ACR Manual on MR Safety

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Disclaimer

Nothing to disclose

Objectives

Discuss the changes from the

ACR Guidance Document on MR Safe Practices: 2013

Guidance

Changes or additions to the 2013 Guidance document will be in red.

History

In 2001, the American College of Radiology formed a Blue Ribbon Panel on MR Safety.

Initially published in 2002, the ACR MR Safe Practices Guidelines established de facto industry standards for safe and responsible practices in clinical and research MR environments.

Subsequently, these guidelines have been reviewed and updated throughout the years to address feedback from the field and installed base as well as changes in the MRI industry since the original publication.

The ACR Manual on MR Safety represents the consensus of those representing the Committee on MR Safety of the American College of Radiology.

It should be noted that these recommendations are not only appropriate from a scientific point of view, but also reasonably applicable in the real world with consideration given to patient care, throughput, and financial pressures and other considerations

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Revisions

Date	Section	Change
1-17-20	All	Creation of the ACR Manual on MR Safety based on the reorganization and updates to previously published ACR Guidance Document on MR Safe Practices: 2013.
	MR Personnel	Expanded staffing guidance to align with VHA Directive on Magnetic Resonance (MR) Safety 2018
		Expectation of formal safety roles
	Screening	Deference to the Heart Rhythm Society on Guidance regarding performing MR examinations in patients with non-MR Conditional cardiac devices
	Full-stop/Final Check	Newly added section
	Special Patient Population Concerns	Updated pregnancy, prisoner/detainee and parolee sections
	MRI Contrast Agents	Updated
	MR Environments	Newly added atypical environments to include complex intraoperative and 7T
	Screening Form	Formally Appendix 2- Removed and will be available as separate document available for download on acr.org MR Safety webpage.

Introduction

The following Manual on MR Safety is intended to be used as a template for MR facilities to follow in the development of a MR safety program.

These guidelines were developed to help guide MR practitioners regarding these issues and to provide a basis for them to develop and implement their own MR policies and practices.

These MR safe practice guidelines along with policies and procedures that are developed are intended to be reviewed and updated annually.

Introduction

The ACR MR Safety Committee supports the recommendations of the consensus document calling for formal MR safety roles and responsibilities for facility management of MR safety. These roles include MR Medical Director (MRMD), MR Safety Officer (MRSO) and MR Safety Expert (MRSE)

Staffing

2013

Except for emergent coverage, there will be a minimum of 2 MR technologists or one MR technologist and one other individual with the designation of MR personnel in the immediate Zone II through Zone IV MR environment.

For emergent coverage, the MR technologist can scan with no other individuals in their Zone II through Zone IV environment as long as there is in-house, ready emergent coverage by designated department of radiology MR personnel (e.g., radiology house staff or radiology attending).

2020

There will be a minimum of two MR technologists or one MR technologist and one other individual with the designation of MR Personnel in the immediate Zone II through Zone IV MR environment whenever patients are in the MR environment.

During this time the two MR Personnel must be able to directly communicate within ear shot of each other at all times.

Staffing

The ACR MR Safety Committee supports the VHA directive of 2018 as follows:

“Ensuring that when routinely scheduled patients or research subjects are present in Zones II through IV, there will be a minimum number of MR personnel in Zones III through IV to assure safe operation and adequate access control. The minimum number of MR personnel is calculated as follows:

(a) For a facility that functions with one MR machine per Zone III/IV, there will be a minimum of two MR Personnel in Zones III through IV, and at least one of these personnel will be designated as Level 2 MR Personnel. NOTE: Temporary exception is made when MR Personnel are interviewing the patient/research subject or retrieving the patient/research subject from the waiting/changing areas.

(b) For a facility with two or more MR machines that share a single Zone III area where both machines are in use at the same time, there will be a minimum of one Level 2 MR Personnel for each machine and a minimum of one additional MR Personnel, i.e., two machines during scheduled hours will require two Level 2 MR Personnel and an additional Level 1 or 2 MR Personnel. When only one machine is in use, e.g. during lunch or an evening shift, there will be a minimum of two MR Personnel in Zones III through IV, and at least one of these personnel will be designated as Level 2 MR Personnel.

Screening

2013

Only MR personnel are authorized to perform an MR safety screen before permitting non-MR personnel into Zone III.

2020

Before Non-MR Personnel enter Zone III, final authorization must originate from Level 2 MR Personnel

Screening

2013

Emergent patients and their accompanying non-MR personnel may be screened only once, providing the screening individual is level 2 MR personnel. There should be no exceptions to this.

2020

Emergent patients and their accompanying Non-MR Personnel may be screened only once, provided that the screening individual is Level 2 MR Personnel. Any exceptions to this must be with the mutual agreement of the ordering physician and covering Level 2 MR physician who specifically acknowledge the potential risks of a decision NOT to screen prior to granting that patient MR access include but are not limited to paralysis, blindness, and/or death.

Screening - History

2013

If no reliable patient metal exposure history can be obtained, and if the requested MR examination cannot reasonably wait until a reliable history might be obtained, it is recommended that such patients be physically examined by level 2 MR personnel. All areas of scars or deformities that might be anatomically indicative of an implant, such as on the chest or spine region, and whose origins are unknown and which may have been caused by ferromagnetic foreign bodies, implants, etc., should be subject to plain-film radiography (if recently obtained plain films or CT or MR studies of such areas are not already available).

2020

If no reliable patient history can be obtained, and if the requested MR examination cannot reasonably wait until a reliable history might be obtained, it is recommended that such patients undergo plain-film radiography (if recently obtained plain films, CT, or MR studies of the following areas are not already available), to exclude potentially harmful embedded or implanted metallic foreign bodies, implants or devices. Plain-film radiography should include the head/neck, chest, abdomen/pelvis and upper arms and thighs. If there are obvious post traumatic changes to the distal extremities, those regions should also undergo plain-film radiography prior to MR exposure.

Screening – Non-ambulatory Patients

MR scanning of hospitalized, higher-acuity, or non-ambulatory patients present additional challenges. In many instances these patients are too sick to enter Zone IV by themselves and must be transported into the MR scanner using an MR Conditional wheel-chair or stretcher. Similarly, metal objects used for patient care (e.g. needles, small oxygen tanks, etc.) may be inadvertently transported after being used at other locations in the facility and hidden around the patient (i.e. within sheets, pillow covers). When possible, transfer of the patient to the MR table should be done in Zone III

Screening – Accompanying Non-MR Persons

In general, it would be prudent to limit accompanying companions to a single individual. Only a qualified, responsible Level 2 MR Physician should make screening criteria exceptions.

Hearing protection and MR Safe/MR Conditional seating are recommended for accompanying companions within the MR scan room.

If a Non-MR Personnel that wishes to accompany a patient into an MRI system room (i.e. Zone IV) requires screening for a possible orbital foreign body (i.e., using X-rays or CT), a Level 2 MR Personnel or Level 2 MR Physician must first discuss with them the requirement for such screening prior to permitting them access to the MRI system room. Should the Non-MR Personnel still wish to proceed to Zone IV or past the 5 Gauss line, and should a Level 2 MR Physician deem it medically advisable that they do so (e.g., for the care of their child about to undergo an MRI examination), written informed consent should be provided to the Non-MR Personnel prior to undergoing radiographic screening (i.e., using X-rays or CT) of their orbits.

Screening – Orbital Trauma

2013

All patients who have a history of orbit trauma by a potential ferromagnetic foreign body *for which they sought medical attention* are to have their orbits cleared by either plain X-ray orbit films(2 views) or by a radiologist's review and assessment of contiguous cut prior CT or MR images (obtained since the suspected traumatic event) if available.

2020

History of orbital trauma: All patients with a history of orbit trauma by a potential ferromagnetic foreign body for which they sought medical attention are to have their orbits cleared by either plain X-ray orbit films or by a radiologist's review and assessment of prior CT or MR images (obtained since the suspected traumatic event), if available. An evaluation of a prior MRI exam's susceptibility artifact of the region of the orbits may provide an experienced reader with important information on the ferromagnetic nature of the foreign body.

Screening – implants/onplants

Implanted/onplanted devices: All Non-MR Personnel with implanted cardiac pacemakers, implantable cardioverter defibrillators (ICDs), diaphragmatic pacemakers, medication pumps or other electromechanically activated devices, upon which the Non-MR Personnel is dependent should be precluded from entering Zone IV and prevented from passing the 5-Gauss (5-G) line unless specifically cleared in writing by a Level 2 MR Physician or the MRMD of the MR facility.

Screening – Aneurysm Clips

2013

All intracranial aneurysm clips manufactured 1995 or later for which the manufacturer's product labeling continues to claim MR Conditional labeling may be accepted for MR scanning without further testing.

2020

All intracranial aneurysm clips manufactured 1995 or later for which the manufacturer's product labeling continues to claim MR Conditional labeling may be accepted for MR scanning under the specified conditions without further testing. Implantation date, absent product manufacturing date information, is not sufficient to make a determination of acceptability for MR scanning without further testing.

Screening – Non Conditional CIED's

Guidance regarding performing MR examinations in patients with non-MR Conditional cardiac devices including implanted pacemakers, implantable cardioverter defibrillators, cardiac resynchronization therapy pacemakers, and cardiac resynchronization therapy defibrillators is deferred to current recommendations from the Heart Rhythm Society recommendations

FULL-STOP/FINAL CHECK

A “full-stop and final check” performed by the MRI technologist is recommended to confirm the satisfactory completion of MR safety screening for the patient, support equipment, and personnel immediately prior to crossing from Zone III to Zone IV. The purpose of this final check is to confirm the patient’s identification, ensure that all screening has been appropriately performed and that there has been no change in patient and/or equipment status while in Zone III .

Pregnant Patients

The safety of MR imaging at field strengths higher than 1.5T (i.e. 3T, 7T) during pregnancy has not been thoroughly assessed. However, the preponderance of research studies have failed to discover any reproducible harmful effects of exposure of the mother or developing fetus to the 3T or weaker magnetic fields used in the routine clinical MR imaging process

3T MR examinations performed within normal operating mode for <30 minute durations should be considered safe in pregnant patients.

Pregnant Patients

MR contrast agents should not be routinely administered to pregnant patients. Indeed, there is widespread consensus that avoiding GCBAs in pregnancy is prudent. This decision is typically made according to the institutional contrast policy, on a case-by-case basis, by the attending radiologist or designated radiology provider (e.g. radiology resident, fellow), who can assess the risk-benefit ratio for that particular patient.

Environment – Access Control

2013

All access to Zone III is to be strictly restricted, with access to regions within it (including Zone IV see below) controlled by, and entirely under the supervision of, MR personnel.

2020

Access by Non-MR Personnel to and supervision over Zone III (including Zone IV, see below) is controlled by, and entirely under the supervision of, Level 2 MR Personnel. Non-MR Personnel must be accompanied by, or under the immediate supervision of and in visual contact with an individual who is a Level 2 MR Personnel throughout their stay in Zones III or IV, except in the changing room and/or bathroom where verbal communication is sufficient.

Environment – Access Control

The entry door to Zone IV (i.e. the MR scanner room) should be closed except when it must remain open for patient care or room/MR system maintenance. During the times that the door to the MR system room must remain open, a “caution” barrier is recommended at the entry to Zone IV to inhibit unintended passage of personnel and/or materials from Zone III to IV. Examples of caution barriers include easily adjusted straps or plastic chains secured across the doorway to Zone IV.

Environment – Intraoperative MRI

Multiple Zone IV (MR system room) entrances (e.g., operative room patient entry, control room entry) each require appropriate controlled access and effective screening practices to prevent the introduction of potentially dangerous objects or equipment. Transient changes in MR Zone labeling can occur in dynamic MR environments.

A space that may be Zone IV in one instance may convert to Zone III at another time or configuration. Thus, multiple points of entry and variable room configurations can considerably increase the complexity required to achieve effective MR safety planning and design of these facilities.

Environment – 7T

There are several particular considerations that should be taken into account for metallic implants, devices, and foreign bodies in the 7T environment. Compared to lower field strength MR environments, 7T is associated with greater transmitted RF energy. Importantly, this may increase the likelihood of resonant-circuit induced heating in electrically conductive materials that were too short to experience significant heating at 3.0T and below. (In human tissue, resonant circuitry conditions for linear metallic implants can manifest for objects with conductive lengths as short as 5 to 7 cm; it would be 12 or 13 cm at 3T, and 25-26 cm at 1.5T.) While there are relatively few linear implants used in human subjects presently that are approximately 25 to 30 cm in length required to satisfy resonant circuitry conditions at 1.5T, there are many more indwelling metallic implants (e.g., overlapping stents, even some of the longer aneurysm clips) that approach 5 to 7 cm in length.

Thus, rapid resonant-related heating leading to dangerous temperature elevations of shorter electrically conductive objects is theoretically more likely at 7T than at 1.5T or even 3T. There are also significantly higher translational, rotational and Lenz's forces associated with 7T environments. Certain implants, such as active implants or devices (e.g., neuromodulation devices, cochlear implants, etc.) which retain functionality at lower field strengths may potentially malfunction or suffer interference, altered settings, or permanent damage at 7T.

Time Varying Radiofrequency Fields

To help safeguard against thermal injuries or burns, pads meeting the MR system manufacturer’s specifications should be placed between the patient’s skin and any transmit RF coil. These pads protect the patient from proximity to the transmit RF body coil, to ensure spacing between the transmit coil and the patient’s tissues. A single layer bed sheet is insufficient insulation or spacing.

Electrically conductive clothing

Some materials used in clothing have been increasingly associated with thermal injury and/or burns in patients undergoing MRI. Recent trends in the manufacturing of clothing and other related products have incorporated metallic and conductive materials (e.g., antimicrobial silver and copper) that are not reliably disclosed in labeling. Such clothing products include, but are not limited to, sportswear (including underwear), brassieres, orthotic-related items (e.g., stump covers or stump shrinkers) and blankets.

Reliance on clothing labeling is not sufficient, as the Federal Trade Commission (FTC) “guidelines” allow clothing to contain as much as 5% impurities, which could be significant for a patient undergoing an MRI examination. For anatomic regions within or near the volume undergoing direct RF (B_1) field irradiation, to avoid such thermal concerns, we recommend gowning patients to skin, wearing only MR Safe gowns or scrubs supplied by the imaging facility.

Screening Form

It will be posted as a separate standalone document on the MR Safety Webpage alongside the MR safety Manual. This will allow facilities to print copies without using the whole manual.

https://www.acr.org/Clinical-Resources/Radiology-Safety/MR-Safety

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