Perioperative CIED Guidelines

Perioperative Guidelines for use in patients with cardiac implanted electronic devices (CIEDs) undergoing elective or emergency surgery.

P. Milligan, A. Shepherd, J. McLenachan, R. Patel, A. Macalister Hall

Anaesthetics, NHS Lothian

L. Burgum, N. Grubb, S. Lidgate

Cardiology, NHS Lothian

Updated December 2023

Authors: P.Milligan, A.Shepherd, J.McLenachan, R.Patel, A.Macalister Hall, L.Burgum, N.Grubb, S.Lidgate
Date: Dec 2023
Approved by: Perioperative Assessment Guideline Group
Next review date: Dec 2025

Table of Contents

Authors: P.Milligan, A.Shepherd, J.McLenachan, R.Patel, A.Macalister Hall, L.Burgum, N.Grubb, S.Lidgate
Date: Dec 2023
Approved by: Perioperative Assessment Guideline Group
Next review date: Dec 2025

Background

These guidelines have been established by the NHS Lothian Anaesthesia and Cardiology Departments to improve the perioperative planning and decision making for all patients undergoing surgery both in the emergency and elective setting.

These 2023 guidelines contain a number of significant changes from the previous version published in 2020, based on new guidance by the British Heart Rhythm Society published in 2023[1]. The key updates are outlined below.

When further advice is required in hours, we recommend first calling the cardiac rhythm management (CRM) physiologist (previously referred to as cardiac pacing physiologist) either on-site or whichever hospital has one on-site that day. Out of hours, the on-call cardiology registrar may be called. For further guidance on requesting advice see Appendix 4.

Summary of key updates

1) Routine deactivation of ICDs for **all** elective surgery is now no longer recommended. Instead, it is now considered reasonable not to deactivate the ICD for surgery **below the level of the umbilicus.**
2) For surgery **above the umbilicus** device-programmed deactivation and temporary magnet deactivation are both considered acceptable methods of deactivating implanted defibrillators. However, in hours when a CRM physiologist is available, device-programmed deactivation should still be the preferred option.
3) For surgery **below the level of the umbilicus** with a pacemaker (regardless of pacing-dependent status) no reprogramming is required.
4) Guidance for pacemakers and ICDs in specific surgical procedures has now been included (see appendix 7)
5) The availability of the CRM physiologists on each site has been updated, although this is subject to change.

Permanent Pacemakers (PPMs)

These are for the control of bradyarrythmias and those at risk of asystole. They may be single chamber (right atrium OR right ventricle) or dual chamber (right atrium AND right ventricle).

There are also relatively new **leadless** pacemakers which have been implanted in a small number of patients. These are implanted directly into the right ventricle. Of note, **leadless pacemakers do not respond to magnets with fixed rate pacing and therefore any programme changes need to be carried out using the specific device programmer. Biotronik pacemakers also do not respond to magnets with fixed rate pacing for the duration of magnet application.** They nominally only pace at fixed rate for 10-20 seconds and will then revert to normal function. These also should ideally be reprogrammed pre-operatively to 'enable magnet response' in addition to any other reprogramming required.

1. Microsoft Word - CIED-Surgical-Guidance-Derm revision 2023 - post council review.docx (bhrs.com)

Pacemakers may also be biventricular in the context of **Cardiac Resynchronisation Therapy** (CRT). A Cardiac Resynchronisation Therapy – Pacemaker **(CRT-P)** device is used for the treatment of heart failure using ventricular resynchronisation. These utilise 2 or 3 leads situated in the right atrium, right ventricle and coronary sinus (to pace the left ventricle).

However there is also a relatively new CRT system called the WiSE-CRT system which has been implanted in a small number of patients. It provides leadless, LV, endocardial pacing to provide CRT. This system uses an ultrasound transmitter with a separate battery unit, both of which are implanted in the chest wall to stimulate a 'seed' (small ultrasound-sensitive electrode) situated in the left ventricle. The manufacturer **advises specific precautions regarding this device, and the implanting centre should be contacted for advice prior to any procedures.**

Pacemakers can be programmed for multiple modes including:

Synchronous modes

Preserve AV synchrony. 'Physiological' in that ventricular depolarisation follows atrial depolarisation. Also known as 'demand pacing'.

Asynchronous modes

Do not preserve AV synchrony. Often used in emergency situations or in an environment (e.g. theatre) where electromagnetic interference (EMI) can cause inhibition of pacing. Also known as 'fixed-rate pacing'.

PPM problems due to Electromagnetic Interference (EMI - e.g. diathermy)

- **Sensing of EMI as intrinsic cardiac depolarisation and NOT delivering a paced beat**
- **THEREFORE RISK OF ASYSTOLE IF COMPLETELY PACEMAKER DEPENDENT**
- **Risk of R On T Phenomenon precipitating arrhythmia**

Implantable cardioverter defibrillators (ICDs)

These are for the treatment of life-threatening ventricular tachyarrhythmias e.g. VF/VT and may be single or dual chamber.

These also may be biventricular, again in the context of Cardiac Resynchronisation Therapy (CRT) for the treatment of heart failure. If the CRT device has a defibrillator component, it is called a Cardiac Resynchronisation Therapy - Defibrillator **(CRT-D).**

ICDs detect ventricular tachycardia and ventricular fibrillation and can deliver a shock, and most have a back-up pacing mode should a bradyarrhythmia or asystole follow shock delivery. Indeed, most can also function as a pacemaker if there is an indication for pacing. If there is not, they are usually programmed just for back-up pacing if required following a shock. Some ICDs called subcutaneous ICDs (**S-ICD) do not have a pacing capability, other than a short duration post-shock response. This is more like external pacing through a defibrillator.**

ICD problems due to EMI:

- **Inappropriate delivery of a shock**
- **Failure to deliver a shock as for PPM and Asystole if CRT-D**
- **Risk of R On T Phenomenon precipitating arrhythmia**

N.B: All CRT devices have the ability to act as a pacemaker (for the treatment of bradyarrhythmia and some tachyarrhythmias). Indications for and the effect of magnet application for CRT-P and CRT-D are not the same – see Appendix 2.

Implantable Loop Recorder (ILRs)

Implanted for detailed, long term cardiac monitoring only. No Pacing. No Defibrillation.

ILR Issues with EMI:

- **Possible episodes of artefact making interpretation a challenge at check-up**

Pacing dependency

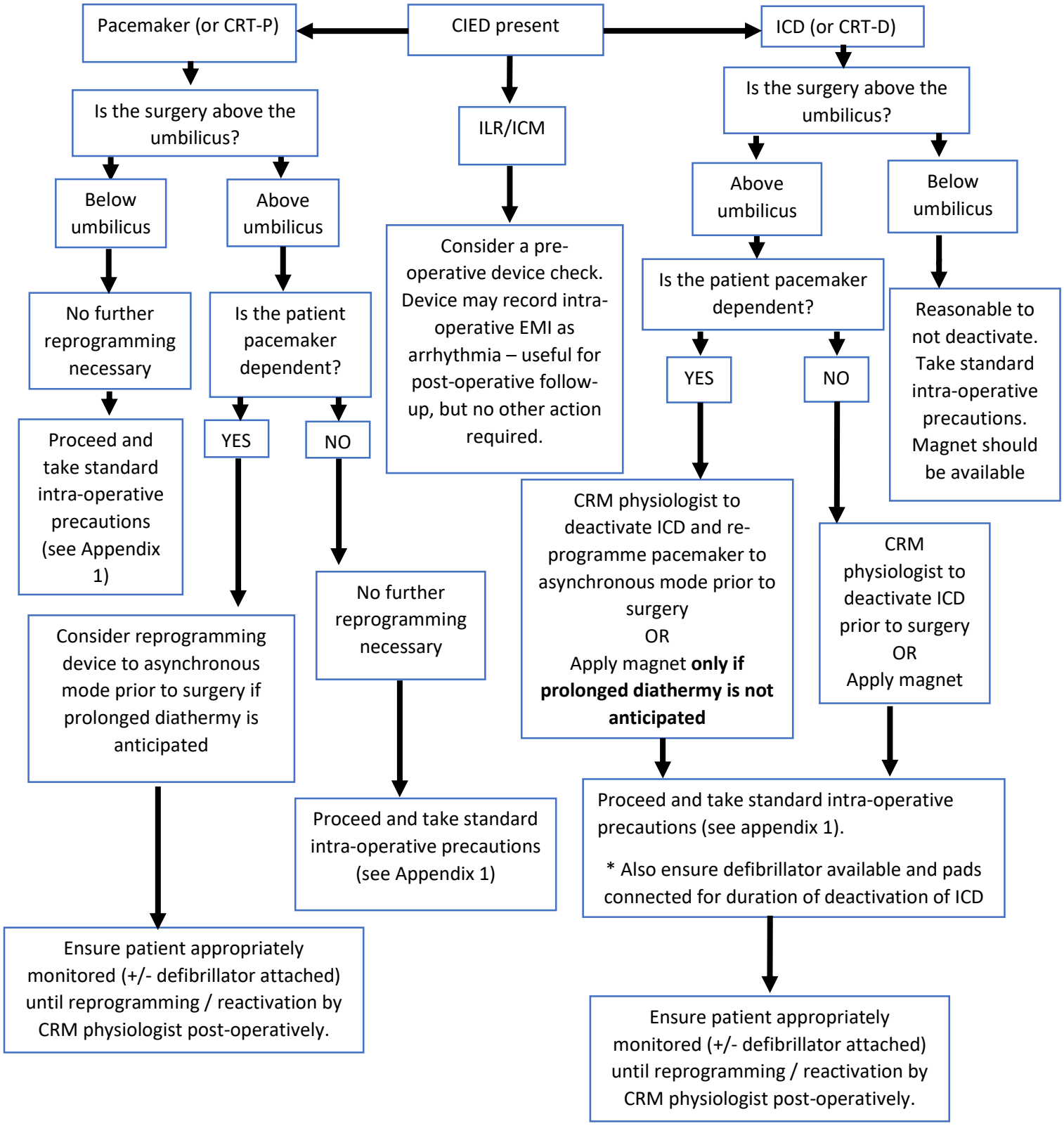
Since CIEDs can be used for several different indications, visible pacing spikes on an ECG do not necessarily mean that the patient is completely pacemaker dependent. There may or may not be an underlying cardiac rhythm. In practice, a patient is pacemaker-dependent if they are haemodynamically unstable or symptomatic with an inadequate or absent rhythm (commonly defined as <40 beats per minute) if the CIED is suddenly deactivated. Most patients are not pacemaker-dependent, but those who are remain at the highest risk from EMI-induced inhibition; consider reprogramming their device to a fixed-rate pacing mode if prolonged diathermy is to be used near to the device (see Suggested Decision Making algorithms).

Sources of EMI:

Potential sources of EMI include:

- Diathermy (poses greatest risk)
- Evoked potential monitors
- Nerve stimulators/transcutaneous electrical nerve stimulation (TENS) machines
- Radiofrequency scanners/ablation devices
- Extracorporeal shockwave lithotripsy (ESWL)
- Intra-operative MRI
- Magnetic guidance systems

Suggested Decision Making For Elective Surgery [In Hours]



Authors: P.Milligan, A.Shepherd, J.McLenachan, R.Patel, A.Macalister Hall, L.Burgum, N.Grubb, S.Lidgate
Date: Dec 2023
Approved by: Perioperative Assessment Guideline Group
Next review date: Dec 2025

Guidance for Management of Patients Presenting For Emergency Surgery [In Hours]

Or elective surgery but without appropriate device workup.

Follow the algorithm for emergency surgery (see next algorithm) but also contact the on-site CRM physiologist (or cardiology on-call) for advice if required/time allows. A CRM physiologist may not be physically on-site 5 days a week. However, from Mon-Fri 9-5pm there will always be one available on one of the sites to contact for advice - See Appendix 4.

NB. CRM physiology advice should be your first port of call. These specialists will usually be more familiar with cardiac devices and their perioperative management than a general on-call cardiology registrar.

Pacemakers

- Generally, if the patient is **not** pacemaker-dependent and **bipolar** diathermy (or no diathermy) can be used, the risk of adverse effect from EMI interference is **low** with modern pacemakers (those sited since 2000 are likely to have bipolar leads which are significantly less subject to interference).
- Risk is **lower** again if surgery is **below the umbilicus**.
- If surgery is **within 15 cm** of pacemaker site, risk is **higher.**
- For elective surgery, it is the decision of the Consultant Anaesthetist and Consultant Surgeon whether to proceed or postpone theatre, depending on the urgency of surgery, balance of risks, and availability of a CRM physiologist (depending on their advice).
- If emergency surgery needs to proceed urgently, continue as per emergency surgery algorithm with standard intra-operative precautions – See Appendix 1.

ICDs

- For surgery **above** the level of the umbilicus, all ICDs/CRT-D devices **must** have the defibrillation/anti-tachycardia component deactivated prior to surgery. In-hours a CRM physiologist should do this where available. If not available, or out-of-hours, magnet deactivation is an acceptable alternative.
- For surgery below the level of the umbilicus, ICD deactivation may not be required but a magnet should be available.
- If a CRM physiologist is physically unavailable, true elective surgery (that can wait) **above the level of the umbilicus, where prolonged diathermy is anticipated**, should be **postponed** and rearranged for another suitable date.
- For 'urgent' elective or emergency surgery in-hours, it may be appropriate to proceed using a magnet. However, advice should be taken from a CRM physiologist/cardiologist and ultimately it is the decision of the Consultant Anaesthetist and Consultant Surgeon whether to proceed or postpone, depending on the urgency of surgery and balance of risks. For emergency surgery out-of-hours, continue as per emergency surgery algorithm with standard intra-operative precautions - See Appendix 1.

Authors: P.Milligan, A.Shepherd, J.McLenachan, R.Patel, A.Macalister Hall, L.Burgum, N.Grubb, S.Lidgate
Date: Dec 2023
Approved by: Perioperative Assessment Guideline Group
Next review date: Dec 2025

Suggested Decision Making for Emergency Surgery [Out of Hours]

Attempt to find out from:

- **Patient/ Relative/Device ID Card**
- **TRAK:** clinic letters/op notes (insertion), CIED check notes
- **CXR:**
  - ICDs usually have a thick radio-opaque coils in the RV lead (except S-ICDs which have a sternal lead tunneled to a device in the axillary chest wall)
  - Thick radio-opaque leads in both ventricles may indicate a CRT-D device.
  - Otherwise can discern if single/dual chamber or biventricular pacemaker (CRT-P) in situ

*Contact on-call Cardiologist at RIE for advice if unsure bleep **4028 or via switchboard**.*

*** If unable to resolve uncertainty** it is **safer to assume** a patient **IS PACING DEPENDENT** and/or that an **ICD IS PRESENT.***

CIED present?

Is type of device known?

NO

YES

PPM (or CRT-P)

- Assess ECG for degree of dependence (see page 4)
- If unsure ASSUME dependence
- For surgery **above** the level of the umbilicus there is a potential risk of asystole with EMI interference. Attach patient to a defibrillator with external pacing facility and have magnet available.
- Remember leadless and Biotronik pacemakers do not respond to magnet application.
- Proceed with vigilance and standard intra-operative precautions (see Appendix 1)
- For surgery **below** the level of the umbilicus (regardless of pacing-dependent status) no reprogramming is required. Monitor to ensure no inhibition is occurring and have a magnet available

ICD (or CRT-D)
OR UNABLE TO RESOLVE DOUBT

For surgery **below** the level of the umbilicus:

- It is reasonable to proceed without deactivating the ICD
- Monitor as per Appendix 1
- Ensure a magnet is available

For surgery **above** the level of the umbilicus:

- Place magnet directly over device for duration of surgery
  - Will suspend defibrillatory/anti-tachycardia function of ICD
  - Will NOT reprogram the back-up pacing function of device (i.e. will NOT revert the back-up pacing to an asynchronous mode)
- Attach patient to defibrillator (with external pacing facility) for duration of magnet placement. [**AP Pad Position preferable**]
- See Appendix 2 for use of magnets.

- Normal CIED function should re-occur after removal of the magnet
- This should be done in theatre recovery

Liase with CRM physiologist post-operatively (as soon as possible within working hours) to check/interrogate device.

Particularly if:

- Significant intraoperative arrhythmia/event has occurred
- DC cardioversion or external pacing was required

Not all patients will require review

ll, L.Burgum, N.Grubb, S.Lidgate

Appendix 1: Standard Intra-operative Precautions

General

- Peripheral pulse must be monitored continuously e.g. pulse oximeter, direct palpation or arterial waveform.
- Always consider arterial monitoring for challenging situations when you may need to directly assess the effect of diathermy. Particularly so for out of hours scenarios (no CRM physiologist available) with patients who are or MAY BE pacing dependent and require diathermy above the umbilicus.
- Place the **diathermy plate as far from the device as possible** and avoid the device being between the operation site and plate (e.g. if the device is in the left upper chest, place a plate on the right thigh for surgery below the chest).
- Always treat CIEDs as **NOT** MRI safe when in doubt. Even MRI safe devices may have been fitted with non-MRI safe leads and therefore be unsafe.
- Caution should be exercised when using magnetic drapes to hold surgical equipment as they may cause magnet effects on a CIED. Avoid placing magnet drapes on patient's thorax.
- The use of surgical magnetic anchoring and guidance systems is not recommended for patients with CIEDs.

If device reprogramming has been carried out for a surgical procedure, continue ECG monitoring until the device has been restored to pre-operative settings.

Drug and fluid considerations

- In patients with pacemakers, be cautious when using suxamethonium as fasciculations may cause inappropriate inhibition of pacing. ICDs are unlikely to deliver an inappropriate shock.

Be vigilant of fluid status in patients with fixed-rate pacing as they will be unable to respond to hypovolaemia by increasing their heart rate.

Diathermy

Monopolar diathermy should **NEVER** be used near a pacemaker generator or ICD (e.g. ipsilateral upper anterior chest wall, shoulder or neck area) as it will probably damage the pacemaker/ICD, and could cause arrhythmias such as asystole or VF, or inappropriate shock delivery from an ICD.

If diathermy must be used:

- Use bipolar diathermy where possible, to minimise electrical interference.
- If monopolar diathermy is essential, use away from the device, and in short bursts, 5 seconds or less, at the lowest possible energy, with intervening pauses, and with ECG monitoring to observe the effect on the rhythm.
- If pacemaker inhibition or inappropriate ICD activation occurs with diathermy use, inform surgeon immediately, attempt to limit diathermy use where possible and consider magnet application.
- Cutting diathermy is better than blend or coagulation current.

Defibrillation Machine and Pads

- **Apply pads in an Anterior - Posterior setting if possible**.
- Ensure application of a machine with pacing function.
- **Do not** adjust required joules because of the presence of an indwelling CIED.

Appendix 2: Use of Magnets intra-operatively

Implantable devices respond to placement of a magnet positioned immediately over them in a variety of ways. The response to the presence of a magnet in both pacemakers and ICDs is only temporary, and normal function will resume as soon as the magnet is removed. Magnets can easily move out of a functioning position and do not provide a reliable or individualised modification of device programming. The advantage of magnet application is the simplicity and the lack of need to reprogram the device after procedures (which avoids the possibility of failure to reprogramme ICD therapies back on).

Pacemakers

- A magnet secured over a pacemaker will produce an asynchronous mode of pacing i.e. will pace either the atria (AOO), ventricle (VOO), or both (DOO) at a **fixed rate**. As it is 'non-sensing' mode, **it will not misinterpret EMI as an intrinsic depolarisation**.
- The exceptions to this are **leadless and Biotronik** pacemakers where pacing function is unaffected by magnet application, unless the Biotronik pacemaker has been reprogrammed to 'enable magnet response' but this is not its default setting. If a patient with one of these pacemakers requires emergency surgery out-of-hours, for surgery above umbilicus, and could be pacemaker dependent, ensure they are attached to a pacing defibrillator and/or consider a temporary pacing wire if high risk of asystole.
- The rate delivered depends on the programming of the individual device and defaults that vary by manufacturer.
- The mode of asynchronous pacing (e.g. AOO, VOO, DOO) depends on the programming of the individual device.
- Asynchronous pacing will continue for the duration of magnet application over the device. Removal of magnet results in reversion to baseline programming.
- Be aware that asynchronous *ventricular* pacing can lead to arrhythmia due to R-on-T phenomenon in the presence of an underlying cardiac rhythm. R-on-T phenomenon would not apply to asynchronous *atrial* pacing (AOO).

ICDs

- For ICDs, a **magnet should suspend the arrhythmia/anti-tachycardia detection function** of the device, preventing an inappropriate discharge of a shock should the device mistakenly interpret EMI as a malignant arrhythmia.
- Subsequent removal of the magnet **immediately reactivates the ICD**.
- A CRM physiologist or cardiologist should ideally be involved for ICD deactivation in all but emergency/out-of-hours situations.
- Most ICDs have a pre-programmed back-up pacemaker mode (except S-ICDs which do not have a pacing capability, other than a short duration post-shock response), should a period of asystole or bradycardia follow a shock delivery. The applied magnet will NOT affect this back-up mode i.e. **will NOT produce an asynchronous mode**.
- Therefore, remember that patients with ICDs who are also completely pacemaker dependent (i.e. the pacemaker component is not just programmed to back-up mode), and those with CRT-D devices who are completely pacemaker dependent, are at risk of asystole with EMI if a magnet is used to deactivate the ICD component.

Applying a Magnet

- Magnet application as the primary method of ICD deactivation should only be considered when reprogramming by CRM physiology is not available.
- Locate the patient's CIED by feeling for the device under the skin (typically in the right or left pectoral area, but S-ICDs are located in the axillary chest wall). To secure, place on chest over the device generator and **secure with tape** – any tape is fine e.g. sleek. Ensure it will not move for duration of procedure.
- Keep the magnet at least 15cm from electronic and recording devices such as computers, phones and bank cards.
    - A Boston Scientific device will produce an audible tone (in synchrony with the R-wave) indicating successful deactivation of the device, which will remain when the magnet is in situ.
    - Medtronic devices also produce audible tones that only indicate an ALERT is present, but not specifically the status of the anti-tachycardia detection or therapy.
    - Biotronik pacemakers nominally only pace at fixed rate for 10-20 seconds and will then revert to normal function. If this occurs, the device will require reprogramming to activate magnet response.
    - Leadless pacemakers do not respond to magnet application with asynchronous fixed rate pacing.
    - Biotronik ICDs will revert to normal function after >8 hours – consider making note of the time of application and removing and then reapplying the magnet in prolonged surgical cases.

When to Apply

For physical magnet locations see Appendix 3.

Table 1. Indication and effect of magnet application to CIEDs

Device	Indication For Magnet (REPROGRAMMING NOT AVAILABLE)	Effect Of Magnet
PPM	Monitor for inappropriate inhibition of pacemaker. If possible, stop or reduce interference from EMI (e.g. short bursts diathermy/switch to bipolar diathermy/stop diathermy). **If not possible or inappropriate inhibition continues - apply a magnet.**	Pacing usually assumes an asynchronous mode (except leadless and Biotronik lacemakers) Rate response suspended.
ICD	**Surgery above the umbilicus**	ICD is deactivated*. No effect on bradycardia pacing function.
ICD + PPM	**Surgery above the umbilicus**	ICD is deactivated*. No effect on bradycardia pacing function i.e. does not produce asynchronous mode. **Risk of asystole with EMI if pacemaker dependent.**
CRT-P	Monitor for inappropriate inhibition of pacemaker. **If this occurs** then **apply magnet**.	Pacing usually assumes an asynchronous mode. Rate response suspended**. Pacing usually continues as biventricular (i.e. CRT continues).
CRT-D	**Surgery above the umbilicus**	ICD is deactivated. No effect on bradycardia pacing function. Pacing usually continues as biventricular (i.e. CRT continues). **Risk of asystole with EMI if pacemaker dependent.**

ICD deactivation *- this means deactivation of all tachyarrhythmia detection and therapies (tachyarrhythmia pacing, cardioversion and defibrillation).*

Suspension of rate response *- rate modulation is switched off and pacing will remain at a fixed rate whilst the magnet is in situ (device dependent but can be 85 – 120bpm)*

Appendix 3: Where to Find Magnets:

Royal Infirmary:

Theatres:

- Pharmacy store room opposite Theatre 2 (for Simpsons use)
- Theatre 17 (CEPOD theatre)

ICU (Ward 118):

- Drug cupboard

CCU (Ward 114):

- One in drug cupboard
- One in pacing procedure room

Ward 103:

- Drug cupboard

ED: Resus bay 1 in defib trolley

CRM physiology also keep a supply of them in the ECG department, OPD 3

Western General Hospital:

Theatres: Main theatre, box at the bottom of pharmacy cupboard 3

ICU: Stuck to the safe in the ICU charge nurse office

St John's Hospital:

Theatres:

- Box in Theatre 4 anaesthetic room/on top of equipment trolley in store room during COVID
- Labour Suite anaesthetic Room

CCU: On wall in office behind main desk

ED: Usually in CD cupboard in Resus (During COVID, there is one located in Green Zone CD cupboard, and one in Red Zone cardiology cupboard)

Appendix 4: Cardiac Physiology Site Cover and Directory

There is not always a cardiac pacing physiologist on site for every NHS Lothian Site every day. However, a member of the pacing team should be available to answer questions even if on a different site. They are also able to arrange for someone to be present on a specific day if they know in advance of an elective case.

Royal Infirmary of Edinburgh

Email: CRM.RIE@nhslothian.scot.nhs.uk

Phone: 21813 (ECG Department) 21817 (Pacing office – not always occupied)

Availability: Fully staffed 5 days a week (0900 – 1700)

Mondays	Tuesdays	Wednesdays	Thursdays	Fridays
Staffed	Staffed	Staffed	Staffed	Staffed

Western General Hospital

Email: CRM.WGH@nhslothian.scot.nhs.uk

Phone: 31852 (ECG Department)

Availability: Monday to Thursday 9-5, Friday 9-3

Mondays	Tuesdays	Wednesdays	Thursdays	Fridays
Staffed	Staffed	Staffed	Staffed	No

St John's Hospital

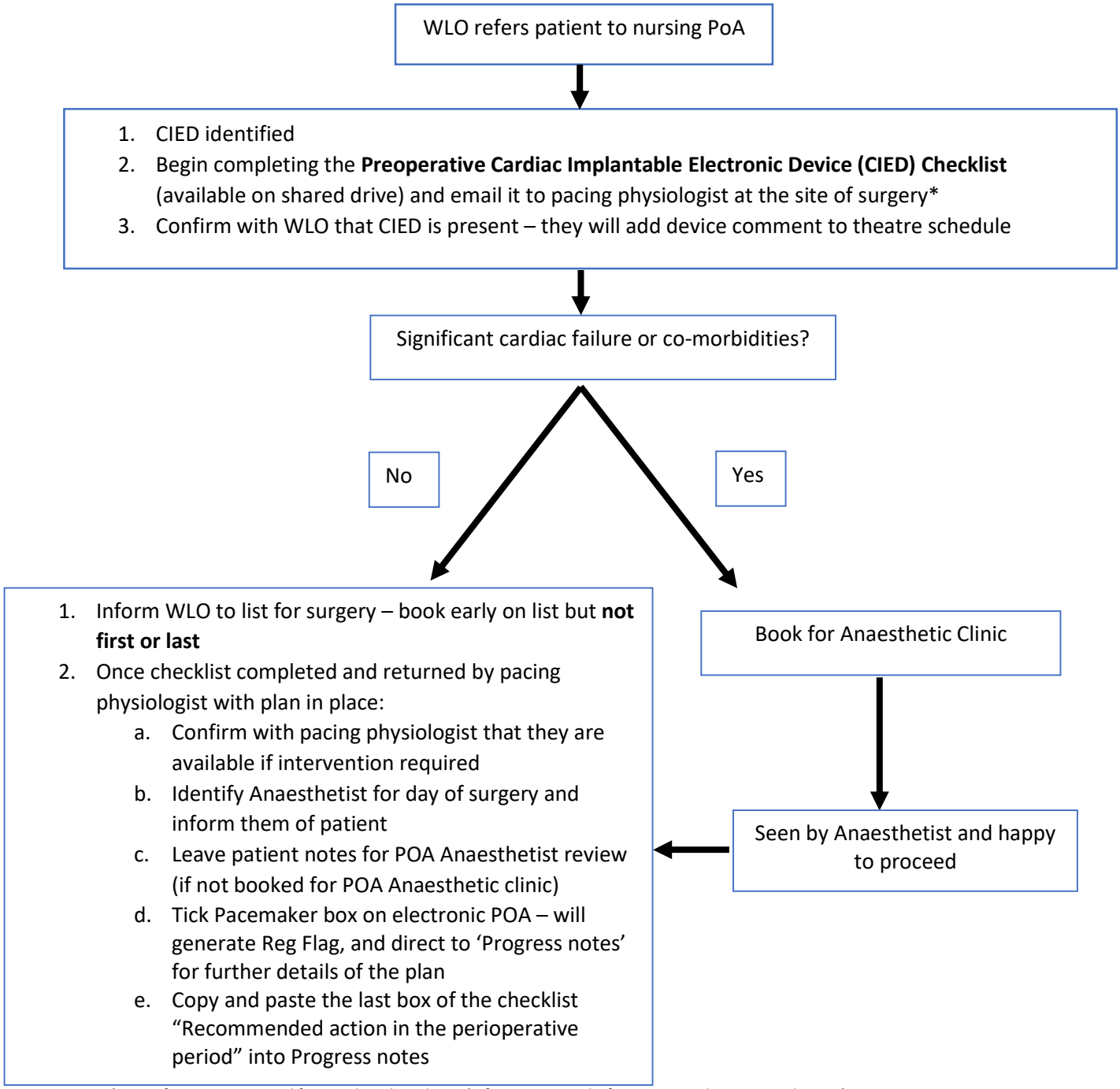
Email: CRM.SJH@nhslothian.scot.nhs.uk

Phone: 53851 (ECG Department)

Availability: Fully staffed on Wednesday & Thursdays. Occasionally there is a physiologist in attendance the other days. (0900 – 1700)

Mondays	Tuesdays	Wednesdays	Thursdays	Fridays
No	No	Staffed	Staffed	No

Appendix 5: Nursing Preoperative Assessment (PoA) Algorithm For Elective Surgery



* Key information required for email to physiologist (information sought from patient, device ID card, TRAK):

- Patient details
- Type of device (if known)
- Location of device e.g. left sub-pectoral region
- Pacing clinic/hospital where device followed up
- Type of surgery (including site if not obvious) and date (if already known)
- Name of Consultant surgeon

For further details please refer to the full policy document 'Perioperative CIED Guidelines'.

Authors: P.Milligan, A.Shepherd, J.McLenachan, R.Patel, A.Macalister Hall, L.Burgum, N.Grubb, S.Lidgate
Date: Dec 2023
Approved by: Perioperative Assessment Guideline Group
Next review date: Dec 2025

Appendix 6: Preoperative Cardiac Implantable Electronic (CIED) Device Checklist (for completion by PoA nurses and cardiac physiologists)

Pre-operative Assessment Nurses to complete:

Please complete the following questions as much as possible from the patient history, device information card and TRAK Notes. The completed form should be forwarded to the cardiac electrophysiology department at the hospital site where surgery will take place:
RIE: CRM.RIE@nhslothian.scot.nhs.uk WGH: CRM.WGH@nhslothian.scot.nhs.uk
SJH: CRM.SJH@nhslothian.scot.nhs.uk

(The key bits of information ideally required are marked with '*'.)

***Patient Name**:	
***CHI**:	

***Proposed Operation:**	**Consultant Surgeon:**
***Operative Hospital Site:**	**Scheduled Date if known:**
Type of Device e.g Pacemaker/ICD/CRT device:	**Date of Insertion:**
Location of Device (e.g. left sub-pectoral region):	***Hospital Following-up Device:**
Date of last device check-up:	**Date of next check-up:**

Cardiac physiology team to complete:

Please complete any unidentified fields above, plus the following, and email back to the sending Pre-operative assessment nurse:

Device details:
Device dependence:
Any further information required? (e.g. type of diathermy to be used by surgeon?)
Recommended action in the perioperative period e.g. reprogramming/deactivation etc:

Appendix 7: Perioperative management of CIEDs in specific cases

The BHRS guidance suggests this table for the required actions in different clinical situations. There is relatively little evidence for specific types of surgery, but this table is based on a consensus of expert opinion, the limited available data and device manufacturers' information.

	Pacemaker		ICD	
	Pacing-dependent	**Not dependent**	**Pacing-dependent**	**Not dependent**
Surgery above umbilicus	Consider reprogramming to fixed rate if prolonged diathermy anticipated	Monitor during surgery to ensure no inhibition of pacemaker. No reprogramming. Have magnet available.	Deactivate ICD. Consider reprogramming to fixed-rate pacing **or** Apply magnet as an alternative **only** if prolonged diathermy not anticipated	Deactivate ICD **or** Apply magnet
Surgery below umbilicus	Monitor during surgery to ensure no inhibition of pacemaker. No reprogramming. Have magnet available.	Monitor during surgery to ensure no inhibition of pacemaker. No reprogramming	Monitor during surgery to ensure no inhibition of pacemaker or inappropriate therapies. Reasonable not to deactivate ICD. Have magnet available.	
Cardiac surgery	Reprogramming likely to be required		Deactivate ICD ± reprogramming during surgery	
Eye surgery	As for surgery above the umbilicus if monopolar diathermy is used			
Endoscopy	Consider reprogramming to fixed-rate pacing if prolonged diathermy or argon beam anticipated	Monitor during surgery to ensure no inhibition of pacemaker. No reprogramming	Deactivate ICD. Consider reprogramming to fixed-rate pacing if prolonged diathermy or argon beam anticipated **or** Apply magnet as an alternative	Deactivate ICD if diathermy/argon anticipated **or** Apply magnet

Authors: P.Milligan, A.Shepherd, J.McLenachan, R.Patel, A.Macalister Hall, L.Burgum, N.Grubb, S.Lidgate
Date: Dec 2023
Approved by: Perioperative Assessment Guideline Group
Next review date: Dec 2025

			only if prolonged diathermy/argon not anticipated	
Dental	No action required unless diathermy is needed			
Electroconvulsive therapy (ECT)	Interrogate device within 1 month after treatment		Deactivate ICD during procedure **or** Apply magnet	
Lithotripsy	Interrogate device within one month after treatment		Deactivate ICD during therapy **or** Apply magnet	
	Avoid focusing the beam near the pulse generator. If lithotripsy triggers on R wave consider disabling atrial pacing during treatment			
Nerve conduction studies	Consider reprogramming to fixed-rate pacing	Monitor during surgery to ensure no inhibition of pacemaker. No reprogramming	Deactivate ICD and consider reprogramming to fixed-rate pacing **or** Apply magnet as an alternative **only** if prolonged stimulation not anticipated	Deactivate ICD **or** Apply magnet
Dermatology	If surgical site within **5cm** of PPM **and** significant diathermy anticipated, reprogramme to asynchronous mode	Monitor during surgery. No reprogramming.	If surgery **above umbilicus** Deactivate ICD **Or** Apply magnet If surgery with 5cm of device and prolonged diathermy anticipated, reprogramme PPM to asynchronous	If surgery **above umbilicus** Deactivate ICD Or Apply magnet If **below umbilicus** monitor during surgery. Reasonable not to deactivate ICD. Have magnet available.

Bibliography

1. **British Heart Rhythm Society Guidelines for the management of patients with Cardiac Implantable Electronic Devices (CIEDs) around the time of Surgery**. BHRS Council. Thomas H, Turley A, Plummer C. Oct 2023 Available from: Microsoft Word - CIED-Surgical-Guidance-Derm revision 2023 - post council review.docx (bhrs.com)

2. **Perioperative management of patients with cardiac implantable electronic devices.** Stone, M. E., B. Salter, and A. Fischer. British journal of anaesthesia 107.suppl 1 (2011): i16-i26.

3. **Management of Patients with Implantable Defibrillators, Pacemakers and Arrhythmia Monitors: Facilities and Patient Management**. Crossley GH, Poole JE, Rozner MA, Asirvatham SJ, Cheng A, Chung MK et al. The Heart Rhythm Society (HRS)/American Society of Anaesthesiologists (ASA) Expert Consensus Statement on the Perioperative Heart Rhythm. 2011. 8(7). 1114-1154.

4. **Evidence-based Guidelines for Preoperative Assessment Units. A Practical Guide.** The Pre-operative Association. 2017 Edition.

5. **Guidelines for the management of patients with Cardiac Implantable Electronic Devices (CIEDs) around the time of surgery and ECT**. Nottingham University Hospitals NHS Trust. Available from: https://www.nuh.nhs.uk/download.cfm?doc=docm93jijm4n1114.pdf&ver=2644. Accessed 28/01/19.

6. **A practical approach to preoperative management of cardiac implantable electronic devices**. Chia PL, Foo D. Singapore Medical Journal. 2015. 56(10): 538-541.

7. **A Closer Look. Magnet use with Boston Scientific Pacemakers and CRT-Ps**. Boston Scientific. 2013. Available from; https://www.bostonscientific.com/content/dam/bostonscientific/quality/education-resources/english/ACL_Magnet_Use_Pacemakers_CRTPs_20131220.pdf Accessed: 28/01/19.

8. **Magnet operation. CRHF Technical Services Standard Letter**. Medtronic.2016. Available from: https://wwwp.medtronic.com/crs-upload/letters/102/102_CQES-StandardLetter-MagnetInstructions-Combined-IPG-and-ICD-FINALv2-2016-Sep02.pdf