



Ferrous Flying Objects: The Most Common MR Hazard

How to prevent, address accidents

As discussed in part one of a series on MR safety (Autumn 2008), taking a systemic approach to MR safety and establishing a culture of awareness and responsibility at all levels of your organization can help minimize the likelihood of MR accidents. When documenting and training policies and procedures, it's important to include common hazards – how to prevent them, and if necessary, how to address them.

MR has a very safe reputation, and in the majority of cases, scans are performed without incident. However, the powerful combination of magnetic forces and ferromagnetic materials can result in objects flying into the magnet. This is the most common hazard faced by anyone who has access to the magnet room. Not only is it dangerous, it can also cause damage to the magnet – resulting in very expensive consequences.

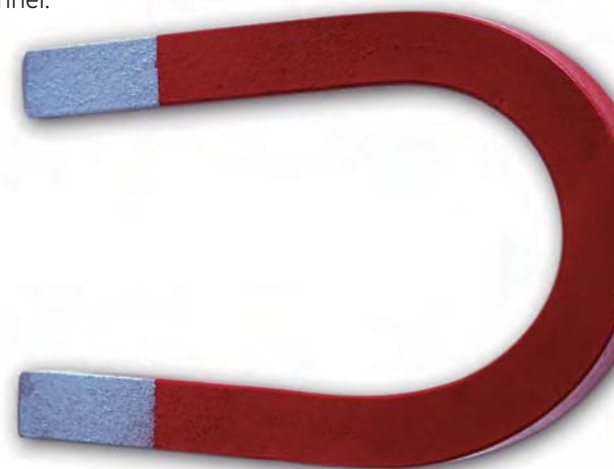
“Flying ferrous objects are scary MR hazards that have the potential to be life threatening,” says Joe Schaefer, principal safety engineer for GE Healthcare and member of the American College of Radiology’s Blue Ribbon Panel on MR Safety. “Deaths associated with MR scanning are extremely rare, but accidents and injuries do occur.”



A pinch of prevention is worth a pound of cure

According to Schaefer, measures should be taken to prevent magnetic field accidents. The following two recommendations are taken from the *ACR Guidance Document for Safe MR Practices 2007*:

- Implement the “Zone” concept into your MR Safety Program. You can categorize your zones in whatever way works best for your facility, but as an example, here is how the ACR defines its zones.
 - **Zone I** – This region includes all areas that are freely accessible to the general public. It is typically outside the MR environment itself and is the area through which patients, healthcare personnel, and other employees of the MR site access the MR environment.
 - **Zone II** – This area is the interface between the publicly accessible uncontrolled Zone I and the strictly controlled Zone III (see below). Typically patients are greeted in Zone II and are not free to move throughout the zone at will, but are under the supervision of MR personnel. In Zone II, the answers to MR screening questions, patient histories, medical insurance questions, etc., are usually obtained.
 - **Zone III** – This area is where free access by unscreened non-MR personnel, ferromagnetic objects, or equipment can result in serious injury or death as a result of interactions with the MR scanner. 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.
 - **Zone IV** – This area is synonymous with the MR scanner magnet room itself. Zone IV will always be located within Zone III as it is the MR magnet and its associated magnetic field which generates the existence of Zone III. Non-MR personnel should be accompanied by, or under the immediate supervision of, one specifically identified and trained person for the duration within Zone III or IV.
- Perform proper screening, and include this in your MR Safety Program. Specific suggestions include:
 - Zone II patient interview/clinical screening, to include disclosure of personal – and potentially ferrous – information such as pacemakers and eye shrapnel, should be done in an area that provides visual and auditory privacy.
 - Patients arriving in Zone II with wheelchairs, walkers, portable oxygen, and other appliances that may be unsafe in the MR environment should be provided appropriate MR-safe or MR-conditional appliances. Designate a “ferrous quarantine” storage area, that is distinct from storage areas for MR-safe and MR-conditional equipment, and ideally locked out of sight. Patient belongings should be retrieved only upon discharging.
 - Zone III physical screening for the presence of ferromagnetic materials, which – no matter the size – can become threats. Designate an area where items can be evaluated and removed, including jewelry, metallic or ferromagnetic objects, implants, and prostheses (as indicated by the manufacturer’s conditional use requirements and physician instructions). Patients should either change out of street clothes or their clothes should be screened, including the pocket contents and the composition of metallic fibers, fasteners, and reinforcing. Consider a high-strength handheld magnet to evaluate the gross magnetic characteristics of objects of unknown composition.
 - In Zone III, it’s advisable to provide a post-screening patient holding area to prevent patient exit and subsequent re-entry. This will help prevent the inadvertent or intentional introduction of unscreened objects and personnel.





Prevention is the best way to avoid accidents related to flying ferrous objects. Updating and continuous training of your MR Safety Program will help keep prevention and safety top of mind.

Because MR is considered to have a high level of safety, operators are often lulled into a false sense of security. To keep those involved on their toes, GE Healthcare suggests that you cover the following points in your MR Safety Program.

1. Assume the magnet is always on. Also, because today's magnets are self-shielding, operators and patients can get closer to the magnet than before. However, the magnetic field falls off faster, presenting serious danger. The 5 gauss line marks the exclusion zone around the magnet (typically this is in the magnet room).
2. Operators and anyone else working in the vicinity of the magnet should understand the magnetic field plots provided with the system. This is important because the force on a ferrous object depends on both the strength of the static field and the spatial gradient of the magnetic field. Review your manufacturer's MR Safety Guide for additional information.
3. Items in the facility that can potentially be taken into the MR environment (such as oxygen bottles, patient monitors, wheelchairs, floor buffers, etc.) should be marked with the appropriate level of MR compatibility – MR Safe, MR Conditional, or MR unsafe. Standard definitions and symbols for labeling can be found in ASTM F2503.
4. Standard metal detectors are not recommended for screening purposes. Ferromagnetic detection systems are a relatively recent development, and may be useful as a supplement to the screening practices described on the previous page.

Be sure to cover these points in your MR Safety Program.

Accidents Happen

While rare, emergencies do occur. According to "Safety of Strong, Static Magnetic Fields" by John F. Schenck, MD and PhD at GE's Corporate Research and Development Center, a

brief literature review in 1998 found reports of seven deaths attributed to MR scanning, one involving a ferromagnetic cerebral aneurysm clip.

Permanently magnetized materials, such as shrapnel in an eye, can rotate to come into alignment with the magnetic field. For obvious reasons, this can present an even greater hazard than the translational forces on such materials. These examples reinforce the importance of efforts to avoid scanning patients with ferromagnetic foreign bodies or implanted electronic devices.

Prevention is the best way to avoid accidents related to flying ferrous objects. Updating and continuous training of an MR Safety Program will help keep prevention and safety top of mind. However, if faced with an emergency, here are reminders:

- The magnet can be shut down by using the Emergency Rundown Unit (ERU or Magnet Rundown). The Magnet Rundown should only be used to free someone pinned to the magnet or to remove a large ferromagnetic object captured by the magnetic field when injury is imminent. The emergency shut down, known as "quenching" when referring to superconducting magnets, involves the rapid boiling of liquid helium that releases the individual. Keep in mind that shutting down is a very expensive option.
- If a smaller object is pinned to the magnet, consider using ropes to pull it free or insert "spacers" to move it away little by little.

The goal of an MR Safety Program is to minimize risks and prevent harm to patients, family members, healthcare professionals, and others who find themselves in the magnetic fields of MR scanners. However, an MR facility can't adopt only a couple interventions and hope to be successful. Integrate and train these tips and your facility will be well on its way to a safer environment.

Look for articles about additional safety risks and how to avoid them in upcoming issues of *SignaPULSE*. ■