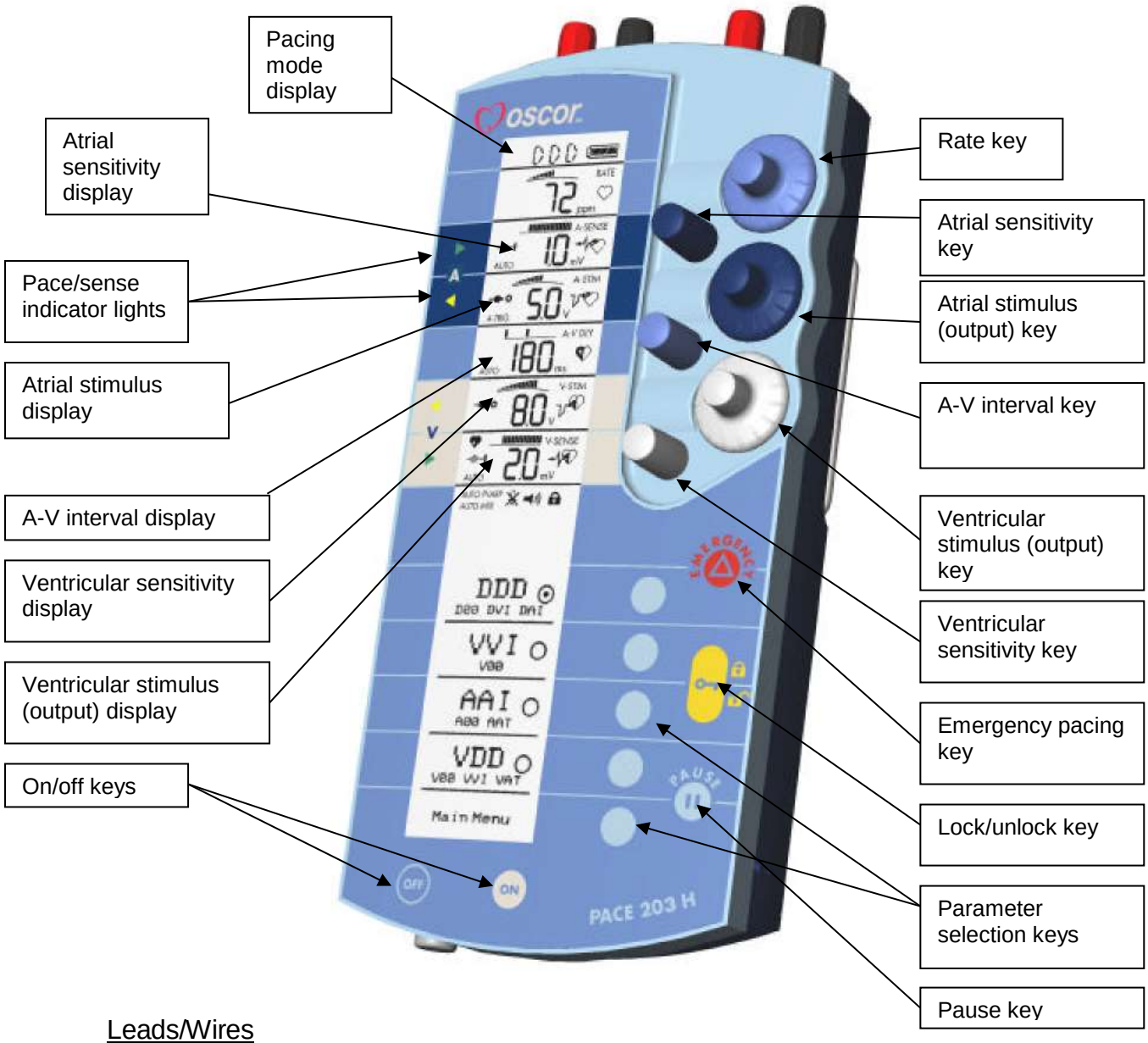
Potential Complications

- Tamponade
- Bleeding
- Infection
- Lead fracture
- Potential for micro-shock
- Lead Maturation:
    - The stimulus of a foreign body moving against the heart muscle can cause fibrosis and therefore begin the inflammatory process
    - After 5 - 8 days of pacing the output required to produce capture may need to be increased due to fibrosing tissue
- Lead Migration/ dislodgement:
    - Pacing wires can sometimes move from their original position. This is commonly the case with transvenous wires. However it can also occur occasionally with epicardial wires if they are not stitched onto the heart.

Pacemaker Components

Pulse Generator

Either Single chamber or Dual chamber



Leads/Wires

Bipolar – most commonly used, but can be unipolar. A variety of wires and coils are used.

The wires are coated with insulation (except the sensing and pacing parts holding the electrodes). Leads must be in direct contact with the heart to enable capture.

Bridging Cable

The bridging cable runs between the wire and the generator box.

Pacing Settings and Terminology

Rate Control Dial

This determines the rate at which the impulses are delivered from the pulse generator to the heart

Stimulus Dial
The amount of current required to elicit depolarisation. A *pacing spike* indicates that the generator box has discharged, however it is also important to note that *no spike* does not necessarily mean that pacing has not occurred (sometimes a spike is not visible with atrial pacing)

Capture
Capture has occurred when the pacing spike is followed by a P wave or QRS complex, indicating that the stimulation from the generator box caused a myocardial contraction

Stimulus Threshold
Stimulus threshold refers to the minimum amount of electrical current that is required for consistent capture. Ideally it should be > 1mA and the output of the generator box should be set 2-3 times higher than the threshold. *Please note that in an emergency situation the stimulus can be turned to the maximum setting.*

Sensitivity
The ability of the generator box to identify and respond to the patients own intrinsic rhythm. The higher the sensitivity setting numerically, the *less sensitive* the pacemaker is and the lower the sensitivity is numerically, the *more sensitive* the pacemaker is to the heart.

A-V Interval
A-V Interval indicates the delay between the atrial and ventricular pacing. This equates to the PR interval. The setting of the A-V interval determines the pacing interval between the atrium and the ventricle in dual chamber pacing.

Pacing Codes

The pacing code uses three letters:

- The first letter indicates the chamber, which is being paced
- The second letter indicates the chamber being sensed
- The third letter describes the response of the pacemaker to the patient's sensed intrinsic activity

The pacemaker's response to the sensed event can be:

I - Inhibited
T - Triggered
D - Dual
O - No change in modes

I (inhibited) is the usual setting seen in this ICU. The pacing modes most commonly used in the CCD are AAI, VVI or DDD.

I **Chamber Paced**	II **Chamber Sensed**	III **Response to Sensing**

O = None A = Atrium V = Ventricle D = Dual (A + V)	O = None A = Atrium V = Ventricle D = Dual (A + V)	O = None I = Inhibited I = Inhibited D = (I + I)

Methods of Pacing

Demand Mode

The pacemaker paces the heart and senses the activity of the heart, which will be inhibited by the heart's own intrinsic activity. The pacemaker only produces a stimulus when the heart rate drops below the pacemaker's preset rate. AAI, VVI and DDD are all examples of demand pacing. We rarely use *asynchronous* modes.

Dual Chamber Pacing (AV Sequential Pacing)

Atrial pacing is only suitable to use if the heart has a fully intact conduction system. If a patient has poor AV node function then dual chamber or ventricle only pacing *must be used*.

Atrial Pacing

Some cardiac surgeons prefer atrial pacing after cardiac surgery as it assists in AV synchrony and therefore improves cardiac output and maintains blood pressure.

Atrial Override Pacing

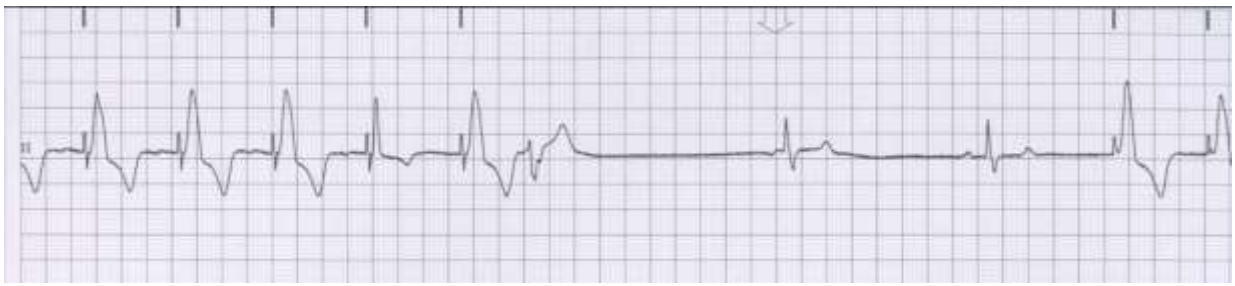
Rapid atrial pacing is used specifically in paroxysmal atrial fibrillation, tachycardia or atrial flutter with the objective of converting the arrhythmia to normal sinus rhythm by overdrive pacing *or* converting to atrial fibrillation by stimulating the atrium during the vulnerable phase of atrial repolarisation. The rapid atrial pulse generator is capable of delivering pacing discharges at rates of up to 800bpm. Because the generator has the capacity for such rapid pacing rates, it is essential that it be used only with atrial pacing wires. *Ventricular pacing, at such rapid rates could produce ventricular fibrillation and cardiac arrest.*

Troubleshooting

In order to identify inappropriate pacemaker function you need to understand how the pacemaker should be functioning in the set mode.

Failure to Pace

No pacing spikes are seen and no capture is achieved



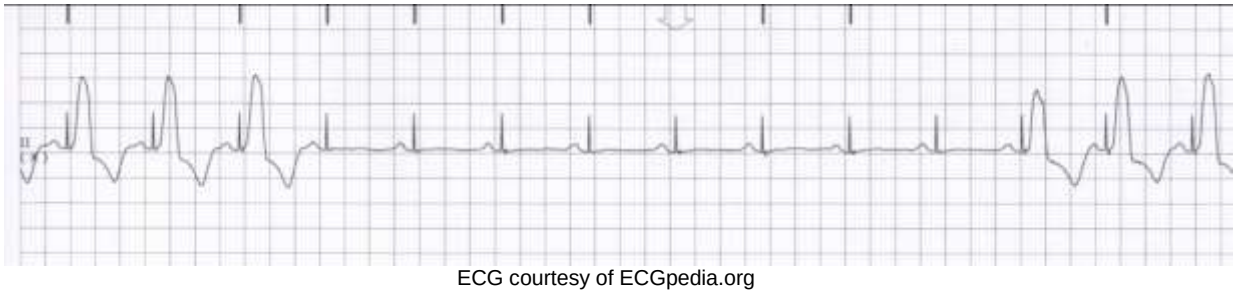
ECG courtesy of ECGpedia.org

Possible Causes

- Faulty generator box
- Disconnected or fractured leads
- Wire short circuit
- Flat battery
- Over sensing

Failure to Capture

A pacing spike is in the appropriate place but is not followed by a p wave or QRS complex



ECG courtesy of ECGpedia.org

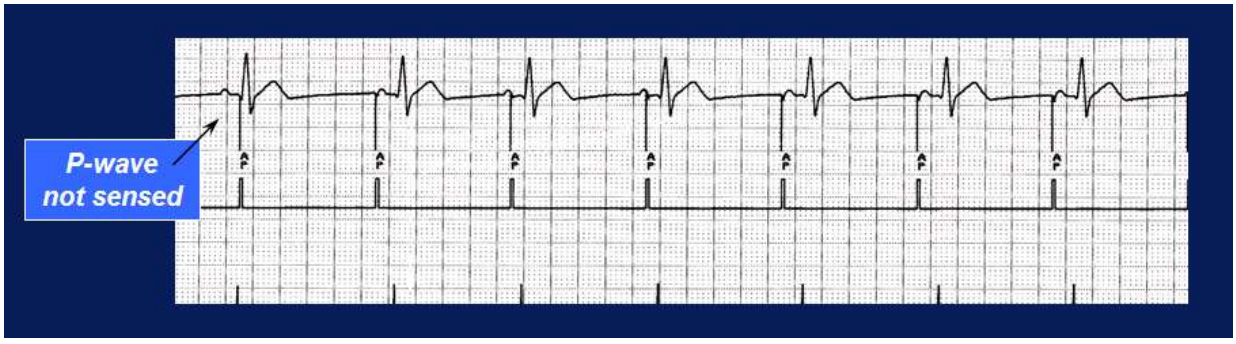
Possible Causes

- Threshold is increased therefore unable to capture
- Output set too low
- Lead malposition
- Old lead/faulty lead
- Short circuit
- U & E's too high/low

Failure to Sense

Pacemaker continues to pace when intrinsic rhythm is competing i.e. pacing spikes seen in inappropriate places

ECG courtesy of ECGpedia.org



Possible Causes:

- Old or fractured lead
- Malpositioned lead
- Sensitivity set too low
- Connection problem
- Battery failure

- Other electrical sources (interference)

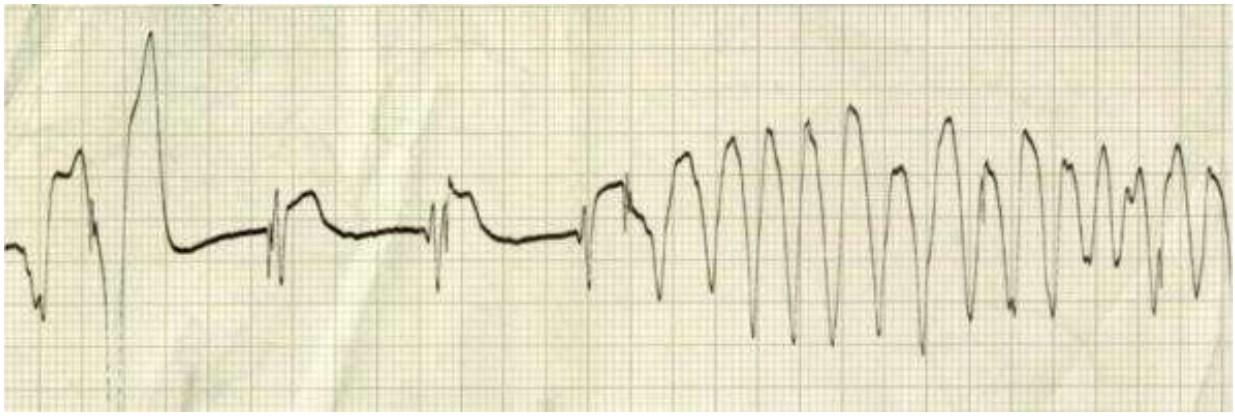
Oversensing
The pacemaker senses electrical activity other than the QRS e.g. T Waves

ECG courtesy of ECGpedia.org

Possible Causes:

- Myopotentials (e.g. skeletal muscle movement - shivering)
- Electromagnetic interference
- Large T waves
- Sensitivity is set too high and therefore the pacemaker is too sensitive

R on T Phenomenon
If a ventricular pacing spike falls during the relative refractory period (i.e. on the T wave) it can potentially cause VT. This can occur when there is competition between fixed rate ventricular pacemakers and the patient's own intrinsic rhythm, or when sensing is inappropriate and fails to inhibit pacing. *This is why VOO pacing is dangerous and should not be used. This is also why AOO and DVI modes can result in AF.*



Nursing Responsibilities

Care of the Pacing Box (Electrical Safety)

- Cardiac surgery patients are at risk of microshock, which could potentially cause ventricular fibrillation
- ALWAYS wear gloves when handling the exposed pacing wires
- Exposed pacing wires should be covered with either transparent waterproof tape (Blenderm) or plastic caps (blue wires with metal rods) when not attached to a pacing box

Monitoring and Documentation

- Know why the patient is being paced
- The patient should have continuous cardiac monitoring while being paced
- Check the pacing box settings at the beginning of each shift:
    - Is the box turned on or off?
    - What is the pacing mode? (AAI, VVI or DDD)
    - What rate is it set to?
    - Is the box set for back up pacing?
    - Is the box pacing and sensing?
- Check connections and leads
- Check pacing wire insertion sites for signs and symptoms of infection
- Assess the underlying rhythm
- Perform a pacing check each shift follow the procedure and document the Mode, Rate, Output, Output threshold, Sensitivity & Sensitivity threshold
- *Never change pacing settings, test thresholds or check underlying rhythm unless patient is in bed and monitored overhead*
- Know where a spare pacing box, batteries and leads are if required
- Ensure emergency transcutaneous pacing is available and you know how to use it if your patient is pacemaker dependent

Required Reading

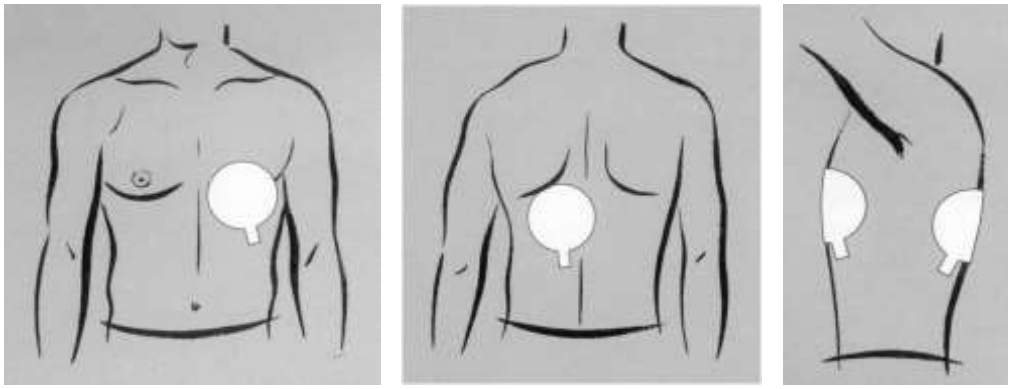
Sidebotham, D., McKee, A., Gillham, M., and Levy, J *Cardiothoracic critical care*. Philadelphia: Butterworth-Heinemann. Read pages 335-340.

Temporary Epicardial pacemakers (TEP) in intensive care, management of patients with. (2011). (ICU service-specific controlled document).

Transcutaneous Pacing

Introduction

Transcutaneous pacing is a non-invasive external pacing method that is useful in maintaining emergency pacing until a transvenous pacing catheter is inserted. Transcutaneous pacing devices deliver an electrical stimulus through the chest wall in an attempt to cause cardiac capture and mechanical contraction. In the conscious patients, these stimuli will be painful and therefore sedation plus analgesia may be required due to the discomfort caused, transcutaneous pacing must be regarded as a temporary measure only. Transcutaneous pacing is performed using a defibrillator and the pacing pads provided. The electrodes are placed in an antero-posterior position with the electrodes sited over the V3 electrode position, and over the tip of the left scapula or the inter-scapula region.



Transcutaneous Pacing Technique

1. Affix pacing electrodes as per figure 1. With the –ve electrode anteriorally and the +ve electrode posteriorally
2. The electrode cables are attached to the pacing device
3. Attach ECG monitoring electrodes to both shoulders and over the left upper abdomen.
4. Set the rate to 70-80bpm
5. Set the current output to 70mA
6. Feel for the femoral pulse and check the ECG to observe whether capture occurs (a pacing spike followed by a QRS complex)
7. If no pulse in detected, increase the current output slowly up to 200mA or until a pulse is detected
8. Reduce the stimulus current to the lowest value giving a palpable pulse and measure the blood pressure
9. If the ECG suggests that electrical capture has occurred but the circulation remains absent, consider the causes of Pulseless Electrical Activity (PEA) and treat as appropriate
10. Periodically stop pacing to examine for return of spontaneous circulation
11. Prepare for transvenous pacing

Additional Reading

External (transcutaneous) pacing. (2011). (ICU service-specific controlled document).