Guideline Title: Transvenous pacing management

Summary:
Temporary cardiac pacing involves electrical cardiac stimulation to most commonly treat a bradyarrhythmia until it resolves or until long-term therapy can be initiated. The purpose of temporary pacing is to increase heart rate and blood pressure; in some situations, temporary pacing can be lifesaving. Temporary pacing can be in the form of, Transcutaneous, Epicardial or Transvenous as discussed in this guideline

Approved by: ICU Medical Director

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1. Background Information:
   Transvenous pacing involves a pulse generator, which is externally connected to an electrode wire, threaded through a large vein, (generally internal jugular, femoral or subclavian), into either the right atrium or right ventricle. These wires come into direct contact with the endocardium in the heart.
   The pacemaker essentially does two things:
   1. It senses the patient’s own rhythm using a “sensing circuit”;
   2. It sends out electrical signals using an “output circuit”.


If the patient’s intrinsic rhythm becomes too slow or absent, the electronic pacemaker senses, and starts sending out signals along the wires leading from the control box to the heart muscle. The signals, if they “capture” properly, provide regular electrical stimuli, making the heart contract at a rate fast enough to maintain the patient’s blood pressure. The electrical signals are represented on the ECG monitor as “spikes”.

2. Definitions

- **Ampere (AMP, A)**
  Is a measure of electrical current flowing past a point in a conductor when one volt of potential is applied across one ohm of resistance. In pacing, these currents are so small that they are expressed in thousandths of amperes (milliamperes, mA) or in millionths of amperes (microamperes, µA)

- **Amplitude**
  The maximum absolute value attained by an electrical waveform, voltage or current. The amplitudes of pacemaker output pulses are expressed in volts (the difference in electrical potential), or in milliamperes (the measure of the electrical current flow).

- **Capture**
  Initiation of depolarisation of the atria and/or ventricles by an electrical stimulus delivered by an artificial pacemaker. Capture can be visualized on the monitor by a spike before every p wave (for atrial pacing) and a spike before every QRS (for ventricular pacing)

- **Electromagnetic Interference (EMI)**
  Radiated or conducted energy – either electrical or magnetic – which can interfere with the function of the pacemaker.

- **Intrinsic**
  Inherent; belonging to or originating from the heart itself, (e.g., an intrinsic beat refers to a naturally occurring heart beat).

- **Inhibited**
  Any pacemaker which, after sensing a spontaneous depolarisation, withholds its pacing stimulus. Examples are AAI, VVI

- **Millivolt**
  One one-thousandth of one volt. A unit of measure for low levels of voltage. Spontaneous, intrinsic P-waves and R-waves are measured in millivolts.

- **Millisecond**
  One one-thousandth of one second. Most pacemaker timing functions, e.g., pulse width and pacing intervals, are expressed in milliseconds.
- **No Output**
The absence of energy delivery to the heart.

- **Output**
The electrical stimulus or energy generated by a pulse generator and intended to trigger a depolarisation in the chamber of the heart being paced.

- **Asynchronous pacemakers**
  (a = not; syn = together; chrono = time) are those that are not together in time with the heart because they do not know what the heart is doing. Pacemakers such as AOO and VOO are asynchronous as they stimulate the heart at a fixed, preset rate independent of the electrical and/or mechanical activity of the heart.

- **Sensitivity**
  Is the pacemaker’s ability to sense a patient’s intrinsic rhythm or when natural depolarisation is occurring.
  - The sensitivity number represents the minimum size, in millivolts, of an electrical signal that will be detected by the pacemaker
  - The higher the sensitivity (number) the less likely the pacemaker will see the patient’s rhythm

- **Sensing Threshold**
The minimum atrial or ventricular intracardiac signal amplitude required to inhibit or trigger a demand pacemaker, expressed in millivolts.

- **Stimulation or output Threshold**
The minimum electrical stimulus needed to consistently elicit a cardiac depolarisation. It can be expressed in terms of amplitude (volts, milliamps) and pulse width (milliseconds), or energy (micro joules).

- **Triggered**
  In pacemaker terms, a Triggered pacing mode is the opposite of inhibited. Upon detecting a spontaneous depolarisation or other signal, a triggered mode will deliver an electrical stimulus to the heart.

### 3. Introduction:
The risk addressed by this policy:

**Patient Safety**

**The Aims / Expected Outcome of this policy:**

Patients admitted to the ICU who require Transvenous Pacing will be managed and monitored appropriately

**Related Standards or Legislation**

NSQHS Standard 1 Governance
4. Policy Statement:
- All care provided within Liverpool Hospital will be in accordance with infection prevention/control, manual handling and minimisation and management of aggression guidelines.
- VOO mode (or sensitivity levels set too high) must not be used in ICU as this is an asynchronous mode of pacing (exception: may be used with diathermy in OT or in an emergency situation with no underlying rhythm or pacemaker failure.)
- Thresholds and underlying rhythm must be checked and documented on pacing chart once a shift
- Pacemaker settings must be checked 2nd hourly and documented on pacing chart
- Always wear gloves when handling pacing wires
- Patient must be monitored at all times
- Daily 12 lead ECG of patients underlying rhythm (if not haemodynamically compromised) must be attended
- If femoral access is used for pacing, patient leg must be kept straight and patient to sit no higher than 45 degrees
- Patient must have ECG monitoring on insertion and at all times
- An ECG adaptor may be used for insertion, to guide placement. Other methods include monitoring surface electrodes or fluoroscopic guidance.

5. Principles / Guidelines
   a) Indications
      - Sinus bradycardia with haemodynamic impairment
      - AV blocks
      - Complete heart block
      - Overriding tachy atrial and/or ventricular arrhythmia (AF, A Flutter & SVT)
      - Re-entrant tachycardia’s
      - Prior to the implant of a permanent pacemaker
   
   b) Contraindications
      - Mechanical prosthetic tricuspid valve
   
   c) Complications
      - Lead dislodgement and disconnection
      - Bleeding
      - Pericardial tamponade
      - Thrombophlebitis
      - Pulmonary embolism
      - Catheter knotting
      - Air embolism
      - Various arrhythmias including ventricular tachycardia and ventricular fibrillation
      - Electrical hazards, such an inadvertent induction of ventricular fibrillation
      - Pneumothorax
      - Sub diaphragmatic stimulation
      - Infection
      - Perforation of the heart
      - Asystole
d) Precautions

- **Do not attempt to change battery while pacing a dependent patient.** It is always safer to use another operating pacemaker whilst batteries are being changed, rather than attempting to change batteries while the device is in use.

- **Asynchronous operation has the potential to induce life threatening arrhythmias. Ensure a defibrillator is at hand, and return to synchronous operation as soon as possible.** Asynchronous operation particularly in patients who have some intrinsic rhythm may potentially induce Ventricular fibrillation, and should always be used with caution, whilst the patient is being monitored.

- **Micro shocks:**
  - While epicardial pacing wires are meant to provide a safeguard against dysrhythmias, they have the potential to cause a lethal rhythm. Because the unattached wires provide a direct route for electrical current to flow to the heart, any stray current poses a threat to the patient, with as little as 0.1mA causing Ventricular Fibrillation.
  - To avoid Micro shocks, when handling pacing wires gloves should always be worn.

e) Equipment

- **Edwards Swan Ganz Bipolar Pacing catheter (Reference No D97120FS).** pictured below
  This is a balloon tipped floatation pacing wire inserted through a compatible 6F sheath.

- **Indicated for transvenous right ventricular pacing via Internal Jugular, subclavian or femoral (right femoral preferred)**

- **Edwards Introflex Introducer/ Sheath 6F (Reference No 1451BF6)**

Other equipment required

- **CVC pack**
- Pacing leads
- ECG adaptor

- Pacing Box Biotronic EDP20 / Generator with new 2 x AA batteries

- Gloves, PPE
- Sterile occlusive dressing
- ECG, SpO₂, BP monitoring

f) Procedure¹¹,¹²,¹³
- Transvenous pacing is accomplished by advancing a pacing electrode wire through a vein (femoral, subclavian or internal jugular) into the right ventricle or atrium. Temporary atrial venous pacing is rarely used.
- This procedure is usually performed in cardiac catheter lab (CCL) under fluoroscopy, unless a balloon tipped or pulmonary artery catheter pacing wire is inserted which can be performed in ICU.

Swan Ganz Bipolar pacing catheter balloon floatation⁴

- Attach red adaptors to electrodes
- Insertion CAN be under ECG guidance, so connect ECG adaptor to distal electrode and V₂. (see picture below)
The remaining ECG leads are attach to patient as normal.
- Check balloon integrity (leaks, asymmetry) by inflating balloon with 1.5-2.0 mLs air and submerging in sterile 0.9% sodium chloride or water.
- **Precaution:** care when handling the catheter. Avoid stretching, kinking or forceful wiping as may damage electrodes and wires.
- Introduce the catheter into vein through the introducer.
- Inflate balloon with 1.5-2.0 cms air and lock syringe.
- The catheter is then slowly advanced while continually monitoring the ECG monitor.
- When catheter is in the superior vena cava, a small negative atrial deflection will be seen.
- If catheter bypasses the heart into the inferior vena cava the atrial deflection will become positive.
- If this occurs withdraw the catheter and readvance.
- When catheter enters the right ventricle a large ventricular signal will be sensed, ie QRS complex will enlarge.
- When catheter touches the right ventricle endocardium expect to see elevated ST segments, PVC’s or both (see picture below).

The ECG adaptor is then disconnected and the distal lead connected to the negative terminal on pacing box.
- Once catheter has entered right ventricle deflate balloon by unlocking the syringe and removing syringe from catheter and letting balloon deflate passively. Prevents catheter from floating into pulmonary outflow tract
- Reattach syringe with all air expel and unlocked (see picture below)
- Another methods to float the pacemaker include monitoring the surface ECG and wait to see capture.
- The depth at which the catheter is in the right ventricle is usually between 35 and 45 CM
- Connect the distal electrode to the negative pacemaker terminal and the proximal to the positive terminal

- Turn pacemaker on in VVI mode, rate 80bpm, output 10mV, sensitivity 0.8mA and AV delay 150-200ms
- Once capture has occurred and patient haemodynamically stable aseptically secure proximal end of catheter to the insertion site to prevent movement that could result in loss of capture
- The ECG should have a LBBB. RBBB may indicate a perforation or insertion into the coronary sinus
- Obtain CXR to confirm position
- Perform output threshold and document pacemaker settings on pacemaker checklist
- For detailed information on modes and threshold settings see Temporary Epicardial pacing guideline 2013

**Removal**
- Ensure balloon is deflated
- Place patient in supine position
- Clean around sheath with chlorhexidine
- Slowly remove pacing wire from sheath watching monitor for arrhythmias
- Once wire is removed sheath can be removed as per CVC removal
6. Clinical Issues:
   - Underlying rhythm
     - The need for ongoing pacing should be regularly reassessed. This is best done by turning down the pacing rate and allowing the intrinsic rhythm to appear. This is a better strategy than turning down the pacing energy output until capture is lost, as there may be no underlying rhythm at all.
     - The patients underlying rhythm should be documented on the pacing chart every shift
     - If the patient is haemodynamically stable when the pacing rate is decreased a daily ECG should be done.

Care of pacing wire and pacemaker
   - The sheath site should be covered with a sterile dressing
   - Note the length at the insertion site of the pacing wire
   - Always wear gloves when handling pacing wire
   - The sites must be checked daily for signs of infection, such as redness or purulent discharge and a swab sent for culture and sensitivity with any change reported to ICU Medical team immediately.
   - If the pacing wire is attached to the pacing box this should be securely hung on an intravenous stand to prevent it from accidentally dropping to the floor, pulling on the cables or pulling out the wire.
   - Connections to the pacing lead and generator should be checked 2nd hourly
   - Settings of the pacemaker should be documented 2nd hourly on Pacemaker observation form No CR155

Battery:
   - Biotronic EDP 20
     - AA-sized) alkaline batteries.
     - Replace for each new patient.
     - Replace when the low battery indicator flashes
     - Replace at least once every week when the temporary pacemaker is in continuous use.
     - Note: When the low battery indicator flashes pacemaker maintains pacing at the current settings for a minimum of 24 hours
     - Pacing is maintained at the current settings for 30 s, minimum, if the settings are at nominal values

7. Performance Measures
   All incidents are documented using the hospital electronic reporting system: IIMS and managed appropriately by the NUM and staff as directed.

8. References / Links
   2. Temporary cardiac pacing. Brian Olshansky, MD. uptodate.com 2015
   4. Edwards Lifesciences. edwardslifesciences.com 2014
   5. Edwards Lifesciences Chandler Transluminal V-Pacing Probe. Instructions for use 2001

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13 Case Presentation. Dizzy. Dr Matt Steimle. https://drhem.files.wordpress.com/2012/05/senior.jpg

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