SAFE USE OF CARDIOVASCULAR IMPLANTABLE ELECTRONIC DEVICES DURING MRI

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Background

Until recently, pacemakers and implantable cardioverter defibrillators were considered absolute contraindications to MRI scanning by most manufacturers. With the development of MR conditional Cardiovascular Implantable Electronic Devices (CIEDs), patients with such implants can now be scanned safely, as long as the proper conditions for scanning are met [1,2]. Inadvertent scanning of patients with implants which are not MRI conditional could lead to complications e.g. skin burns[1]. Screening procedures and protocols have to be in place [3,4] to ensure patient safety.

Aim(s)

1. To ensure the **safety** of MRI patients.

2. To facilitate the **preparation** of patients with MR conditional CIEDs so that they can undergo MRI with minimal disruption.

Methodology

Collaboration among representatives from Radiology, Cardiology, and Clinical Measurements Unit (CMU)

Brainstorm on issues and solutions over several meetings

Literature review to identify safety aspects requiring attention

Develop algorithms and checklists

Result

1. The following were created:

- **Algorithms to screen** and **prepare patients** at various stages **(Fig. 1, 2)**
- A **guide** to follow in the event of **inadvertent scanning** of patients with CIEDs **(Fig. 3)**

→ These minimise the risk of an adverse event to the patient

→ Clear steps for urgent action are outlined to review the patient and device

- **Checklists (Fig. 4-5)** covering **safety aspects** requiring **special attention**[1,3]:

2. The various personnel involved in the patient's care can easily follow the steps required for the patient to safely undergo the MRI scan.

→ Scheduling delays and incidences of inadequate preparation are minimised

Figure 1: Algorithm for Screening for Patients with CIEDs

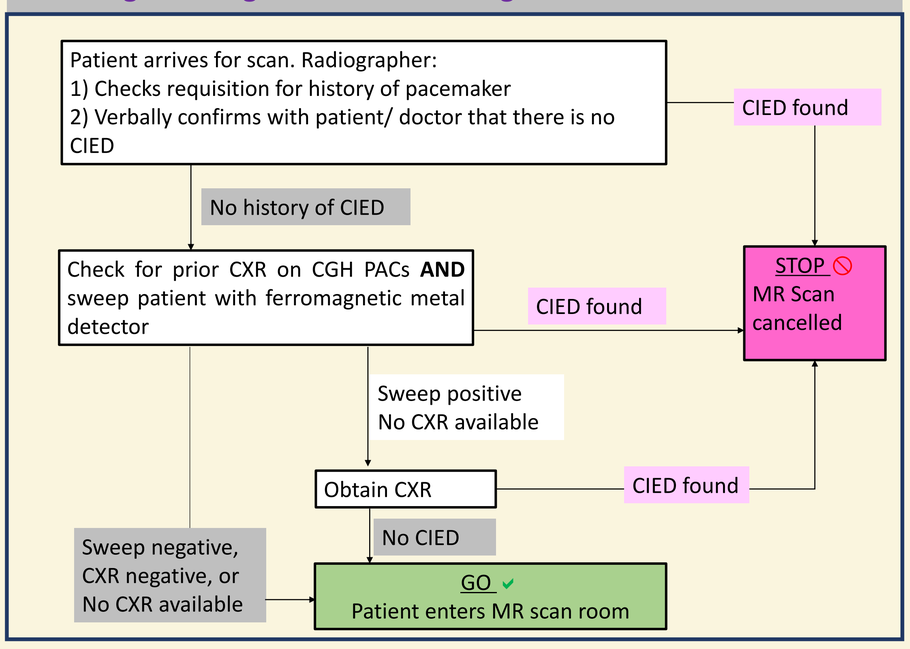


Figure 2: Algorithm for MRI Scanning of Patients with CIEDs

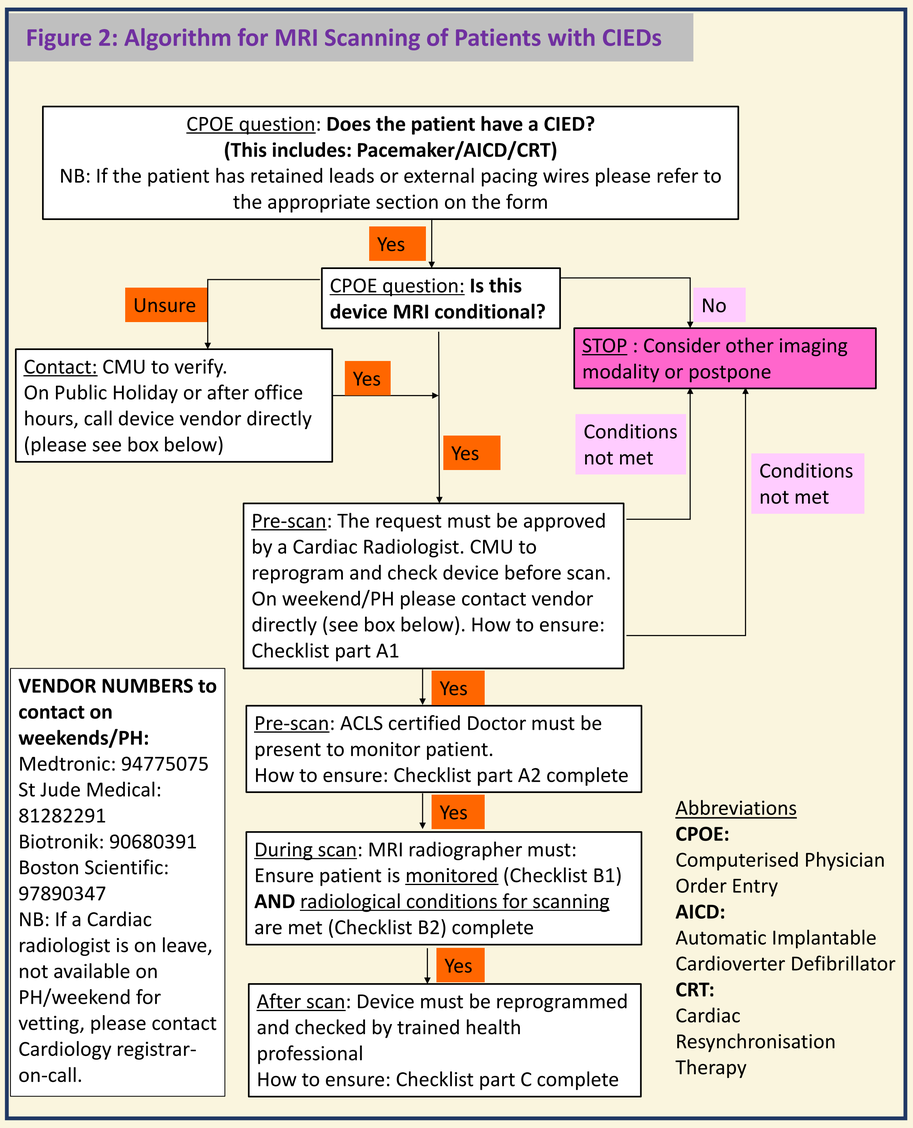


Figure 5: MRI Radiographer Checklist

CGH Radiology conditions for use checklist (CHECKLIST B1 and B2):
MRI radiographer to fill out checklist B1 and B2 (please tick if condition is met)

CHECKLIST B1

☐ Proper patient monitoring and preparation must be provided during the MRI scan:

☐ An ACLS trained doctor will be present during the scan

☐ Visual and verbal contact with the patient

☐ Monitoring heart rate using pulse oximetry or electrocardiography

☐ An external defibrillator must be available nearby during the MRI procedure

☐ A Radiologist **or** Cardiologist has reviewed any prior Chest X-Ray (if available) for abandoned leads and broken leads. If no prior CXR is available, consider performing an urgent CXR before the scan.

CHECKLIST B2

☐ MRI scanner of **1.5 Tesla ONLY** (not higher field strength than this) must be used in Normal Operating Mode

☐ Gradient systems with maximum gradient slew rate performance per axis of ≤ 200 Teslas per meter per second (T/m/s) must be used

☐ Whole body averaged SAR must be ≤ 2W/kg, head averaged SAR must be ≤ 3.2W/kg

☐ Isocenter of radiofrequency coil must be above C1 or inferior to T12 vertebra.

SIGNATURE OF VERIFYING RADIOGRAPHER : _____ DATE: _____

VERIFYING RADIOGRAPHERS NAME : _____

Figure 4: Requesting Doctor Checklist

CHECKLIST A1

Patient's Sticky Label

Confirm make and model of CIED YES / NO

Clinical Measurement Unit (CMU) has been contacted to reprogram device before scan YES / NO

NAME OF DEVICE: MANUFACTURER:

YEAR IMPLANTED :

CHECKLIST A2

Arrangement has been made for an ACLS trained doctor to be present during the MR scan YES / NO

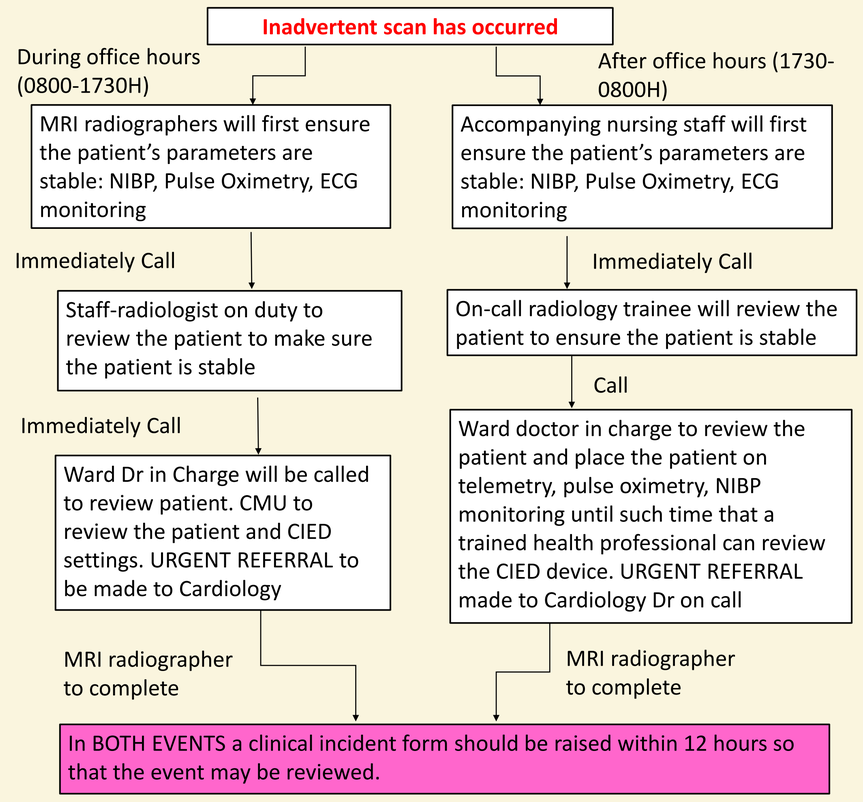
Arrangement has been made with CMU (ext. no. XXXX) for a trained health professional to reprogram CIED after MR scan YES / NO

SIGNATURE OF VERIFYING DOCTOR: _____

VERIFYING DOCTOR'S NAME AND MCR NO.: _____

DATE CONFIRMED : _____

Figure 3: Algorithm for Inadvertent Scanning of Patients with CIEDs



Related works

A similar work process for the scanning of patients with cochlear implants is currently being developed. We are collaborating with the Ear, Nose and Throat (ENT) department to counsel and prepare patients prior to their MRI scan.

Conclusion

Having clear processes in place ensures that MRI safety is not compromised, and provides guidance on the steps for urgent review should inadvertent scanning occur. Patients with MR conditional CIEDs can now be scanned safely with minimal disruption.

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