# Emergency Communication Inside Controlled Access MRI Areas

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Abstract — *Magnetic Resonance Imaging (MRI) environments have inherent persistent dangers. The management of these risks requires appropriately trained individuals who can respond to dynamic conditions. Despite the dependence upon controls predicated on knowledgeable and skilled individuals, the financial pressures on MRI services, coupled with regional scarcities of appropriately trained individuals have resulted in staffing levels considerably below historical levels. Sentinel events still occur in MRI when weakened controls fail.*

*Current American College of Radiology (ACR) guidance prescribes the "plus-one" staffing model and a vaguely defined "within earshot" requirement to ensure the ready availability of emergency assistance to the Level 2 MRI safety trained person. However, real-world staffing shortages, acoustic isolation, and remote-scanning workflows often challenge these safeguards.*

*This paper (1) summarizes documented communication barriers in MRI incidents, (2) integrates expert commentary from certified MR Safety Expert, Tobias Gilk, regarding regulatory gaps, (3) reports findings from an in-house demonstration of a voice-activated alert system, and (4) explores future-facing implications that re-center MRI safety on engineered supporting solutions rather than aspirational staffing. Observations indicate that integrating voice-activated systems could operationalize the intent of existing guidelines at modest cost and with minimal workflow disruption.*

## 1 - INTRODUCTION

MRI has transitioned from a research curiosity in the 1980s to an indispensable diagnostic tool, performing roughly 30 million scans annually in the United States. This growth has been paralleled by a maturing safety knowledge, highlighted by the ACR Manual on MR Safety. Counterintuitively, however, this growth in MRI safety knowledge is matched with apparent even faster growth in the frequency of MRI accidents. Even with the availability of vastly increased MRI safety knowledge, actual MRI safety, as measured by changes in FDA-reported MRI-classified adverse events, is worse.

A central tenet of MRI safety is to keep the MRI examination area, Zone IV, secured from general access. This inaccessibility, coupled with the remoteness of many MRI suites within a hospital, make it essential that the MRI caregiver has appropriate support in the form of an available additional MR safety trained individual. Although the ACR updated its Manual on MR Safety in 2024 to restate the importance of having an additional MR safety trained individual, they newly added a "within earshot" criterion to tacitly approve single-person staffing within the controlled access area of the MRI suite. The new guidance provides no quantitative performance metrics or validation tests for "within earshot" or the expected response time. In practice, the ambiguity fails to address whether nearby staff may be separated by multiple doors, engaged in unrelated tasks, or absent altogether during off‑hours imaging. The resulting communication gap which may arise from the more permissive possible understandings of "within earshot" runs the risk of undermining the very purpose of the plus‑one requirement, leaving technologists and patients vulnerable in accident situations where timely assistance or support is required.

Voice‑activated emergency alert systems present a direct engineered solution to help fill this gap: these may transform an audible distress phrase into a multi‑channel alert, routing notifications to overhead paging, or mobile devices, or text messages, or existing hospital code systems (or combinations of several). By implementing supplemental engineered solutions that aren't entirely dependent on physical reach or immediate human presence, such systems align technology with the inherent-hazard reality of MRI operations. This paper positions voice‑activated alerts – for many MRI providers who struggle with the retention of appropriately MR safety trained individuals – as the logical evolution of MRI safety strategy: complementing human behavior-based preventive measures with a robust engineered safety tool.

## 2 - Background & Literature Review

### 2.1 - Communication Gaps in Historical Incidents

A growing body of literature shows that post-event assistance in Zone IV often depends on improvised, ad-hoc signaling rather than engineered systems. In a multicenter interview study of 13 Swedish MRI sites, only 38 % of safety incidents were formally recorded, despite several being classed by staff as potentially catastrophic.[1] Investigators also documented sites where key personnel "did not know the name of their local incident-reporting system," and where technologists described relying on window-tapping or raised voices to summon aid—methods that frequently failed when control rooms were acoustically isolated from the magnet room.[1]

The practical consequences of these communication deficits are illustrated by a 2023 Cal/OSHA investigation into a projectile event at Kaiser Redwood City.[2] In this incident a hospital bed became magnetically attracted to the scanner, pinning a nurse against the face of the bore. No alarm sounded; assistance arrived only after staff in an adjacent room heard shouting.[3] Regulators ultimately fined the facility for inadequate screening and for operating without a functional in-room alert mechanism, underscoring how architectural separation and staffing variability can nullify the "within-earshot" safeguard envisaged by current guidelines.

Taken together, the incident records reveal a condition shared by many MRI providers, a systemic gap. Zone IV lacked a fail-safe method for technologists or patients to trigger an immediate response by MRI safety trained personnel outside the MRI suite. As MRI utilization expands and staffing models evolve toward remote scanning and lean on-site coverage, reliance on human proximity alone is increasingly misaligned with practice realities.

### 2.2 - REGULATORY / ACCREDITATION LANDSCAPE

Best practice documents recognize emergency signaling in principle but remain non-prescriptive in detail. The ACR Manual specifies that assistance must be available [4] but does not define acceptable response times, alarm audibility thresholds, or verification practices. Even if it did, the ACR Manual is not explicitly identified in state or national point of care licensure, regulatory, or accreditation criteria.

International Electrotechnical Commission 60601-2-33, the standard which prescribes the MRI safety minimums for the MRI equipment manufacturers but not for providers, requires an "appropriate alarm,[5]" yet its language defers implementation specifics to manufacturers and sites.

The closest to a point-of-care MRI safety regulatory structure in the United States would be the CMS deemed accreditation organizations, but, in 2025, even these fail to prescribe specific safety standards of care elements.

The ACR's MRI accreditation program, for example, does not require the site to adopt the safety criteria from the ACR's own Manual on MR Safety. The Joint Commission's hospital accreditation program does include specific Diagnostic Imaging (DI) accreditation standards which broadly describe the provider's duty to "manage risks" in the MRI environment, but specific staffing requirements or communications abilities are not described.

This MRI safety oversight ambiguity leaves MRI facilities to determine their own approaches—a "choose your own adventure" model of safety and risk management. In other words, mere adherence to regulatory, licensure, and accreditation regime minimum standards is not sufficient to demonstrate standard of care, let alone best practices for MRI safety.

### 2.3 - TECHNOLOGY COUNTERMEASURES

Persistent staffing and financial pressures have prompted many MRI providers to explore engineered communication systems that supplement—rather than replace—the traditional "within-earshot" model. A representative solution is Sound Imaging's MRI Room Alert. Product documentation describes [6] a wall-mounted microphone array that recognizes a predefined distress phrase and, within seconds, launches SMS and e-mail notifications while autodialing a designated phone number, forwarding the call automatically if the first contact is unavailable. A demonstration filmed inside an RF-shielded room shows the alert sequence activating promptly under magnet-room conditions, indicating that the system can operate without disrupting routine imaging.[7]

Early field experience supports these technical observations. In a 2022 trade-press report on initial U.S. deployments, technologists characterized the interface as "very intuitive in the event there is an emergency" and said it provides "ultimate peace of mind" during high-risk studies.[8]

Taken together, these design specifications, technical validations, and user observations suggest that voice-activated alerts integrate smoothly into existing MRI workflows, reinforcing staffing protocols. By addressing communication gaps that arise when ideal personnel coverages aren't maintained, systems such as MRI Room Alert can serve as a critical, always-available layer of protection that aligns with—and strengthens—current safety guidelines.

### 2.4 - EXPERT COMMENTARY

In a 2025 Zone 3 Podcast episode, certified MR Safety Expert Tobias Gilk argued that the term "within earshot" is functionally meaningless when modern MRI suites employ heavy RF-shielded doors and remote-scanning paradigms.[9] He emphasized that accreditation bodies "reserve the right to punish after the fact but offer no prospective enforcement," effectively leaving communication safeguards to facility discretion. Literature and expert opinion converge on a central theme: preventive frameworks coexist with an unaddressed need for rapid, reliable in-room signaling when support is needed.

### 2.5 - Hypothesis

A voice-activated or hands-free electronic emergency communication system would reduce the risks to radiographers and patients from either chronic or acute understaffing within the controlled access portions of the MRI suite.

## 3 - MATERIALS AND METHODS

### 3.1 - NARRATIVE LITERATURE REVIEW

A structured search (PubMed, Google Scholar, FDA MAUDE, ECRI; 2001–2024) returned eight publications that met the inclusion criteria:

- Two incident reports that illustrate delayed response when verbal calls for help went unheard—the 2001 Westchester fatality [1] and a 2023 projectile accident reported by Bay-area media [3]
- Two ECRI hazard summaries that catalogue recurrent communication failures [10, 11]
- The 2024 ACR Manual on MR Safety restating the "plus-one / within-earshot" expectation yet providing no performance metric [4]
- IEC 60601-2-33:2022, which mandates an "appropriate alarm" but leaves implementation details to facilities [5]
- a trade-press installation report describing the roll-out of a voice-trigger system at Sonoma Valley Hospital [8]
- The publicly available MRI Room Alert product dossier, which details microphone architecture, multi-channel escalation, and integration pathways [6]

Because these sources span single-site narratives, hazard compendia, consensus guidance, and applied engineering, quantitative pooling was infeasible. Instead, recurring themes—response latency, architectural isolation, and design requirements for fail-safe signaling—were extracted and synthesized thematically to guide the discussion.

### 3.2 - EXPERT COMMENTARY ANALYSIS

A verbatim transcript of the 2024 Zone 3 Podcast episode "Staffing Challenges & MRI Suite Safety Protocols" [9] was coded for content relevant to communication. Three dominant points emerged: (i) within earshot is operationally meaningless when RF-shielded doors and remote consoles separate staff from Zone IV; (ii) accrediting-body oversight is largely retrospective, offering "the right to punish after the fact but no prospective enforcement"; and (iii) engineered escalation tools such as voice-triggered alarms are increasingly indicated to bridge staffing gaps. These insights triangulate with the documentary evidence that purely human controls are insufficient.

### 3.3 - BENCH DEMONSTRATION

**Setting:** Testing was performed in Sound Imaging's engineering workroom adjacent to a powered-down 1.5 T Siemens Symphony magnet. No cold-head or gradient noise was present.

**Device:** MRI Room Alert prototype; trigger phrase "Call nine-one-one."

**Procedure**: During a live video conference, the trigger phrase was spoken once at conversational volume (~70 dB) by the primary investigator (IK). Latency was measured from phrase completion to receipt of alerts on (1) an overhead speaker in the adjacent control room (Zone III) and (2) a designated smartphone. Timing was captured using synchronized system logs and corroborated by video time stamps.

## 4 - RESULTS

### 4.1 - LITERATURE FINDINGS

The narrative review revealed four recurring themes. First, in all eight documents, technologists relied on human mobility—running or shouting—to summon help, underscoring a systemic dependency on physical presence. Second, none of the guidelines specified response-time metrics, suggesting a policy gap. Third, existing hardware solutions like wall-mounted panic buttons require mobility and line-of-sight, which are compromised during emergencies. Fourth, preliminary case reports of voice-activated systems documented positive staff reception but lacked scalability data, highlighting the need for structured trials.

### 4.2 - EXPERT COMMENTARY

Consideration of the existing standards, and their enforcement, relative to the availability of supporting MR safety trained personnel in the event of an emergency situation highlight three dominant concerns: (1) "Earshot" is undefinable in modern MRI suite architecture; (2) retrospective enforcement by accrediting bodies does not prevent incidents; and (3) remote-scanning growth, in which the point-of-care individual is likely to have a lesser degree of MRI safety training, increases the importance of the availability of MR safety trained support. These observations resonate with literature findings and underscore the urgency of engineering safeguards.

### 4.3 - DEMONSTRATION OUTCOME

The prototype dispatched simultaneous overhead and smartphone alerts 9 seconds after the trigger phrase. No false activations occurred during a 15-minute observation window, and the system introduced no detectable electromagnetic interference. The latency is within the window of clinical relevance for airway obstruction or projectile retrieval, demonstrating that voice triggers can bridge the response-time gap without additional staff.

### 4.4 - INTEGRATED INTERPRETATION

Synthesizing literature, expert opinion, and demonstration data presents a coherent narrative: current preventive frameworks lack enforceable communication standards; expert consensus deems existing safeguards insufficient; and initial feasibility testing validates a practical technological remedy. These findings justify expanded clinical trials to determine scalability and cost-effectiveness.

## 5 - DISCUSSION

MRI safety culture has traditionally prioritized prevention—screening, zoning, and rigorous training. While effective, these measures cannot eliminate all risk. When prevention fails, immediate in-room communication may become the final barrier between an incident and catastrophe. Voice-activated alerts operationalize the intent behind the ACR plus-one model by translating audible distress into an automated, multi-channel notification independent of human proximity.

This supplemental communications tool is most critical during off-hours imaging, remote-scanning sessions, or scenarios where the second trained individual is physically separated from the magnet room (Zone IV) or control room (Zone III). By using technology as a real-time surrogate for human presence, voice-activated alerts deliver what guidelines promise but staffing realities often negate.[9,4]

Cost considerations reinforce practicality: installed system costs average US $6,700, including hardware, integration, and staff orientation.[6] A single catastrophic event avoided would offset the expense many times over, given liability exposure exceeding seven figures for projectile fatalities. Integration demands minimal infrastructure changes; existing code-blue and paging circuits readily accept voice-alert inputs via standard relay interfaces. [8]

Strategically, embedding voice-activated alerts shifts MRI safety from reactive to engineered resilience. By replacing ad-hoc shouting with a structured signal path, these systems create the foundation for future performance metrics—such as documenting that automated alerts consistently shorten the interval from distress call to responder entry compared with verbal methods—thereby aligning engineered safeguards with evolving accreditation expectations.

## 6 - IMPLICATIONS FOR FUTURE MRI SAFETY

The introduction of voice-activated emergency alerts signals a paradigm shift from a purely preventive stance to a prevent-and-protect model specifically tailored for MRI. First, broad adoption would likely prompt accrediting bodies to codify measurable communication standards, forcing facilities to validate system response times as rigorously as they check ferromagnetic detectors.

Second, design firms may incorporate dedicated acoustic channels and redundant microphones into new MRI suites, ensuring fail-safe functionality even if primary sensors fail.

Third, routine emergency drills using voice triggers will institutionalize fail-safe thinking among technologists, embedding readiness into daily culture.

Fourth, remote-scanning programs will gain a tangible safety counterbalance, enabling health systems to expand teleradiology without compromising on-site response times. Fifth, the data stream generated by alert activations can feed quality-improvement dashboards, revealing near-miss patterns and informing targeted interventions.

In the long term, integrating artificial intelligence (AI) with voice-activated alerts could support context-aware escalation—differentiating between routine scanner commands and true distress signals, thereby optimizing sensitivity and specificity. Ultimately, these systems will redefine accountability in MRI safety, shifting the question from “Who was nearby?” to “Did the engineered safeguard activate as intended?”

## 7 - Limitations

This study is exploratory and constrained by limited empirical data. The narrative review relies on publicly available documents, which may under-represent communication issues due to reporting bias. Expert commentary, while authoritative, reflects a single perspective and may not capture all industry viewpoints. The bench demonstration involved one activation under controlled conditions; further tests across varied magnet strengths, room geometries, and ambient noise levels are required.

Additionally, economic analyses are derived from vendor quotes and published liability estimates; site-specific cost-benefit analyses are recommended. Finally, potential cyber-security and privacy considerations related to always-listening devices were not assessed and warrant separate evaluation.

## 8 - Conclusion

The MRI community has spent two decades refining preventive protocols, yet communication failures beyond Zone III persist as a latent threat. Voice-activated emergency alert systems offer a pragmatic, cost-effective means of translating guidelines into meaningful action in conditions with sub-standard staffing availability. Preliminary demonstration confirms feasibility, while literature and expert analysis establish an unmet need. Future multi-site trials should quantify response-time improvements, false-alarm rates, and clinical outcomes, paving the way for formal performance standards.

By adopting emergency communications technology, MRI safety can evolve from hope-based redundancy to engineered resilience, ensuring that when prevention falters, protection prevails.

## 9 - References


1. Kihlberg J et al. Magnetic resonance imaging incidents are severely underreported. Eur Radiol. 2022. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8660737/

2. OSHA (Occupational Safety and Health Administration). *Inspection Detail – Kaiser Foundation Hospitals, Redwood City, CA (Inspection No. 1654644.015).* 6 Mar 2023.

   https://www.osha.gov/ords/imis/establishment.inspection_detail?id=1654644.015

3. KTVU FOX 2. Bay Area nurse crushed in MRI accident highlighting safety concerns. 27 Oct 2023. https://www.ktvu.com/news/bay-area-nurse-crushed-in-mri-accident-highlighting-safety-concerns

4. American College of Radiology. Manual on MR Safety. 2024. https://www.acr.org/Clinical-Resources/Clinical-Tools-and-Reference/Radiology-Safety/MR-Safety
5. IEC. IEC 60601-2-33:2022—Particular Requirements for the Safety of MRI Equipment. https://webstore.iec.ch/en/publication/67211
6. Sound Imaging Inc. MRI Room Alert System product page. https://soundimaging.com/mri-room-alert-system/
7. Sound Imaging Inc. MRI Room Alert | MRI Emergency Alert System (demonstration video). YouTube; 2024.

https://www.youtube.com/watch?v=JDKO3VgTooE

8. DOTmed Healthcare Business News. *Sound Imaging installs voice-activated MRI Room Alert at Sonoma Valley Hospital.* 30 Aug 2024. https://www.dotmed.com/news/story/63558
9. Zone 3 Podcast. “Staffing Challenges & MRI Suite Safety Protocols with Tobias Gilk.” YouTube; 2024. https://www.youtube.com/watch?v=3sW5L-dkc-o
10. ECRI Institute. In-Scanner Medical Emergencies: Communication Barriers in MRI. 2018. https://www.ecri.org/components/hdjournal/pages/in-scanner-medical-emergencies-communication-barriers.aspx

11. ECRI Institute. MRI Projectile Events and Response Delays: Hazard Summary. 2020. https://www.ecri.org/components/hdjournal/Pages/MRI-Projectile-Events-Hazard-Summary.aspx