Development of an Evidence-based MRI Safety Guide for Risk Stratification of Implanted Devices and Objects

George Yacoub BS[1], Samuel Einstein PhD[1,2], Cristy French MD[2], Matthew Capodarco DO[2], Lane Miner DO[2]
Penn State College of Medicine, Hershey, PA, USA[1], Department of Radiology, Penn State Health, Hershey, PA[2]

INTRODUCTION

- Magnetic resonance imaging (MRI) is frequently withheld in patients with implanted devices and retained metallic objects despite growing evidence supporting safe imaging in many scenarios.
- Historically, concerns regarding radiofrequency-induced heating, gradient-induced currents, device malfunction, and magnetic forces led to **broad contraindications.**
- Contemporary studies and societal guidelines demonstrate that MRI safety is **context-dependent**, varying based on device type, configuration, and clinical scenario.

PURPOSE

- To develop an **interactable, evidence-based MRI safety guide** to assist radiologists in evaluating patients with implanted devices/objects and to provide a structured risk stratification framework to improve decision-making and MRI access.

METHODS

- A review of societal guidelines, meta-analyses, and manufacturer data was performed to evaluate MRI safety.
- Devices/objects were stratified into **low-, intermediate-, and high-risk categories**, and **decision-making pathways** were developed to guide individualized risk–benefit assessment.

RESULTS

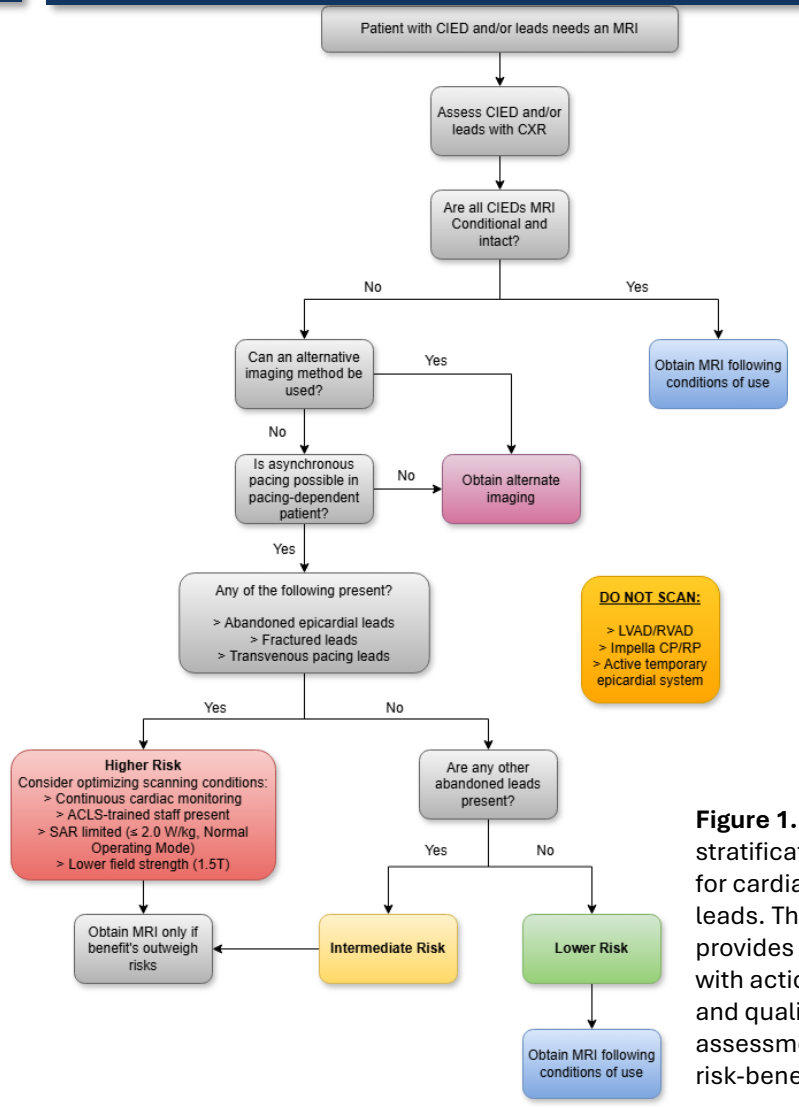

Figure 1. Example risk stratification pathway for cardiac devices and leads. The flowchart provides radiologists with actionable steps and qualitative risk assessment to aid their risk-benefit analysis.

DISCUSSION

- Many devices historically labeled as contraindications can be safely imaged under appropriate conditions, with risk dependent on **device composition (ferromagnetic vs non-ferromagnetic), configuration (intact, abandoned, or fractured), anatomic location, and imaging parameters such as field strength and SAR**.
- Application of this framework led to reclassification of common clinical scenarios, including temporary epicardial pacing wires (low risk), abandoned intracardiac leads (intermediate risk), orthopedic devices such as external fixators, select retained ballistic fragments, etc.
- The guide provides clear, actionable pathways to determine when MRI is appropriate, when multidisciplinary input is required, and when alternative imaging should be considered.
- Included in the guide is an **interactable table of contents** to assist radiologists in efficiently assessing the risk profile of common implanted devices and objects for MRI.

CONCLUSION

- MRI safety should be approached as a **risk continuum rather than a binary decision**, and use of structured risk stratification may improve **radiologist confidence, standardize decision-making, reduce unnecessary MRI denial, and expand equitable access to imaging**.

REFERENCES

1. *ACR Manual on MR Safety*. Latest edition (2024–2026 update)
2. Verma, Anil, et al. *Joint British Society Consensus Recommendations for MRI in Patients with Cardiac Implantable Electronic Devices*. **Heart**, 2018.
3. Kim, Daniel, et al. *SCMR Expert Consensus Statement for Cardiovascular Magnetic Resonance of Patients with a Cardiac Implantable Electronic Device*. **Journal of Cardiovascular Magnetic Resonance**, 2020
4. Russo, Robert J., et al. *HRS Call-to-Action: Improved MRI Access for Patients with Cardiovascular Implantable Electronic Devices*. **Heart Rhythm**, 2025.