Heart Rhythm New Zealand: Guideline for the Perioperative Management of Patients with Pacemakers and Implantable Defibrillators: January 2014

Susan Sinclair, Nigel Lever, Warren Smith, Margaret Hood, Andrew Gavin, David Heaven, Fiona Riddell. Northern Regional Electrophysiology Service

The purpose of this document is to enable safe perioperative management of patients with pacemakers and implantable cardiac defibrillators (ICD). The main references for these guidelines are The Heart Rhythm Society Expert Consensus Statement on the Perioperative Management of Patients with implantable defibrillators, pacemakers and arrhythmia monitors [1], The Practice Advisory for the Perioperative Management of Patients with Cardiac Implanted Electronic Devices [2], and the United Kingdoms Medicines and Healthcare products regulatory agency guidelines [3]. These comprehensive documents supply further background information and reference material.

Previous perioperative recommendations have been based upon limited data and historical concerns with earlier devices. The current generation of devices are designed with a higher degree of tolerance for routine electrosurgical interference, however newer technologies for the operating room are continuously being developed and represent challenges to the manufacturers of these devices.

Preoperative Recommendations for Pacemakers:

All guidelines recommend the relevant Pacemaker Follow up Clinic is contacted to obtain accurate and up to date information on the patient prior to a procedure. A single recommendation for all patients with Pacemakers is not possible. The clinic will provide advice relevant to the planned procedure, and the patient's type of device.

The following information should always be obtained:

1. **Date of last check**: To have occurred within the last 6 months. Will identify any lead or device concerns. Battery Longevity should be greater than 6 months as aging batteries are more vulnerable to electromagnetic interference (EMI) damage[4-5].
2. **Date of implant**: Check for leads that have been implanted for less than 3 months as these are more likely to dislodge particularly in situations where central venous lines are placed or with cardiac surgery. Very old devices or unipolar leads may be at greater risk of interference [4-5].
3. **Type of pacemaker**: These can be a single or dual chamber or cardiac resynchronisation therapy (CRT) device. A minority of pacemakers/ICD's are implanted in the abdomen (typically paediatric or adult cardiac congenital patients) and different recommendations apply.
4. **Programmed settings**: These vary widely and many patients are now programmed to back up pacing rates as low as 40bpm. Modes such as Managed Ventricular Pacing (MVP) may cause confusion as non-conducted p waves are seen during normal function. Rate increases may occur with rate responsive pacing. Minute ventilation sensors have been seen to increase the pacing rate when the patient is ventilated or from monitoring system interference[6].
5. **Underlying rhythm and indication for pacing**: Pacemaker dependency must be established to allow safe management. It should be noted that some patients may become dependent during the operative phase as a result of vagal stimulation, opiates or other drugs.
6. **Magnet rate of device**: The rate and mode of action is variable between models and manufacturers.

Perioperative Precautions

Electrocautery : Can be used in either the bipolar or monopolar mode. There is minimal interference in the bipolar configuration unless directly applied to the device. Monopolar electrocautery has current flow through the patient's body to a large return electrode, casting a wider electrical field. Most case reports of problems with monopolar cautery involve surgery above the umbilicus[7]. Pacemakers implanted in the abdomen will be more exposed to interference during abdominal or pelvic surgery.

Electrocautery can cause:[8,9,10]

1. Inhibition of pacing due to oversensing, which can result in asystole in the pacemaker dependent patient.
2. Electrical reset to a safety mode (different from the usual operating mode).
3. Permanent damage to the device but this is unlikely if used >15cm from the device.

The following recommendations reduce the likelihood of these interactions:

1. Place the diathermy grounding pad as far away from the device as possible, preferably on the opposite side of the body. Do not place so current can flow through the device.
2. Use of bipolar mode is unlikely to result in an interaction.
3. Keep bursts in monopolar mode to less than 5 sec.
4. Use the lowest feasible energy.
5. Monitor patients by both ECG and pulse oximetry, or arterial line. During electrocautery the ECG amplifiers are saturated with interference and it is impossible to see inhibition of the pacemaker.
6. If inhibition of pacing function occurs and results in asystole, stop electrocautery. This will allow a return to normal pacing function. If further electrocautery is to be used, a magnet should be placed over the device to allow asynchronous pacing (see below).
7. Ensure a defibrillator capable of transcutaneous pacing is immediately available for all cases or in the operating room for pacemaker dependent patients. Place transcutaneous pacing/defibrillator pads prior to draping if there are any concerns or barriers to placement during the case.

Radiofrequency Ablation (RF):
The radiofrequency current path should be kept as far away as possible from the pulse generator and lead system. The high frequency signals generated by the RF electrodes may interact with the pacemaker causing inhibition, asynchronous pacing, pacemaker reset, elevated pacing up to the sensor rate. A defibrillator capable of pacing should be immediately available. A pacemaker check should be performed post procedure.[1]

Magnets:
A magnet (preferably a large donut model) should be available in the operating room. In the modern pacemaker, magnets work by closing a magnetic switch or in older pacemakers by closing a reed switch. Use of a magnet will avoid inhibition of pacing by initiating asynchronous pacing at the manufacturer specific rate. However there is marked variation between manufacturers and models and the pacemaker clinic will advise the rate for each patient preoperatively. Magnets should only be used if inhibition is seen or if it will be difficult to place one during the surgery. Rarely asynchronous pacing can produce atrial or ventricular arrhythmias when there is competition with the intrinsic heartbeat.
Magnets can also be used to inhibit inappropriate rate responses or interrupt automatic algorithms such as automatic threshold capture. Removal of the magnet will result in the pacemaker returning to normal settings.

Recommendations:

1. A routine pre surgery check is not required unless special circumstances exist or it is recommended by the Pacemaker Clinic. (i.e. the patient is due for a routine check, followed for pacemaker or lead malfunctions, or is near elective replacement time). [11]
2. A routine post surgery check is required only if abnormal pacemaker function is seen during the surgery or if diathermy has been used within 15 cm of the pacemaker, or external cardioversion/resuscitation has occurred.
3. Rate Response only needs to be disabled in devices that use minute ventilation as the rate sensor.
4. Many patients are now programmed to back up pacing rates such as VVI at 50bpm with hysteresis rates down to 40bpm (ie heart rate slows down to 40bpm before pacemaker

paces at 50bpm). These patients can have their programmed rates increased for the duration of the surgery to facilitate management.

5. **These guidelines apply to surgery >15cm from the pacemaker. If surgery is closer than this in a pacemaker dependent patient further advice should be sought from the Pacemaker Clinic.**

Preoperative Recommendations for Implantable Cardioverter Defibrillators (ICDs):

Electromagnetic interference (EMI) from electrocautery leading to oversensing and inappropriate shock therapy from an ICD is one of the major concerns in the perioperative environment[11]. **There is no asynchronous pacing** mode with magnet use in an ICD if pacing inhibition due to EMI occurs. Full information regarding the device and its programming should be obtained from the managing pacemaker clinic prior to the procedure.

It is recommended that anti-tachycardia therapy is disabled in procedures where EMI can occur as this may lead to an inappropriate shock. Rarely an inappropriate shock can induce ventricular or atrial arrhythmias and the associated unexpected patient movement can cause concerns during surgical procedures. Therapy can be disabled by either reprogramming or correct use of a magnet. The Heart Rhythm Society has no objection to the use of a magnet to disable therapy as long as the magnet response is known and its use is feasible[1]. However for maximum patient safety, the American Society of Anaesthesiologists Practice Advisory recommends tachyarrhythmia functions are programmed off [2] rather than relying on a magnet alone. Given the above, the risk of EMI and the site of the surgery will determine whether a magnet can be used safely or whether the anti-tachycardia therapy should be disabled by reprogramming.

Surgery above the umbilicus incurs the greatest risk for EMI and therapy should be programmed off in this situation[1]. Additionally for the pacemaker dependent ICD patient some of the current generation of devices can be programmed to an asynchronous pacing mode prior to surgery. As above for maximum patient safety, advice for the management of pacemaker dependent patients should be sought from the Pacemaker/ICD clinic prior to the procedure.

Electrocautery Recommendations:

1. Place the diathermy grounding pad as far away from the device as possible, preferably on the opposite side of the body. Do not place so current can flow through the device.
2. Use of bipolar mode is unlikely to result in an interaction.
3. Keep bursts in monopolar mode to less than 5 sec.
4. Use the lowest feasible energy.
5. Monitor patients by both ECG and pulse oximetry, or arterial line. During electrocautery the ECG amplifiers are saturated with interference and it is impossible to see inhibition of the pacemaker.
6. If inhibition of pacing function occurs and results in asystole, stop electrocautery. This will allow a return to normal pacing function.
7. Ensure a defibrillator capable of transcutaneous pacing is immediately available for all cases or in the operating room for pacemaker dependent patients. Place transcutaneous pacing/defibrillator pads prior to draping if there are any concerns or barriers to placement during the case.

<u>Use of a magnet to disable anti-tachycardia functions</u>:
To successfully disable therapy a magnet can be placed over the device and taped securely in position. The patient must be in a supine position. Two manufacturer's devices emit a beeping sound to help identify correct placement of the magnet. Most manufacturers have no reliable means to detect appropriate magnet placement so there is some risk of inappropriate shock if the magnet is placed incorrectly[12]. There will be no change in the pacing rate or asynchronous pacing with the use of a magnet. Some devices can be permanently disabled by placing the magnet and others will have the magnet feature programmed off. If a magnet is used to disable detection then bipolar

diathermy would be recommended as it generates less interference. If a magnet is to be applied, then:

- The patient must be continuously monitored whilst the magnet is over the ICD and an external defibrillator must be immediately available.
- All ICD patients who have had function temporarily disabled by magnet should have a check as soon as possible after surgery to document normal function.
- All ICD patients who have had therapy programmed off for a procedure should have this programmed on at the end of surgery.
- The managing Pacemaker Clinic should be advised well in advance of impending surgery where a physiologist will need to be present to deactivate anti-tachycardia therapy.

If a patient has had their ICD disabled (either by reprogramming or use of a magnet), continuous ECG monitoring and access to a defibrillator system is mandatory until the device is checked and reprogrammed.

Emergency Situations:

Proceeding to surgery without all the pre operative information available is suboptimal and should only occur in an urgent situation. All the above recommendations apply and in the absence of accurate information a defibrillator capable of transcutaneous pacing and a magnet should be in the operating room.

If pacing spikes are seen on the 12 lead ECG, it should be assumed the patient is pacemaker dependent and a magnet and transcutaneous pacing pads placed. Electrocautery should be used in bursts of <5sec and if a magnet is used to disable detection in an ICD then bipolar diathermy would be recommended as it generates less interference. Patients must be continuously monitored whilst a magnet is over the ICD.

All ICD patients who have had function temporarily disabled by magnet should have a check as soon as possible after surgery to document normal function. Contact your local Pacemaker/ICD clinic as soon as possible post surgery to organise. Patients must remain in a monitored environment until discussion with the clinic has occurred and advice given.

Cardioversion/Defibrillation ICD's and Pacemakers:

High voltage cardioversion and defibrillation can induce a large amount of current through implanted devices resulting in permanent damage to the device or reversion to a back up safety pacing mode[13,14]. Some case studies have shown transient loss of capture post cardioversion[14]. The risk is low if pads are placed in an anterior posterior position and away from the pulse generator[15]. Transient dysfunction is more common in older devices, unipolar leads or if anterior- lateral electrode positions are used.

Recommendations:

- Prior to cardioversion in a pacemaker dependant patient, the pacing amplitude should be increased and a Physiologist should be present.
- All patients are monitored throughout the procedure.
- A transcutaneous pacing capable defibrillator should be present in the room or used.
- All patients should have a post procedure check.

1. The Heart Rhythm Society (HRS)/American Society of Anesthesiologists (ASA) Expert Consensus Statement on the Perioperative Management of Patients with Implantable Defibrillators, Pacemakers and Arrhythmia Monitors: Facilities and Patient Management www.hrsonline.org/ClinicalGuidance/cieds_consensus-statement.cfm

2. Practice Advisory for the Perioperative Management of Patients with Cardiac Implantable Electronic Devices: Pacemakers and Implantable Cardioverter-Defibrillators, Anesthesiology: February 2011 - Volume 114 - Issue 2 - pp 247-261
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Pacemakers:

The following preoperative information should be sought from the managing pacemaker clinic:

1. Date of last Check
2. Date of Implant
3. Type of Pacemaker
4. Programmed Settings
5. Underlying Rhythm
6. Magnet Rate

Recommendations:

a) Electrocautery: can cause pacemaker inhibition resulting in asystole.

- Electrocautery should be used in short bursts.
- Place the grounding pad as far away from the pacemaker as possible -usually on the opposite thigh.
- If asystole is seen, a magnet should be placed on top of the pacemaker. This will cause asynchronous pacing at the programmed magnet rate as identified prior to the surgery. Magnets should not be routinely taped over the pacemaker for the duration of the surgery.

b) General

- All pacemaker patients should be monitored by ECG and pulse oximetry or arterial line during the procedure.
- A routine pre procedure check is not required unless special circumstances exist or it is recommended by the Pacemaker Clinic. (ie the patient is due for a routine check, followed for pacemaker or lead malfunctions, or is near replacement time)
- A routine post surgery check is required only if abnormal pacemaker function is seen during the surgery, post cardiac surgery or if cardioversion/resuscitation has occurred
- Rate Response only needs to be disabled in devices that use minute ventilation as the rate sensor.
- Many patients are now programmed to back up VVI at 50bpm with hysteresis rates down to 40bpm (ie heart rate slows down to 40bpm before pacemaker paces at 50bpm). These patients can have their pacing rates increased for the duration of the surgery to facilitate management.
- A defibrillator capable of transcutaneous pacing should be immediately available for all cases or in the operating room for pacemaker dependent patients.
- **These guidelines apply to surgery >15cm from the pacemaker. If surgery is closer than this in a pacemaker dependent patient further advice should be sought from the Pacemaker Clinic.**

Implantable Cardioverter Defibrillators (ICD's)

The above pacemaker recommendations also apply to ICD's.
Additionally:

- There is **no** asynchronous pacing mode with a magnet available in ICD's but stopping electrocautery should result in a return to pacing.
- Tachycardia detection and therapy should be disabled to prevent therapy being given for noise detection due to electrocautery. Failure to program these will result in the patient receiving shock therapy. For surgery below the umbilicus or in emergency situations it is reasonable to use a properly positioned magnet to temporarily disable therapy.
- Patients should be continuously monitored and an external defibrillator immediately available.
- Therapy should be programmed on at the end of surgery.
- A full check to confirm normal function should be performed post procedure.

Cardioversion and Defibrillation

- Failure to capture, damage to the pacemaker or transient inhibition can occur.
- Recommendations:
- It is essential that the defibrillation pads should be placed in an anterior/posterior configuration to prevent damage to the pacemaker/ICD.
- In pacemaker dependent patients reprogramming of the pacemaker will be required pre cardioversion and a Physiologist with a programmer should be present
- A full pacemaker check to confirm normal function should be performed post procedure.
- A defibrillator capable of transcutaneous pacing should be in the procedure room