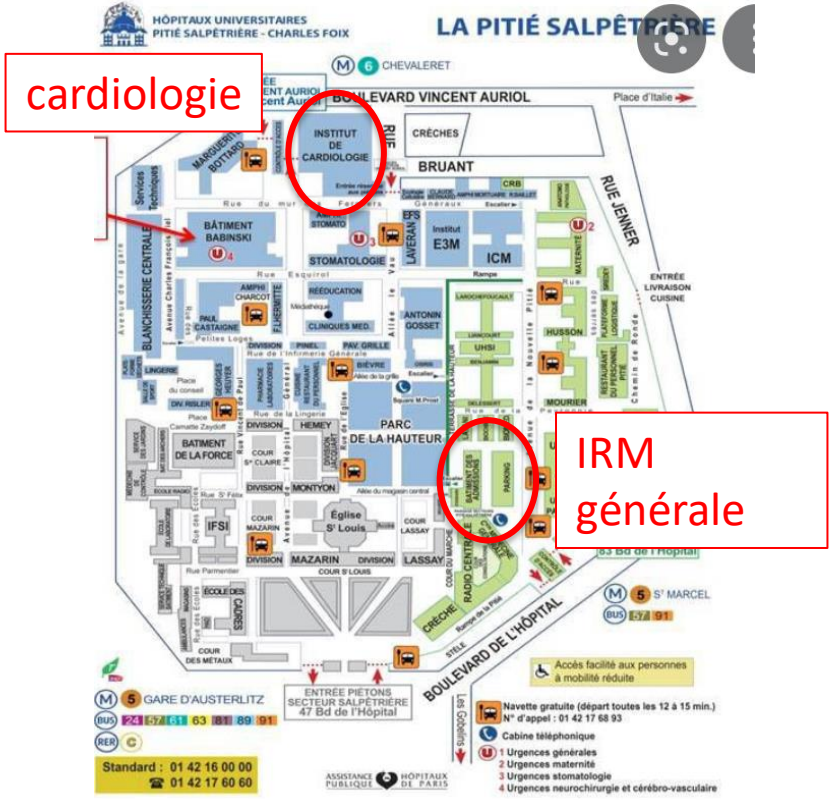
La gestion de l’examen IRM chez les patients porteurs de dispositifs cardiaques implantables. Algorithme AutoMRI.

Estelle Gandjbakhch, Paris

- 78 yo patient
- PM for 3rd degree AVB
- MRI conditional system
- Prostate MRI needed for cancer

- How should I do?

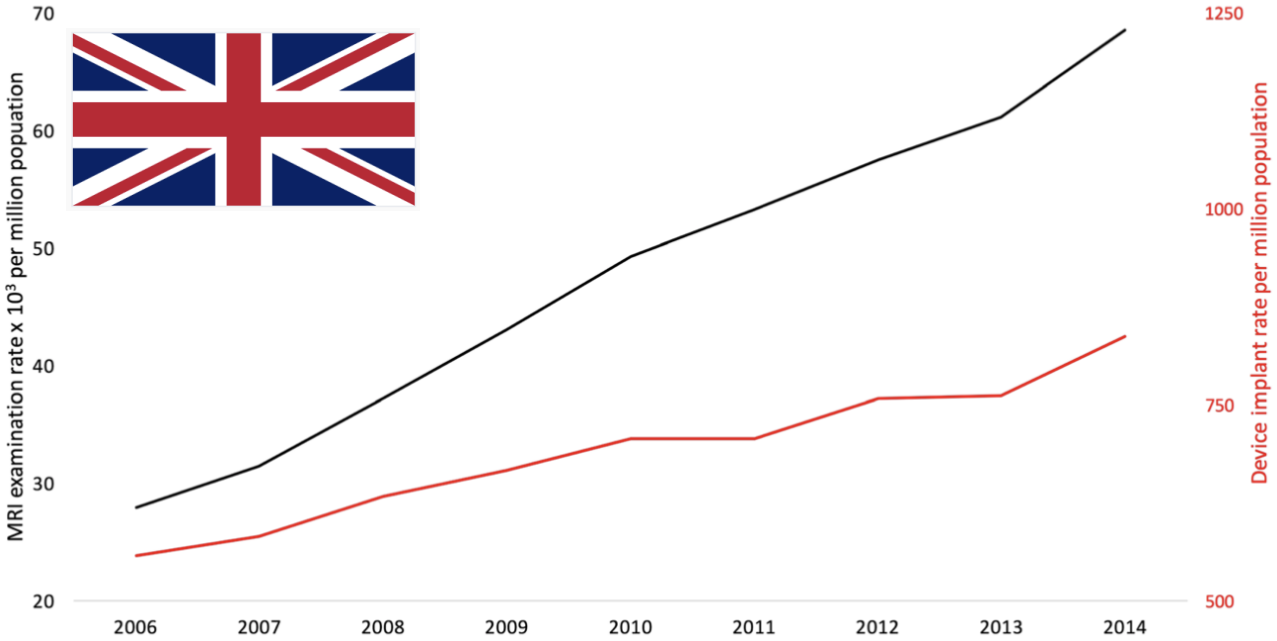


IRM/PM evolution

70 000 examens
IRM / million hab^{ts}

800 PM/million hab^{ts}

- 1000 PM/million hab^{ts} en France



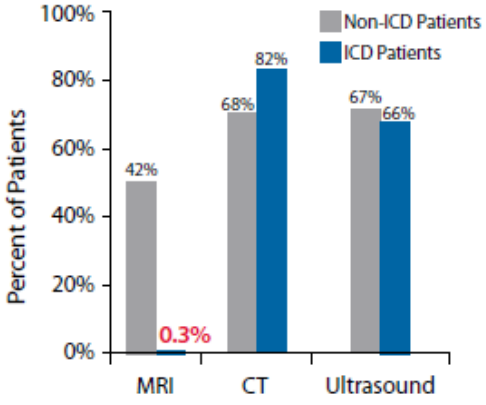
Bhuva AN et al. Eur Radiol 2020; 30:1378-84

Patients with PM/ICD have a difficult access to MRI

Exemple with ICDs – Source ACR

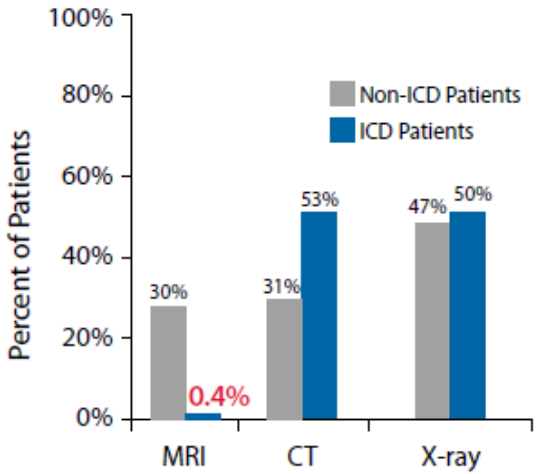
Stroke patients with an ICD are not getting optimal diagnostic imaging

42% of non-ICD patients undergo an MRI within 3 days of stroke or TIA diagnostic vs. **0.3%** of patients with a traditional ICD.[1]



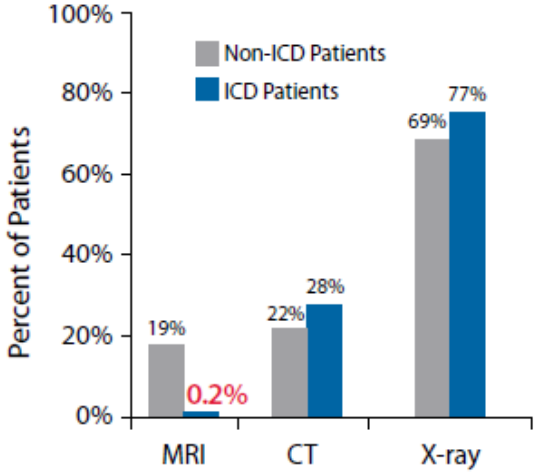
Back Pain

30% of Non-ICD patients undergo an MRI within 30 days of back pain diagnosis vs. **0.4%** of patients with a traditional ICD.[1]



Joint Pain (Knees, ankles, elbows, shoulders, and wrists)

19% of Non-ICD patients undergo an MRI with 30 days of jo pain diagnosis vs. **0.2%** of patients with a traditional ICD.[1]



Turakhia M, Reynolds M, Wolff S, et al. Medtronic Data on File 2013. Data from 2011 MarketScan® ~~Commercial and Medicare database, Truven Analysis, Inc. were used for this r~~esearch.

Two opposite tendencies

Since development of conditional PM/IRM,

- Wrongly referred in France as "compatible"
- Some trends to trivialize the use of PM/ICD in MRI
- Despite **a non-zero risk**
- especially with the development of high magnetic fields

And yet,

- Implanted patients are refuted in MRI at most MRI centers in Europe
- An implanted patient is 50 times less likely to get an MRI VR than a non-implanted one
- Increased machine time
- No financial recognition

Nazarian S et al. J Magn Res Imaging 2016; 43: 115-27

Risks of MRI on PM/ICDs (conditional and non-conditional)

MRI

- **Oversensing**
  - Pacing inhibition
  - Bradycardia in pacing-dependent patient
  - Inappropriate shock
- **Burns (RF)**
  - abandoned leads
- **Migrating or moving components** (Purely theoretical risk)
- **Battery depletion**
- **Deprogramming**
- **Switching to Reversion Mode (VVI)**
- **Permanent failure**
- **Thresholds changes**

Programing

- **Arrhythmia caused by asynchronous** pacing mode VOO, DOO **(<u>the main cause of death describe</u>)**
- Non-detection of ventricular arrhythmia (**inhibition of ICD therapy**)

There is no "MR safe" device

The latest reported deaths are related to old models

- 6 deaths following MRI in patients with PM
- patients not monitored during the examination
- Risk contexts (SCA, advanced heart disease, hydro-electrolyte disorders)
- examined outside hospital, no cardiological supervision
- all not pacing-dependent
- Essential cause: VT, VF
- All standard field ≤1.5T
- The MRI department was not informed of the PM; communication +++
- No deaths reported in selected and monitored patients

Irnich W. Europace 2005; 7: 353-365

Prospective registries of non MRI-conditional devices

Magnasafe Registry

- 1500 patients
- 2/3 PM- 1/3 DAI
- IRM 1.5 T extra thoracic

- 0.3% in« back up » mode
- 1 mute ICD → change
- Sensing/pacing thresholds modifications : non significant

John Hopkins Registry

- 1509 patients
- 58% PM- 48% DAI
- IRM 1.5 T thoracic /extra thoracic

- 0.5% in« back up » mode
- 1 mute PM (end of life battery)
- Sensing/pacing thresholds modifications : 4% but non significant

Nazarian et al. NEJM 2017
Russo et al. NEJM 2017

Dedicated Protocols +++

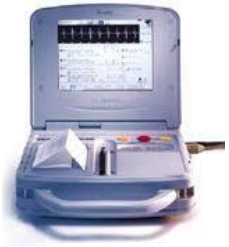
Gandjbakhch E et al. Arch Cardiovasc Dis.2020
Dacher JN et al. Diagn Interv Imaging 2020

Prescription

Discussion with cardiologist

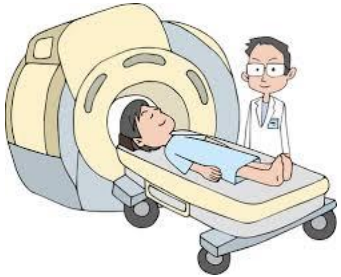
- Determine if the system is IRM conditional
- Benefit/risk?
- Can MRI be substituable?
- No contra-indications
- Indication of PM/DAI
- Pacing-dependency?
- History of VA (ICD)

Pre-MRI programming



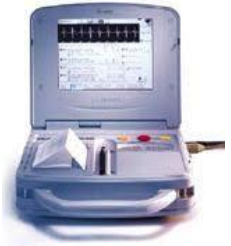
- What mode?
- Where?
- Surveillance?
- Who? How?

MRI



- Monitoring: Who? How?
- Reduce the number of sequences to the minimum
- Never exit the standard mode (SAR control)

Post-MRI programming



- Restoration of standard settings and device control
- Where?
- Who? How?

I	B-R	MR imaging in a patient with an MR conditional system should always be performed in the context of a rigorously applied standardized institutional workflow, following the appropriate conditions of use. [32–36,39,42,44]

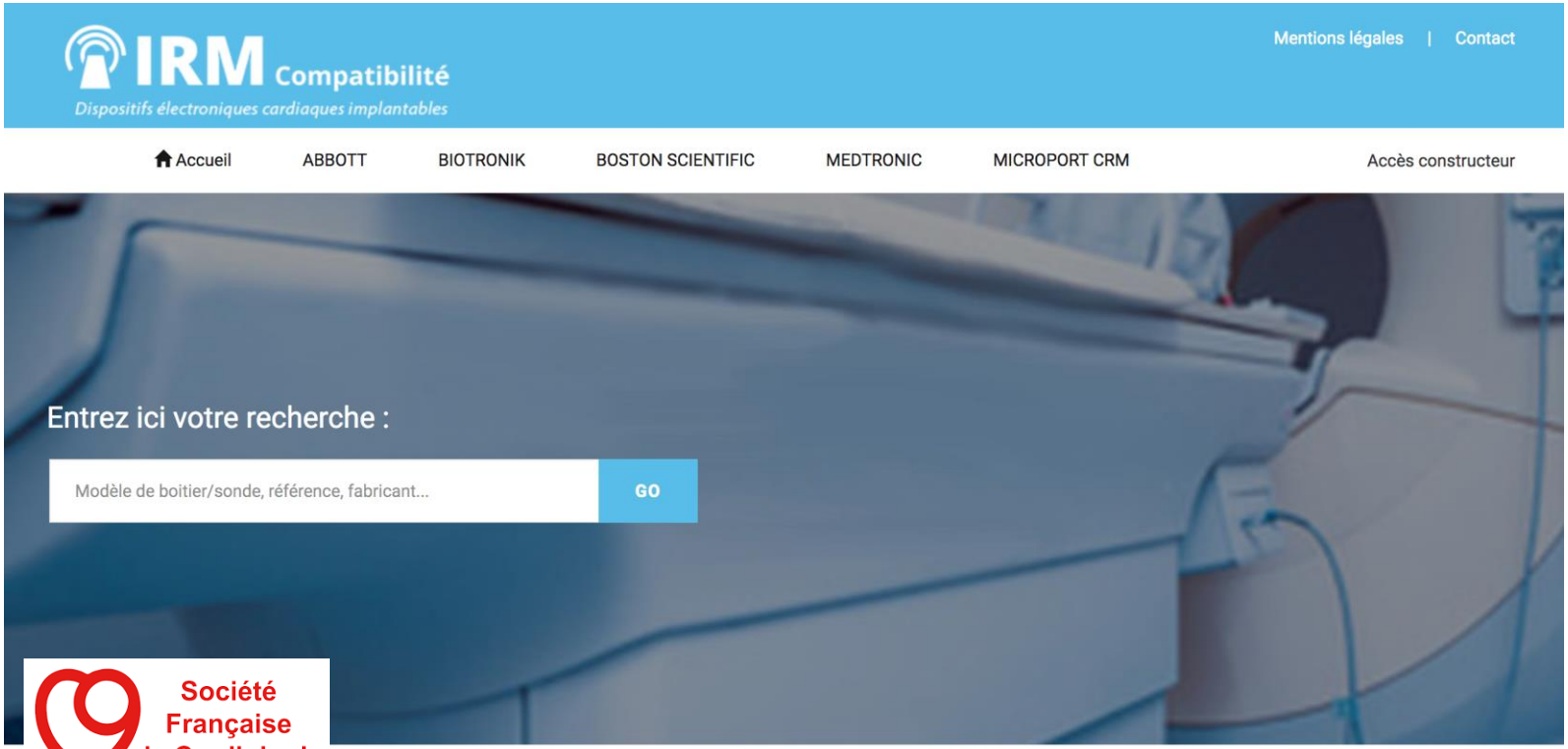
Essential data

- **Lead and can model: MR conditional?**
- **Pacing-dependent +++**
- **ICD or PM**
- **History of appropriate therapies for ICD**
- **No contra-indications:**
  - **Abandoned leads/ epicardial leads/connectors** : interrogate the patient, scars, chest Xray if necessary
  - **Device malfunction**: elevated pacing thresholds, battery close to end of life
- Device implantation > **4-6 weeks (except emergencies)**
- **Clinical state of the patient**: no fever or acute medical problem

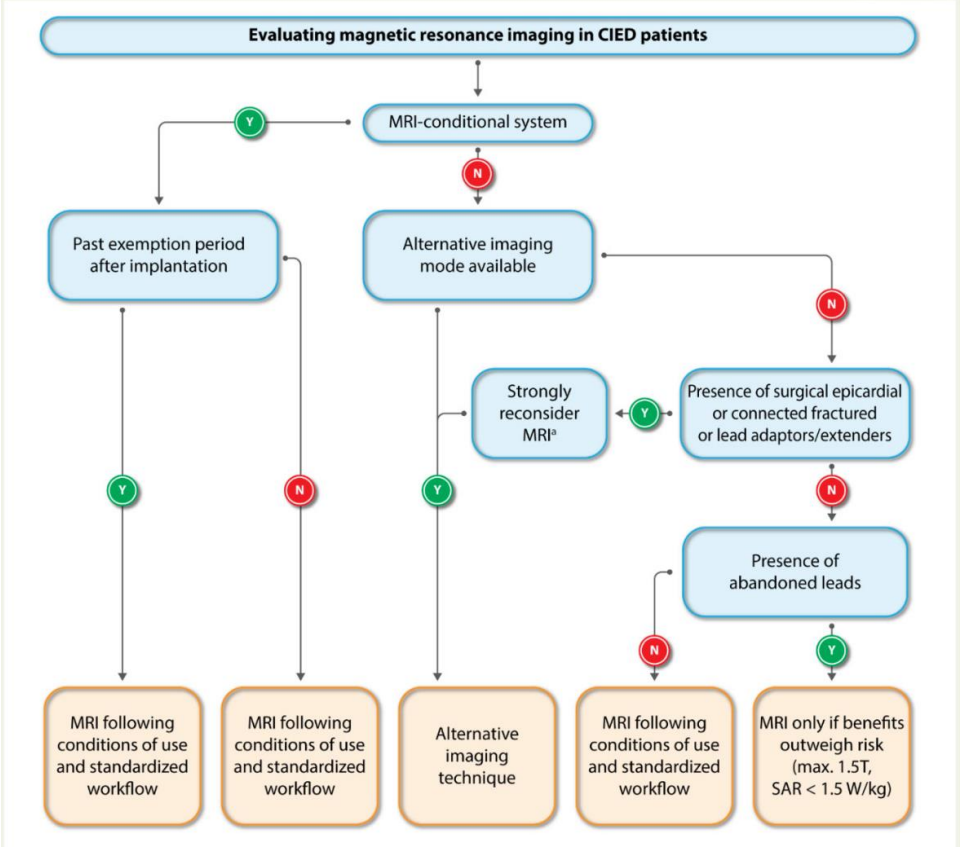
Gandjbakhch E et al. Arch Cardiovasc Dis.2020
Dacher JN et al. Diagn Interv Imaging 2020

Determine if the system is MR conditional

www.irm-compatibilite.com



ESC European Society of Cardiology
Europace (2022) **00**, 1–26
https://doi.org/10.1093/europace/euac040



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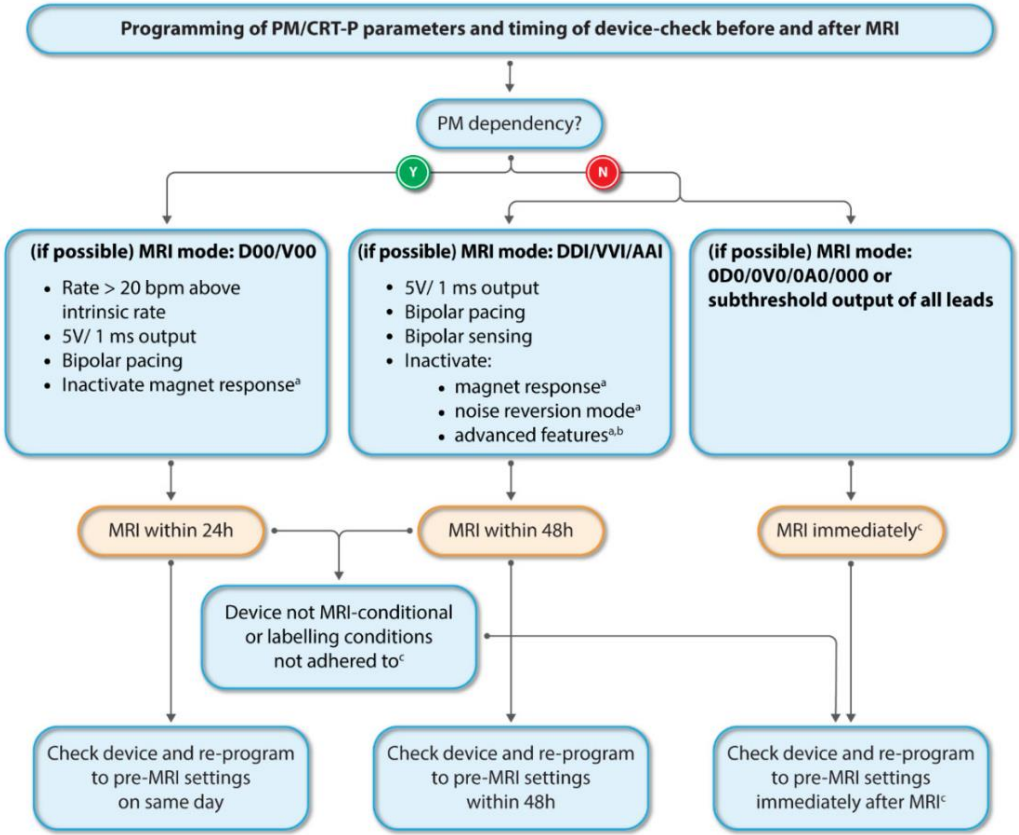
Europace (2022) **00**, 1–26
https://doi.org/10.1093/europace/euac040

Other pacing functions (magnet, rate response, noise reversion, ventricular sense response, AF response) should be deactivated in asynchronous and inhibited pacing to ensure that sensing of electromagnetic interference does not lead to unwarranted pacing

It is advisable to perform CIED programming as closely as possible to the MRI facility and adequate monitoring should be ensured during MRI mode, especially in ICD patients

A



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Europace (2022) **00**, 1–26
https://doi.org/10.1093/europace/euac040

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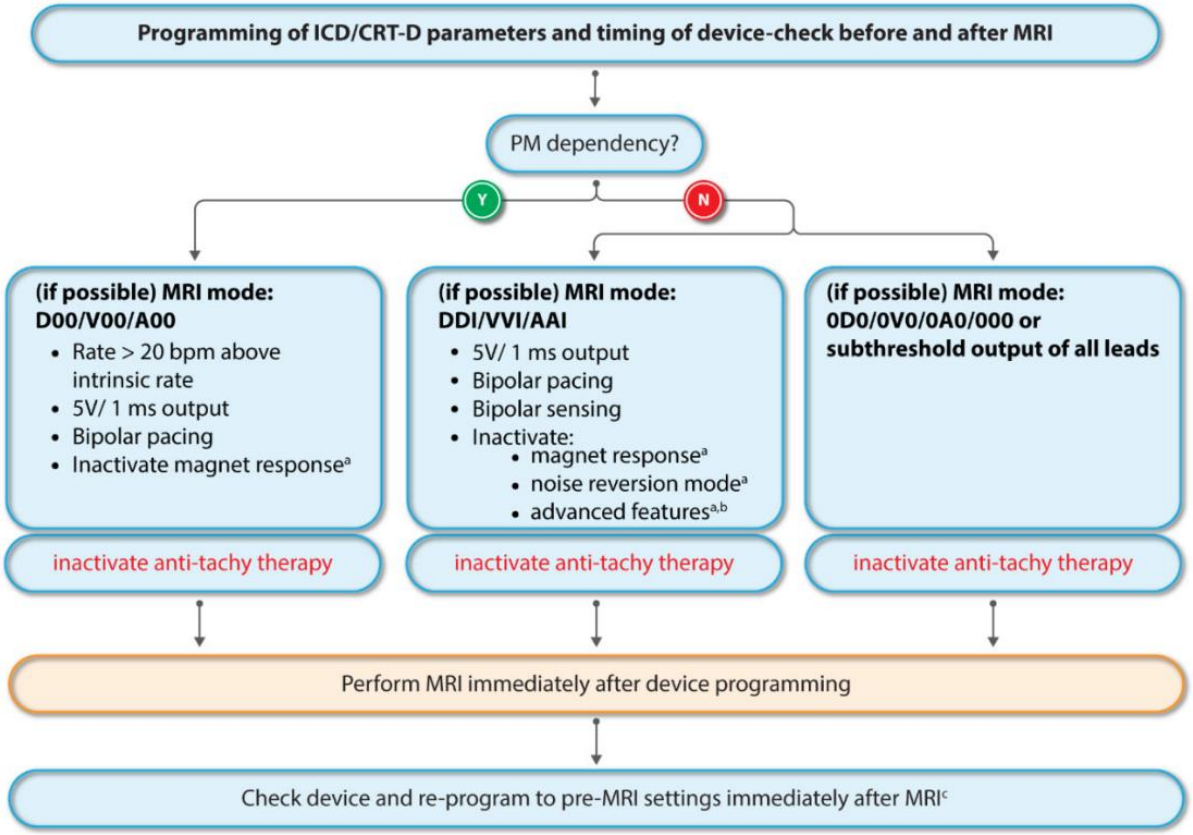
B



Check list ++

SFICV

Société Française de Cardiologie
Rythmologie - Stimulation cardiaque

NOM du Patient : .....

Etiquette

INDICATION d'APPAREILLAGE : .....

BOITIER (ou fournir une photocopie du carnet):

Date d'implantation du boitier : ___/___/_____
Marque et Modèle du boitier : .....

SONDES (ou fournir une photocopie du carnet)

Marque et modèle:	Date d' implantation
Atrial lead:	___/___/_____
RV lead:	___/___/_____
LV lead :	___/___/_____

Système ☐ IRM-compatible sous conditions
☐ non-IRM compatible

Le patient est-il dépendant de la stimulation cardiaque ?	☐ OUI	☐ NON	☐ND
Présence de sondes abandonnées ?	☐ OUI	☐ NON	☐ND
Présence de sondes épicardiques ?	☐ OUI	☐ NON	☐ND

Défibrillateur implanté en prévention ☐ Primaire ☐ Secondaire ou ATCD de thérapies appropriés

Recommandations pour l'examen IRM

IRM 1.5T full body ☐ IRM 1.5T avec exclusion thoracique ☐
IRM 3T full body ☐ IRM 3T avec exclusion thoracique ☐
IRM contre indiquée ☐

Présence du rythmologue requise dans les locaux (bâtiment)	☐ OUI	☐ NON
Programmation possible en consultation de cardiologie	☐ OUI	☐ NON
Programmation durant l'examen : mode IRM possible	☐ OUI	☐ NON

☐ VOO/ODO ☐ ODO/OOO ☐ VVI/DDI ☐ Désactivation des thérapies (DAI)

Reprogrammation du boitier nécessaire après IRM: ☐ OUI ☐ NON

Nom et signature du Cardiologue : ..... Date : ___/___/_____

Gandjbakhch E et al. Arch Cardiovasc Dis.2020
Dacher JN et al. Diagn Interv Imaging 2020

How to improve the work flow? The MRI auto modes

MicroPort

AUTOMRI™ ON

BIOTRONIK

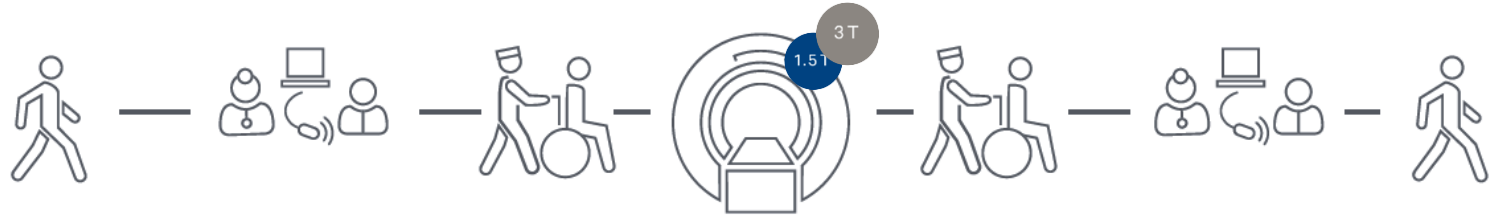
MRI AutoDetect

Modes IRM

Description des modes Manuel et Auto

Mode Manuel

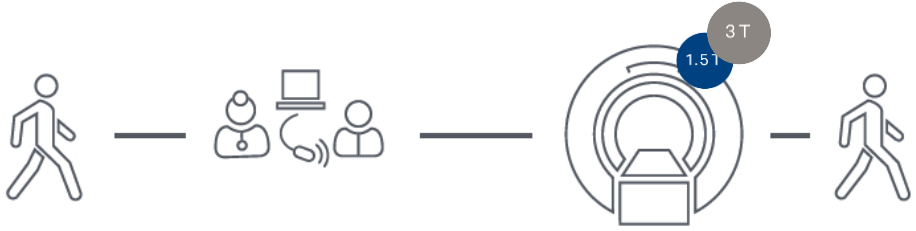
Stimulation en mode asynchrone



AUTOMRI™ ON

Stimulation en mode initial

Stimulation en mode asynchrone



Alerte

Notification envoyée le jour suivant le retour aux réglages initiaux du dispositif

AutoMRI™
Principe

Le rythmologue active le mode Auto-MRI™

Période de surveillance allant jusqu'à 10 jours pour passer un examen IRM

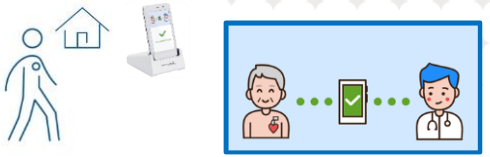
Aucune limitation du nombre d'examens durant ces 10 jours maximum de surveillance

Mode IRM dès la détection d'un champ magnétique
Retour aux réglages initiaux 5 minutes après être sorti du champ

Retour à la configuration initiale en fin de période de surveillance

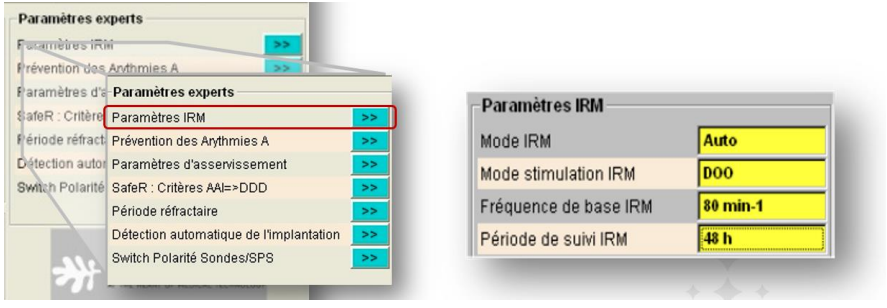
Notification IRM envoyée le jour suivant le retour aux réglages initiaux du dispositif

Avec les stimulateurs Alizea uniquement



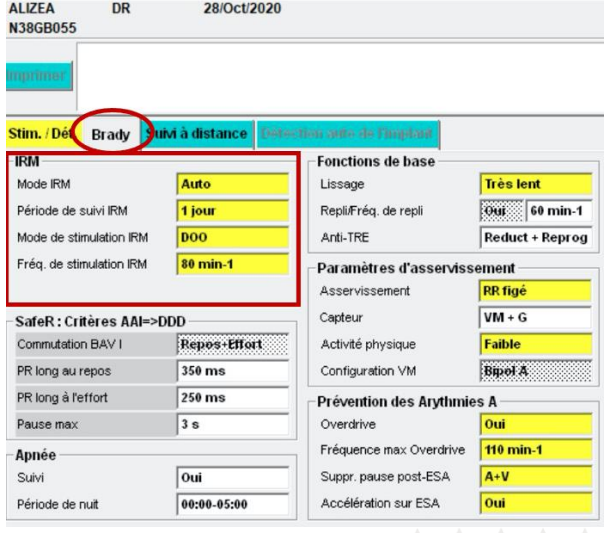
AutoMRI™

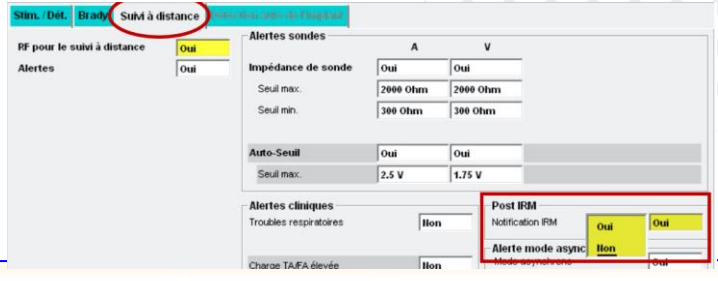
Programmation sur les gammes Kora100, Kora250 et Eno



La notification IRM est envoyée pour confirmer que le PM a rebasculé dans les paramètres non IRM à la fin de l'examen : la notification est envoyée le jour suivant le retour aux paramètres initiaux.

Programmation sur la gamme ALIZEA, Ulys VR/DR, Gali CRT





Remaining concerns and perspectives

Many remaining issues

Organizational problem ++++
Time-consuming ++
Availability of device specialists
No financial valuation

Perspectives

Need to generalize the auto detect mode as a “standard of care” in the future

No patient with implantable electrical cardiac devices should be formally contra-indicated from an MRI because of their device if the MR is vital