Augusta University
Standard Operating Procedures Concerning Magnetic Resonance Safety
(MR Technologist version)
V1.0.4 11-July-2016

I. ACR Guidance on Safety

II. Designated MR Medical Director and Key MR Safety Personnel
At Augusta University, the designated MR Medical Director is Dr. Kandace Klein (706-721-0128), Professor in the Department of Radiology and Imaging. Medical physicists may advise the MR Medical Director with regards to technical concerns related to MRI. Dr. Nathan Yanasak (706-721-3602) and Dr. Jerry Allison (706-721-3088) are responsible for on-site technical MR safety guidance. Within the Department of Radiology & Imaging, MR safety concerns and policies are discussed with the MR Quality User Committee (QUC).

III. Zones and Appropriate Signage in the MR Environment
The MR sites at AU have been divided into four zones as per ACR2013, and signs are installed in visible areas to indicate these areas. Note that, generally (exceptions noted below), access to these areas follows guidance presented in ACR2013.

IV. Clearance/Screening/Monitoring of Individuals for MRI Room
A. General Principles
   1. Entry Access to the MR Scanner Room
   No one enters the MR Scanner room without verbal authorization of technologist. This includes not only patients but medical personnel from other services.

   2. Screening Form
   The Technologist must clear individuals via a screening form before the patient enters the scan room. The requirements are different between patients (who should fill out a screening form for each visit) and staff (who should fill out a form annually and whenever their medical status has changed during
the year such that MR safety is more cause for concern – i.e., implant surgery, etc...)

3. Gowning of Patients
All patients will wear clothing that has no conductive material on it, principally to avoid conductor heating and burns. Patient scheduling will indicate to the patient before their procedure to dress in ordinary clothing that is appropriately lacking in electrical conductors (such as zippers, metal snaps, etc...). The patient's clothing will be screened by the MR Technologist for MR appropriateness, both visually and using a handheld metal detector (see II.A.6 below). Examples of unacceptable clothing with conductors include belts, clothing containing metal fabric or patches, most jewelry, body piercings, clothes with snaps, and boots/shoes with steel toes. If the clothing still has electrically conductive materials on it, the patient will be asked to change into a gown (with straps and no snaps) and “pajama bottom”-scrubs supplied by the hospital before the scanning procedure. Additionally, all sedated patients must be gowned.

4. Personal Belongings
All patients must remove all readily removable metallic personal belongings and devices. An incomplete list of these devices include cellphones, keys, knives, belts, wallets, and jewelry.

5. Ferromagnetic Materials and Personnel History
Individuals with a history of ferromagnetic foreign object penetration must undergo further investigation before being permitted entrance to Zone III. This investigation includes a “best effort” by the MR technologist and other members of the MR safety committee (e.g., attending physician, physicist) to determine that history precisely. For example, if a patient reports that he was involved in an accident where metal fragments needed to be removed from his body, then an investigation needs to occur to identify the probability that metal remains behind in the patient. This “best effort” should be balanced between criticality of the MR study, time, and the safety risk from the history.

6. Use of Ferromagnetic Screening Devices, Metal Detectors, and Survey Magnets to Find Ferrous Objects
The appropriate procedural order for identifying and finding ferrous metal on patients is as follows:
   Step a. Use of ferromagnetic screening devices at the door.
   Step b. Use of hand-held metal detectors to find metal.
   Step c. Use of survey magnets to identify ferrous content.
Each step is described in more detail below.

Step a: The alarms in front of the scan room are ferromagnetic detectors. This means that they give off a warning light or an alarm depending on whether ferrous materials are present. Ferrous materials present a particular MR safety risk because of their strong attraction to the MR scanner, allowing them to become projectile hazards in many circumstances. In order to assess whether a conscious patient has ferrous material on their body, the following procedure should occur:

   a. The MR tech will stand just inside the screening devices (i.e., inside the scan room just beyond the doorway, to prevent a patient from entering the room fully).
   b. Have the patient walk towards the doorway as if to enter, without going through the door.
   c. If the alarms trigger, or the lights indicate red, the patient has some degree of ferrous material on them.

Step b: The next procedure to perform if the patient has ferrous materials on their person is to use a hand-held metal detector to search their person. These detectors give off signal for ALL metals, including non-ferrous metals. Once the MR technologist is satisfied that the patient clothing is appropriate and that all metal objects are off that person, then they can enter the scan room. Metal detectors are located in each MRI control room, and their battery power will be verified periodically every month.

Step c: If materials are discovered that are of questionable ferrous content, the MR technologist can determine whether the material is ferrous by using a survey magnet. These are found in the control room. Items with ferrous content will exhibit an attraction to the survey magnet. Note that, because the survey magnet is magnetic, it should NEVER be taken into the MR scanner room as it will become a projectile hazard.

Note that many devices that enter into the MR scan room have trace amounts of ferrous material in them (e.g., the scanner bed, ventilators). As a result, they will trigger the alarm of the ferromagnetic screening device. Each of these devices may be safe under some conditions but not all. For devices that are not exclusively designated as “MR safe” but that trigger the alarm of the ferromagnetic screening device, a screening procedure is required.
7. General Communication with Aware Patients during an Exam

During an exam, it is important to maintain contact with patients that are awake and aware. In most cases, the patient will be equipped with a squeeze ball in order to indicate physical or mental discomfort to the technologist. The technologist will maintain contact with the patient using the MRI intercom. All patients are visible through windows in front of the scan console.

B. Non-Patients

No one enters the MR Scanner room without verbal authorization of technologist. This includes not only patients but medical personnel from other services. Although many medical personnel routinely enter into the MR Scanner room on a daily basis, the technologist is responsible for assessing whether those personnel are ready for entry at that particular time on that particular day. One example of a reason for concern is that haste may allow for personnel to carry personal belongings forgetfully into the scanner that may be a hazard (e.g., cellphone). Non-patient assessment by the MR technologist of medical personnel will involve some simple screening questions at the least, or it may involve more extensive measures (e.g., screening form, hand-screening with a metal detector).

C. Non-Emergent Patients

All non-emergent patients should be MR safety screened onsite by a minimum of 2 separate individuals (at least one is the MR Technologist, while the other may include the attendant at the front desk or another Technologist). This would include interrogation after filling out a screening form, as well as screening using the ferromagnetic screening devices. A hand-held device may be used for further screening.

D. Emergent Patients

All emergent patients and accompanying personnel may be screened by one individual—the MR Technologist.

E. Awake and Aware Patients

During screening, the MR Technologist and other individuals responsible for screening will review the screening form with the patient. In the case of contraindications of potential safety hazards associated with the patient (e.g., implants), the technologist will contact either the Medical Physicist if available (Nathan Yanasak or Jerry Allison), or the MR Medical Director (Kandace Klein), or attending Radiologist who is chief of the section that will read the images, in that order of priority. The Medical
Physicists will automatically contact the appropriate attending Radiologists as the circumstance dictates.

**F. Patients Under Anesthesia**

For patients who are incapable of reviewing a screening form with the MR Technologist, the screening should be conducted in the presence of a family member. If a family member is unavailable or uncertain as to the answer to a question, the use of hand-held metal detectors and survey magnets will be used as described in Section 6 of this document to ensure a more thorough screening survey. Additionally, the MR Technologist will provide a physical inspection of the patient to locate foreign objects such as ECG leads, etc... AU follows the established ACR-SIR Practice Parameter for Sedation/Analgesia.

**G. Pediatric Patients**

Adherence to standards of care mandates following the sedation guidelines developed by the American Academy of Pediatrics, the American Society of Anesthesiologists, and the Joint Commission on Accreditation of Healthcare Organizations. Additionally, body temperature is monitored for all sedated pediatric patients and for other pediatric patients deemed important for monitoring due to circumstances of the patient (e.g., illness severity).

Due to the unreliability of self-report for children within a hospital environment, additional care is made during screening of children for safety reasons. Children are screened in the presence of adults to improve self-report of harmful objects on their person. Family members of pediatric patients may be allowed access to Zone IV after undergoing a screening identical to a patient, subject to approval of the MR technologist. Hearing protection is mandatory for family members.

**V. Screening of Devices**

**A. General**

All devices should be screened before entering into the MR scanner room. This includes devices that repeatedly enter into the MR scan room, as well as unknown devices. Although some devices are used frequently within this institution, the status of a device may change over time. For example, a ferrous component may be used during a repair as a replacement for a non-ferrous component, changing the safety status of the device.
B. Conditions of MR Safety

All devices can be designated as MR Safe, or MR Conditional, or MR Unsafe. Definitions are given by the ACR, as follows:
MR Unsafe – never in the scanner room
MR Conditional – can be used in the scanner room under some circumstances
MR Safe – no magnetic or conducting materials in them, so they can always be used in the scanner room

C. Designation of MR safe/MR conditional status

Ideally, all object/devices in Zone III and IV should be identified with labeling as MR safe, MR conditional, or (in the case of Zone III only) MR Unsafe. External devices or objects demonstrated to be ferromagnetic and MR Unsafe or incompatible in the MR environment may still, under specific circumstances, be brought into Zone III if for example, they are deemed by MR personnel to be necessary and appropriate for patient care. They should only be brought into Zone III if they are under the direct supervision of specifically designated level 1 or level 2 MR personnel who are thoroughly familiar with the device, its function, and the reason supporting its introduction to Zone III. The safe usage of these devices while they are present in Zone III will be the responsibility of specifically named level 1 or 2 MR personnel. If MR safety data is not prospectively available for a piece of equipment or object that requires electricity (or battery power) to operate, it should not be brought into Zone IV without being subjected to the testing.

D. Devices that have been Previously Brought into the Scanner Room

As per AU legal policy, all devices should be surveyed/inspection at the time of entry into the MRI scan environment, checking for ferrous materials using a survey magnet. It should be noted that alterations performed by the site on MR Safe, MR Unsafe, and MR Conditional equipment or devices may alter the MR safety or compatibility properties of the device. The MR Technologists are responsible for this.

E. Unknown Devices

Any device that has never entered the scanner room must be screened. First, a Medical Physicist should perform a literature search on the device to ascertain its ACR safety level as well as specific MR safety concerns for that device. Next, each device should be surveyed by a Medical Physicist or MR Technologist using a survey magnet. If the safety of a device in the scanner room cannot be
ascertained (e.g., lack of documentation), then it will not be allowed in the room.

VI. RF Heating and Thermal Burns
A. General Precautions about Electrical Conductors (i.e., metallic objects)
All unnecessary or unused electrically conductive materials external to the patient should be removed from the MR system before the onset of imaging. Electrical voltages and currents can be induced within electrically conductive materials, which may result in heating and subsequent patient injury. Examples of unnecessary or unused electrical conductors include unplugged leads, unused coils, and metallic items in clothing.

B. Minimizing Heating Hazards from Clothing
In order to minimize thermal heating during an MR procedure, all patients will wear clothing that has no conductive material on it, as described in Section IV. A.3.

C. Placement of Conductors in a Scanner with a Patient
When electrically conductive materials external to the patient are required to be within the bore of the MR scanner with the patient during imaging, care must be taken to physically separate the patient from electrical conductors. For example, avoiding direct contact between patient and conductor by moving the conductor away from the patient is most effective, followed by the use of thermal insulation (e.g., pads) between a patient and a conductor. It is also important to consider positioning leads or wires are far from the inner walls of the MR scanner if the body coil is being used during scanning, as this may cause the wires to heat more readily. Examples of using the body coil include studies that require phased-array coils for RF reception.

D. Loops
When electrically conductive materials are required to remain within the bore of the MR scanner with the patient during imaging, care should be taken to ensure that no electrically conducting loops are formed within the MR scanner during imaging. Loops can lead to induced current and increased heating. Examples of material that may form loops include wires, leads, implanted devices.

Human tissue is also electrically conductive, although to a lesser degree than metals. Loops arising from human anatomy can induce current and heating. Therefore, care should be taken to ensure that the patient's arms or legs or other body parts are not positioned in such a way as to form a large caliber
loop within the bore of the MRI imager during the imaging process (e.g., forming a loop with both arms by clasping the hands together). Patients should be instructed not to cross their arms or legs in the MR scanner. Furthermore, skin-to-skin contact in regions such as the inner thigh may create a tissue loop and stimulate thermal injury during scanning. In these cases, one should consider placement of a pad between points of skin-to-skin contact.

E. Patient and Scanner Contact
Under certain circumstances, direct contact of the patient (e.g., arm) with the inner walls of the MR scanner can lead to thermal injury. If the patient width is significant such that he will likely contact scanner surface in the bore, pads should be placed between the patient and the scanner to serve as insulation. One suggested method for this is 1) to place the pads against the side of the bore, before putting the patient on the table; 2) Next, as the patient is moved into the bore on the table, hold the pads so that they do not slide out the other side with the patient.

F. Unconscious patient and conductors
In some cases, an unconscious or unresponsive patient will have attached leads associated with medical procedures (e.g., EEG leads). The problem in this circumstance is that the patient in this state will be unable to perceive or react to thermal heating and injury from the MR environment. As per the practice involving other medical implants, the safety of the leads and associated device in the presence of or during the operation of an MR scanner must be determined through the usual consultation with the manufacturer or safety documents. Before scanning of the patient, an attending Radiologist must be notified that a) a patient has a particular set of leads, and b) the patient is unconscious or unresponsive, in order to get final approval of the procedure.

G. Tattoos
During screening, a subset of patients will report having a tattoo or tattooed eyeliner. Although many tattoos present no complications in the MR environment, some experience thermal heating because of conductive pigments. The MR Technologist will inform the patient of the possibility of tattoo heating after the screening, and the patient will be asked to respond via squeeze bulb in case they experience this heating during the procedure.

VII. Implants
A. General Guidelines
Many MR conditional devices exist that do not contraindicate a patient from receiving MRI scanning procedures. However, each device has its own set of warnings and MR procedures to minimize patient risk. The Department of Radiology has established internal policies to provide compliance with these warnings. Note that if a device is not listed as MR conditional or MR safe, MR scanning will not be performed on a patient with that implanted device. The ordering Physician must insure that the appropriate technical personnel are notified for turning off the device before scanning and restoring functionality after scanning, when appropriate.

B. Field Strength
Safety guidelines for implants that relate to field strength of the MR scanner cannot be translated to a scanner with a different field strength. For example, a device that is safe for use under certain conditions in a 1.5T scanner may not be safe in a 3T scanner. It has also been demonstrated (e.g., ACR2013) that safe scanning conditions on a 3T scanner may not assure safe scanning on a 1.5T.

C. Specific Guidelines
1. **Deep Brain Stimulation systems:** For patients having a DBS system, a Medical Physicist must be present to supervise the exam, monitoring SAR during the procedure. The device must be prepared before the MRI examination to comply with MRI operation setting appropriate for that device (e.g., changing the operation mode of the stimulator). Head exams are the only exams that will be allowed, using only a transmit/receive head coil. The exam must take place on the 1.5T MRI scanner. A DBS protocol has been specified on the 1.5T system. Only sequences from this protocol may be used for scanning a DBS patient. The patient must sign an informed consent form attesting to his knowledge of the risks associated with DBS in the MRI environment.

2. **Vagus Nerve Stimulation systems:** For patients having a VNS system, a patient must be scanned on the 1.5T MRI scanner. The device must be prepared before the MRI examination to comply with MRI operation setting appropriate for that device (e.g., changing the operation mode of the stimulator). As a matter of routine, VNS scanning is generally performed only for a) examination of the head, b) using a transmit/receive head coil, and c) using the VNS protocol. If these three conditions are met, a Medical Physicist must be present to supervise or a Neuroradiologist must provide consent and an appropriately trained MR Technologist may supervise. If any one of these conditions is not met (e.g., non-VNS protocol), a Medical Physicist and Neuroradiologist must provide consent based on safety guidelines for the device and patient need. Furthermore, a Medical Physicist must be present to supervise the
exam. The patient must sign an informed consent form attesting to his knowledge of the risks associated with VNS in the MRI environment. Note that extra time prior to the exam (i.e., days) will be required to insure the safety of the patient while using a non-VNS protocol.

3. Pacemakers: The only two pacemakers that are currently MR conditional and approved for scanning at AU are the Medtronic Revo MRI Surescan Pacing system and the Medtronic Advisa MRI Surescan Pacing system. For patients having either system, a patient must be scanned on the 1.5T scanner. The device must be prepared before the MRI examination to comply with MRI operation setting appropriate for that device (e.g., changing the operation mode of the pacemaker). Only patients with a complete Surescan system (i.e., leads and pacemaker) will be scanned. Considering the operation of the 1.5T GE scanner, exams will be restricted to those that position isocenter superior to C1 (e.g., head exams) or inferior to T12. As long as SAR and gradient slew rate performance constraints are met, any protocol and any coil combination may be used. If these conditions are met, a Radiologist having undergone tutorials for both Radiology and Cardiology on the Medtronic website must provide consent and supervision.

4. Cardiac Monitors: Medtronic Reveal DX (Model #9528) and Reveal XT (Model #9529) Cardiac Monitors appear frequently in our patient population that requires scanning. Both of these devices are suitable for scanning in either the 1.5T or 3T environment, given a few key considerations. First, the devices MUST have been implanted greater than six weeks before the scan; otherwise, the devices may experience significant tugging at the site of the implant. Second, the uninterrupted duration of active scanning over the chest must not exceed 30 minutes. If a longer procedure is necessary, a waiting period of 10 minutes is required after the initial 30 minutes of scanning. Finally, Patient Assistant and CareLink Model 2090 Programmer should NOT be allowed into the MRI scanner room, as they are not MRI safe. Note that the patient should be notified that the MRI procedure may affect the quality of data recorded during the procedure (e.g., falsely detected episode may be present).

5. Baclofen Pumps: Although many procedures have been performed safely on patients with baclofen pumps, in the worst-case scenario, the function of a baclofen pump may be compromised by introduction to the MR scanner environment. As these devices deliver medication that a patient may rely on critically, the integrity of a baclofen pump needs to be checked before sending the patient home or to another service. All patients will be informed of the potential for pump malfunction as a result of insertion into the scanner, and they will be informed that they should have their pump checked out by
their primary physician or the service that installed their pump.

6. **Aneurism clips:** MRI studies on patients having aneurysm clips will not be performed unless the referring surgeon submits a written attestation that the aneurysm clip is MRI conditional and that the conditions of the procedure can be met for safe scanning of that clip (e.g., the clip is safe for 1.5T imaging and the 1.5T magnet will be requested; the spatial gradient field must be below X Ga/cm and the scanner conforms to this condition).

7. **Other devices:** Other MR conditional devices may be appropriate for scanning. In order to determine the safety of such a procedure, a Medical Physicist must be notified before scheduling the procedure. The Medical Physicist will then determine the safety limits of the device to the best of his ability. He will consult with a Radiologist to determine whether to proceed and how, and to give consent. Note that extra time prior to the exam (i.e., days) may be required for investigating the nature of the device and for insuring the safety of the patient. If the procedure is determined to be safe, it will be scheduled at a time when a Medical Physicist can be present, to supervise the procedure.

**VIII. Hearing Protection**

MR Technologists will provide hearing protection to each MR patient. In addition, personnel who attend patients within the MR scanning environment will also be provided with hearing protection. On the GE scanners downstairs, earplugs will be provided. On the Philips scanner upstairs, both earplugs and protective headphones will be provided. In the case of pediatric patients, both earplugs and external noise guards are provided. Technologists will place the hearing protection on all patients undergoing anaesthesia.

**IX. Management of Patients with Claustrophobia, Anxiety, or Emotional Distress within the Scan Environment**

AU follows the established ACR-SIR Practice Parameter for Sedation/Analgesia, in the case of patients who suffer from claustrophobia, anxiety, or emotional distress in the MR environment.

**X. Contrast Agent Safety**

Use of gadolinium-based contrast agents is to be performed considering ACR policy (ACR Manual on Contrast Media). The name of the administered contrast agent, the administered dose, and the route of administration as well as any adverse reactions, if any, should be recorded for all contrast agents.
administered as part of the executed MR examination.

XI. Reporting of MR Safety/Adverse Events
In the case of adverse events, the MR technologist and hospital personnel in the area of the MR suite where the incident occurred will notify following personnel promptly (not necessarily in this order). Most importantly, an attending radiologist must be notified of the adverse event, in the following order of preference in the case of personnel being unavailable: 1) ordering physician, 2) any other physician in the section that ordered the exam, 3) chief of section associated with the exam, 4) department chair. Risk management must be notified after the incident. Other personnel who should be notified include the MR medical director and a physicist who oversees MR technical safety guidance. When the adverse event directly involves the MR scanner in operation, the vendor must be contacted. When appropriate (e.g., burns), other services such as Plastic Surgery should be notified.

XII. Infection Control and Medical Waste
The scanning table and any other surfaces that have come into contact with a patient or any other potential infectious substance must be properly cleaned and the linens changed before the next MRI study is conducted. Surfaces other than the scanning table may include the coil and/or pads. Gloves must be removed and disposed of properly BEFORE touching common areas such as scanner keyboard, log books, light switches, counter surfaces and other objects. All biohazard material must be disposed of according to hospital regulations.
OBJECTIVE
The objective of this policy is to provide a safe environment for patients, health care providers and other individuals while in the vicinity of a Magnetic Resonance Imaging (MRI) scanner. This policy will be administered by the Department of Radiology and adhered to by all persons in the vicinity of an MRI scanner. This policy will attempt to prevent ferrous objects and prohibited devices from entering MRI magnet rooms. This policy will also carefully control access to the MRI scanner by patients, health care providers and other individuals.

SCOPE
This policy applies to all MCGHI departments, both their personnel and their equipment, working inside MRI magnet rooms or in the vicinity of any MRI scanner at MCGHI. This policy also applies to patients, patient families and visitors that must enter the vicinity of any MRI scanner at MCGHI.

POLICY
Definitions:

Ferrous objects in the magnetic field of an MRI magnet will be attracted with great force and speed toward the magnet. Objects used in MRI magnet rooms shall not consist of or contain components that are ferrous objects. Example items that may be ferrous objects are mop buckets, surgical instruments, procedure carts, code carts, gas cylinders, scissors, hairpins, watches and pocket contents (keys, pens, etc.). Code carts shall never be taken into an MRI magnet room; the patient is to be removed from an MRI magnet room for the code to be conducted.

Non-ferrous objects do not contain ferrous parts and have no attraction to a magnetic field. Non-ferrous objects are safe to use in MRI magnet rooms after being cleared by an MRI technologist. Examples of equipment which MIGHT be non-ferrous and which MIGHT be safe for use in MRI magnet rooms, provided that they are MRI compatible, are anesthesia machines, wheel chairs, stretchers, ECG equipment, pulse oximetry equipment, stereotactic frames, IV poles, IV needles and catheters. MOST EQUIPMENT USED IN THE HOSPITAL AND CLINICS IS NOT MRI COMPATIBLE (ex: anesthesia machines, wheel chairs, stretchers, ECG equipment, pulse oximetry equipment, stereotactic frames and IV poles) and can be extremely dangerous if taken into an MRI magnet room. Most intra-oral dental implants, restorations and corrective devices are non-ferrous. Most devices surgically implanted in the body are non-ferrous. Most types of spinal fusion hardware and joint prostheses are MRI compatible.

The MRI Magnet is a primary component of the MRI equipment. THE MRI MAGNET IS ALWAYS TURNED ON. The magnet will attract, with tremendous force and speed, any ferrous object. Ferrous objects become projectiles; both small and large objects have the potential to cause serious injury. Persons in the path of a projectile may sustain significant bodily injury, possibly death. Cost for repair to the MRI equipment and lost clinical time can easily exceed $25,000. These hazards exist 24 hours per day, 365 days per year even if electrical power is lost in the area.
The magnet room is the room where a large MRI magnet is located and where MRI imaging studies or MRI scans are performed.

PROVISIONS

I. The Department of Radiology MRI technologists will be responsible for giving clearance for all patients, health care providers, other individuals and equipment to enter an MRI magnet room. **Without clearance, no one may enter an MRI magnet room and no equipment may be taken into an MRI magnet room.**

A. Clearance of patients entering MRI magnet rooms:

No patient may enter an MRI magnet room until verbally authorized by an MRI technologist. Prior to authorizing a patient to enter an MRI magnet room, the MRI technologist will “clear” the individual through a screening process. The purpose of the screening process is to determine if the patient has any material or device implanted in their body that may be contraindicated for the MRI procedure (e.g. a ferromagnetic aneurysm clip, pacemaker, etc.) or if there is any condition that needs careful consideration (e.g. the patient is pregnant, has a disability, etc.). In the case of metal workers, radiographs of the eyes are obtained to check for metal fragments. The screening process involves the use of a screening form for patients to document the screening procedure, a review of the information on the screening form, and a verbal interview to verify the information on the form and to allow discussion of any question or concern that the patient may have. If the screening process reveals the presence of any material or device implanted in the patient’s body that may be contraindicated for MRI, an MRI study cannot be performed unless a radiologist signs the screening form to clear the patient for MRI. The radiologist may investigate the safety of a specific device through nationally recognized MRI safety resources (http://www.mrisafety.com). MRI studies on patients having aneurysm clips will not be performed unless the referring surgeon submits a written attestation that the aneurysm clip is MRI compatible for use at 1.5T and/or 3T (see Appendix A for the written attestation).

Before administering an MRI scan to a female patient of childbearing age, the date of last menses will be documented on the screening form. MRI scans on pregnant patients or MRI scans of a fetus may be indicated if diagnostic ultrasound or other imaging studies are inadequate or if the MRI will provide important information that would otherwise require exposure to ionizing radiation. MRI scans on patients who are pregnant or who suspect there is a possibility of being pregnant and MRI scans of a fetus are done only on the specific direction of a radiologist. Particular caution should be exercised during the first trimester. The effects of MR imaging contrast agents on the human embryo or fetus are unknown. The use of MR imaging contrast agents in a pregnant patient or in MRI scans of a fetus are done only on the specific direction of a radiologist. It
is not known whether MR imaging contrast agents are excreted in human milk. The use of MR imaging contrast agents in a breastfeeding patient are done only on the specific direction of a radiologist.

The screening process will be accomplished and the screening form for patients will be completed before each MRI procedure.

**Prior to entrance into an MRI magnet room, all metallic objects shall be removed from the body and clothing.** This will include hearing aids, dentures, partial plates, keys, beeper, cell phone, eye glasses, hair pins, barrettes, jewelry, body piercing jewelry, watch, safety pins, paper clips, money clip, coins, pens, pocket knife, nail clipper, belts, shoes, tools, clothing with metal fasteners and clothing with metallic threads. Additionally, magnetic media such as credit cards, bankcards, audiotapes, and floppy diskettes shall not be taken near an MRI magnet, or their contents will be erased.

**Patients shall not enter an MRI magnet room until verbally directed to enter by an MRI technologist.**

**B. Clearance of health care providers and other individuals entering MRI magnet rooms:**

It is sometimes necessary for health care providers and other individuals to enter an MRI magnet room. For example, nurses, doctors, a family member, environmental services personnel and maintenance personnel may need to enter an MRI magnet room to help take care of the patient or to maintain the facility. No health care provider or other individual may enter an MRI magnet room until verbally authorized by an MRI technologist. Prior to authorizing a health care provider or other individual to enter an MRI magnet room, the MRI technologist will “clear” the individual through a screening process. The purpose of the screening process is to determine if the individual has any implant that may be contraindicated in the MRI environment (e.g. a ferromagnetic aneurysm clip, pacemaker, etc.) or if there is any condition that needs careful consideration (e.g. the individual is pregnant). The screening process involves a review of the contraindicated devices and conditions that would be dangerous to the individuals in the magnet room.

**Prior to entrance into an MRI magnet room, all ferrous objects that would be attracted by the magnet shall be removed from the body and clothing.** This will include hearing aids, keys, beeper, cell phone, hair pins, barrettes, watch, safety pins, paper clips, money clip, pens, pocket knife, nail clipper, belts and tools. Additionally, magnetic media such as credit
cards, bankcards, audiotapes, and floppy diskettes shall not be taken near an MRI magnet, or their contents will be erased.

Health care providers and other individuals shall not enter an MRI magnet room until verbally directed to enter by an MRI technologist.

C. Devices/Objects/Equipment Entering MRI Magnet rooms

Devices/objects/equipment shall be carefully surveyed prior to use in an MRI magnet room. The survey will initially seek to identify the presence of any metallic components. Metallic components shall be surveyed using a hand-held magnet. Attractive force between the metallic component and the hand-held magnet will preclude use of the devices/objects/equipment in MRI magnet rooms. For equipment operated by other departments (Anesthesiology, Respiratory Care, etc.) the following procedure will be followed:

1. A survey will be conducted first by the non-radiology employee using a hand-held magnet to check the equipment for ferrous metal. If the non-radiology employee finds the equipment to be free of ferrous metal, he/she will then ask the MRI technologist to give clearance.

2. The MRI technologist will then survey the equipment using a hand-held magnet.

3. Any equipment taken into an MRI magnet room shall be logged into an MRI Magnet room Log Book by the MRI technologist. Information to be logged is: (1) the date and time and (2) the equipment to be taken into the MRI magnet room. The non-radiology employee and the MRI technologist will initial the logbook.

4. After devices/objects/equipment have been surveyed for entry, they shall not be taken into an MRI magnet room until verbal direction is given by an MRI technologist.

Do not assume that because devices/objects/equipment were previously used in an MRI magnet room, that it is safe to do so again. A non-ferrous component may have been replaced with a ferrous component example: a non-ferrous gas cylinder may have been replaced by a ferrous gas cylinder).
As new medical equipment becomes available, the Department of Radiology medical physicists will investigate their MRI compatibility and add compatible equipment to the list of equipment acceptable for use in MRI at MCGHI.

II. Procedure for Anesthesia

The Department of Anesthesiology is responsible for: (1) marking / tagging anesthesia equipment which is MRI compatible, and (2) educating their staff as to the identification of the MRI compatible anesthesiology equipment, and (3) educating their staff as to this policy.

All anesthesiology personnel who enter an MRI magnet room shall first be cleared by an MRI technologist. All anesthesiology equipment brought into a magnet room will be surveyed by anesthesiology personnel to detect the presence of ferrous metal. Next the equipment will be cleared by the MRI technologist prior to entering an MRI magnet room. (See I. B. above.) Only non-ferrous gas cylinders may be taken into an MRI magnet room with anesthesiology equipment.

III. Procedure for Respiratory Care

All Respiratory Care personnel who enter an MRI magnet room shall first be cleared by an MRI technologist. Respiratory Care staff members shall check all respiratory care equipment for ferrous metal. The only ventilators that can be brought into an MRI magnet room are the Biomed IC2A and Biomed MVP-10 ventilators. No cylinders of any kind are to be brought into an MRI magnet room with a respiratory care ventilator. Respirometers, flowmeters, and similar equipment are usually made of aluminum and brass, and are MRI compatible; nevertheless, each component shall be checked with a hand-held magnet. (See I. B above.)

IV. Syringe Infusion Pumps

It is sometimes necessary to use syringe infusion pumps in an MRI magnet room for delivery of medication or maintenance of I.V. sedation. This is primarily required by anesthesiology personnel and personnel from the Pediatric ICU.

Only one syringe infusion pump can be used in an MCGHI MRI magnet room, the MEDFUSION Model 3500.

The MEDFUSION Model 3500 syringe infusion pump has some magnetic components that will be attracted by the magnet if taken too close to the entrance to the bore of the magnet. Additionally, syringe infusion pumps will not work correctly if taken too close to the entrance to the bore of the magnet. When using the MEDFUSION Model 3500 syringe infusion pump in an MRI magnet room:

A. The syringe infusion pump shall not be taken into a fringe magnetic field stronger than 150 Gauss, which occurs approximately at the end of the MRI patient table (seven feet from the bore of the magnet).
B. At least 3 I.V. tubing extension sets shall be used for delivery of drugs to the patient.

C. A syringe infusion pump will normally be kept in each MRI magnet room. A syringe infusion pump shall not be taken into an MRI magnet room until verbal direction is given by an MRI technologist.

V. Hazard/Warning Communication

Warning signs will be posted outside of all rooms that have magnetic fields higher than 5 Gauss. Appropriate signage will indicate the presence of a high magnetic field and danger to people with pacemakers, etc.

VI. Response to Respiratory or Cardiac Arrest in the Magnet Room

In the event of a respiratory or cardiac arrest in the magnet room:

A. Summon medical personnel in the immediate area to provide assistance and call the hospital emergency operator at extension 12222.

B. Move the patient onto a non-magnetic patient cart and move the patient out of the magnet room immediately. **Code carts shall never be taken into an MRI scan room; the patient is to be removed from an MRI scan room for the code to be conducted.** (A non-magnetic patient cart shall be in the magnet room at all times.)

C. Close the magnet room door to prevent anyone from entering the magnet room during the conduct of a code procedure.

VII. Response to a Fire

In the event of a fire in the MRI area:

A. Remove persons in danger.

B. Alert other personnel in the area and call the hospital emergency operator at extension 14787. Pull the nearest fire alarm station.

C. Close all doors.

D. Extinguish the fire if possible. In trying to extinguish or contain the fire:
   1. Disconnect all electrical power to the MRI system by pressing an emergency “off” button.
   2. Use only a non-magnetic fire extinguisher that has been labeled as MRI compatible.
   3. Notify emergency personnel, including firefighters, that the magnet is on and dangerous.
   4. One MRI area is equipped with a FM-200 fire suppressant system in the magnet room and computer room. **If an FM-200 system alarm occurs, evacuate everyone from the magnet room and**
computer room immediately. The FM-200 system will dump the fire suppressing material into the magnet room and/or
c
computer room approximately 10 seconds after the alarm horn begins sounding an intermittent tone.
5. Do not press the emergency magnet Rundown button or Quench button unless it is absolutely necessary as described subsequently.

VIII. Cryogen Safety

The superconducting magnet used with the MRI system requires a liquid cryogen (liquid helium). In the liquid state, liquid helium is extremely cold and will freeze human tissues.

A quench of an MRI magnet refers to the rapid loss of magnetic field. This can happen if the temperature of the magnet windings rises above 9.5 K and the windings become electrically resistive. During a quench, the magnet windings heat up, which will turn all of the liquid helium to gaseous helium in less than one minute. While the gas is odorless, non-flammable, and non-poisonous, it poses the risk of suffocation if it escapes into the magnet room because it may drastically dilute or displace the oxygen in the magnet room. Gaseous helium released during normal operation and gaseous helium released during a magnet quench normally spews harmlessly outside of the building through a quench pipe.

Liquid cryogens require replenishment because of boil-off. This operation shall be performed only by fully trained service personnel following proper safety procedures.

IX. Procedure for Response to Low Oxygen Alarm

A. Oxygen in the magnet room can be displaced if gaseous helium escapes into the magnet room. This situation could occur if there is a failure in the venting system (quench pipe). Helium gas can displace the oxygen in the air, presenting the possible danger of asphyxiation.

B. The magnet room is equipped with an oxygen monitor that will sound an alarm if the oxygen level drops below OSHA specified levels and the magnet room emergency exhaust fan should automatically activate to exhaust the helium gas from the room.

C. The magnet room emergency exhaust fan can be manually activated if necessary.
D. If an alarm sounds due to failure of the cryogen gas venting system (quench pipe), evacuate the patient and all personnel from the magnet room immediately.

E. When all persons have been evacuated from the magnet room, close the magnet room door.

F. Notify service personnel and the MRI supervisor immediately.

X. Environmental Services

The MRI area shall be cleaned according to normal hospital procedures, except for the magnet room itself.

A. No person shall enter the magnet room until verbally directed to enter by an MRI technologist.

B. The MRI technologist will screen each person that needs to enter the magnet room as described previously to the presence of a cardiac pacemaker, cerebral aneurysm clips or other surgically implanted metal devices and conditions that are contraindicated.

C. Persons entering the magnet room shall remove ferrous objects and magnetic media before entry.

D. Environmental Services personnel shall be advised of the danger of taking any ferrous object into the magnet room and that the magnet is always turned on (24 hours per day, 365 days per year).

XI. Precautions for Public Safety Personnel

Even in an emergency situation, Public Safety personnel shall remove firearms before entering the magnet room. Magnet compatible constraints (plastic shackles) must be used for restraint of prisoners taken into the MRI magnet room. At the conclusion of an MRI scan on a prisoner wearing plastic shackles, the prisoner must be removed from the magnet room before the shackles are cut off using ferrous tools.

XII. Employee Pregnancy

All employees in the MRI area shall report a pregnancy to their supervisor as soon as it is known.
The pregnant employee will continue all required duties, with the exception of occupying the magnet room during the acquisition of MRI images.


XIII. Acoustic Safety

The MRI systems produce substantial noise when scanning. Ear plugs and sound attenuating head phones are available in the MRI magnet rooms for hearing protection.

XIV. Education for All Health Care Providers

Education will be provided by the Hospital Education Department in Hospital Orientation and will be reviewed annually in the Annual Safety Training Update or Annual Mandatory Training. A copy of this training guide will be available at each MRI magnet room for user review.

RESPONSIBILITY

The department of Radiology is responsible for the upkeep of this policy.

Approved

President & CEO
MCG Health, Inc.