

**HAZARD**

# Patient Death Illustrates the Importance of Adhering to Safety Precautions in Magnetic Resonance Environments

## Problem

A recent incident, widely reported in the news media, occurred in a magnetic resonance (MR) scan room of a hospital near New York City. According to reports, a young patient suffered a fatal blow to the head from a metal oxygen canister that flew into the MR system where the patient was lying. While the details of the incident have not yet been disclosed, the *New York Times* account of the incident (July 31, 2001) stated that a “metal oxygen tank somehow made it into the examination room.”

## Discussion

The static magnetic field generated by MR systems will attract ferromagnetic objects (i.e., permanent magnets or other materials that can become strongly magnetized in the presence of an external magnetic field) with considerable force. Other classes of magnetic materials are also subject to this attraction; however, the force exerted on these objects is of smaller magnitude. When the attraction causes an object to move toward a magnet (typically referred to as the “projectile effect”), anyone or anything in the direct path of the object may be struck as the object moves toward the MR system. Patients or other individuals in or near the MR system could be seriously — even fatally — injured by the projectile. In addition, the object, the MR system, and possibly even other equipment could be damaged.

This is not the first report of an object becoming a projectile in the MR environment. Our search of ECRI’s Health Devices Alerts (HDA) database\* and the U.S. Food and Drug Administration (FDA) Medical Device Reporting (MDR) database revealed several instances over the last decade or so in which ferromagnetic objects have crashed into, or been pulled into the bore of, MR systems. The objects involved in these incidents include oxygen

cylinders, IV poles, parts of a forklift, a helium cylinder, a mop bucket, a laundry cart, a chair, a ladder, a patient lift, a light fixture, a floor buffer, a pulse oximeter transformer, tools, scissors, and traction weights. (See References, below, for a partial listing of MDR reports.)

Even devices that might appear safe have become projectiles in the MR environment. For example, although sandbags are often assumed to contain only sand, some also contain ferromagnetic pellets that can be attracted by the MR system. (These pellets are included to add weight to the bag without increasing its size.) In several instances reported in the literature, such sandbags have been pulled into an MR system. ECRI detailed one such instance in a Hazard Report published in the July 1998 issue of its monthly journal *Health Devices* (ECRI 1998).

Projectile incidents have on occasion resulted in patient injuries, some of which were serious. However, to our knowledge, the recent report from the New York hospital describes the first fatality that can be directly attributed to an object being drawn toward a patient in an MR system.

Considering the large number of MR examinations that are performed annually, the number of adverse incidents is quite small. This is primarily because MR personnel typically adhere to safety protocols. However, projectile incidents continue to occur in the MR environment, and it is likely that near misses that are never reported also occur. Therefore, as this incident illustrates, it is extremely important for hospitals to routinely review their MR center policies and procedures. Also needed is routine assessment of the level of compliance with these policies and procedures by hospital staff (e.g., medical, nursing, housekeeping, engineering), emergency medical technicians, and others.

ECRI will be publishing a detailed guidance article on MR safety in an upcoming issue of *Health Devices*. The article will discuss the hazards that exist in the MR environment related to the use of medical equipment and other devices — the projectile effect being only one of these

\* The HDA database contains abstracts of health technology hazards published in the medical literature from 1978 to the present.

---

hazards. The article will also provide recommendations for eliminating or reducing the risks to patients and personnel as well as the risks of damage to equipment.\*

## Recommendations

The following are recommendations for preventing hazards related to magnetic field-induced forces in the MR environment:

1. Appoint a safety officer responsible for ensuring that procedures are in effect and enforced to ensure safety in the MR environment.
2. Establish and routinely review MR policies and procedures, and assess the level of compliance by staff.
3. Provide all MR staff, along with other personnel who would have an opportunity to enter the MR environment (e.g., transport, security, housekeeping, maintenance), with formal training on safety considerations in the MR environment.
4. Always assume that the MR system's static magnetic field is present, and treat the system accordingly.
5. Identify zones in the MR suite and surrounding rooms (including adjacent floors) where the magnetic field strength exceeds 5 gauss (G). Define this area as the MR environment, and restrict access to this area.
6. Don't allow equipment and devices containing magnetic (especially ferromagnetic) components past the 5 G line, unless they have been tested by the device manufacturer and have been labeled "MR safe" for your specific MR environment. Also, adhere to any restrictions provided by suppliers regarding the use of MR-safe and "MR-compatible" equipment and devices in your MR environment.

A label of MR safe means that "the device, when used in the MR environment, has been demonstrated to present no additional risk to the patient or other individuals, but may affect the quality of diagnostic information" (CDRH Magnetic Resonance Working Group 1997). MR-compatible equipment, on the other hand, not only is MR safe, but also can be used in the MR environment with no significant effect on its operation or on the quality of diagnostic information.

---

\* *Health Devices* is a membership benefit of ECRI's Health Devices System and its SELECTplus™ program. For information about these programs, or for details about purchasing single issues of the journal, contact ECRI's Communications Department at (610) 825-6000, or visit our Web site at [www.ecri.org](http://www.ecri.org).

7. Don't make assumptions about devices or equipment (e.g., sandbags) being MR safe. Err on the side of caution: Unless a device or piece of equipment has been proven to be MR safe, do not bring it into the MR environment.
8. Maintain a list of MR-safe and MR-compatible equipment, including restrictions for use. This list should be kept in every MR center by the MR safety officer. It is critical that the safety officer know which equipment has been determined to be safe or compatible for which particular MR environments. Further, if MR systems are upgraded or new MR systems are purchased, the safety officer must determine whether the equipment is still MR safe or MR compatible with the new or upgraded system.
9. Test equipment or devices with a powerful handheld magnet to determine their potential to be attracted by the MR system before allowing them into the MR environment. This is important even for MR-safe and MR-compatible equipment. As a case in point, ECRI recently found, while on a hospital visit, that the hospital had used a ferromagnetic wire to attach a plastic sign to an MR-compatible oxygen regulator, thereby making the device incompatible. (ECRI recommends that hospitals not alter MR-safe or MR-compatible equipment.)

Keep in mind that this test will not catch all magnetic materials. (For example, it probably won't detect ferromagnetic pellets in a sandbag.) However, the test will generally detect sizable magnetic objects.
10. Be extremely careful if you must use equipment containing ferromagnetic components in the MR environment:
  - A. To prevent the equipment from being moved too close to the MR system, the equipment should be physically secured a safe distance (as defined by the equipment supplier) from the MR system through nonmagnetic means — for example, through the use of nonmagnetic bolts, rope, plastic chains, or weighted base assemblies. It is important that the method used to secure the equipment is adequately tested before it is used. In addition, the equipment should be properly labeled.
  - B. Any small, ferromagnetic components of devices, such as caps and covers, should be firmly attached to the device (by nonmagnetic means), since ferromagnetic components can work loose over time.

11. Bring nonambulatory patients into the MR environment using a nonmagnetic wheelchair or wheeled stretcher. Ensure that no oxygen bottles, sandbags, or any other magnetic objects are concealed under blankets or stowed away on the transport equipment.
12. Ensure that IV poles accompanying the patient for the MR procedure are not magnetic.
13. Carefully screen all people entering the MR environment for magnetic objects in their bodies (e.g., implants, bullets, shrapnel), on their bodies (e.g., hair pins, brassieres, buttons, zippers, jewelry), or attached to their bodies (e.g., body piercings). Magnetic objects on or attached to patients', family members', or staff members' bodies should be removed if feasible (dental fillings are an example of a nonremovable item) before such individuals enter the MR scan room.  
Patients with ferromagnetic materials in their bodies may not be candidates for MR imaging, unless the physician has reviewed the case and approved scanning.
14. Have patients wear hospital gowns — those without metallic fasteners — for MR procedures if possible. Patients' regular clothing can contain magnetic objects (e.g., fasteners, hooks, zippers).

---

**UMDNS information.** Scanning Systems, Magnetic Resonance Imaging [16-260]

### References

- Chaljub G, Kramer LA, Johnson RF, et al. Projectile cylinder accidents resulting from the presence of ferromagnetic nitrous oxide or oxygen tanks in the MR suite. *Am J Roentgenol* 2001 Jul;177(1):27-30.
- Chen DW. Boy, 6, dies of skull injury during M.R.I. *NY Times* 2001 Jul 31: Sec. B:1, 5.
- Chu WK, Sangster W. Potential impacts of MRI accidents. *Radiol Technol* 1986 Nov-Dec;58(2):139-41.
- ECRI. Ferromagnetic sandbags are hazardous in magnetic resonance imaging (MRI) environments. *Health Devices* 1998 Jul;27(7):266-7.
- Food and Drug Administration (FDA), U.S.:  
Center for Devices and Radiological Health (CDRH) Magnetic Resonance Working Group. A primer on medical device interactions with magnetic resonance imaging systems [draft; online]. 1997 Feb 7 [cited 2001 Aug 2]. Available from Internet: [www.fda.gov/cdrh/ode/primerf6.html](http://www.fda.gov/cdrh/ode/primerf6.html).
- Medical Device Reporting database. (The following are some of examples of reports about projectiles in the MR environment; these reports are accessible through FDA's Web site [<http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfm/drsearch.CFM>]. We have provided a brief description of each report and its date of publication.)
- M531154. An AC power transformer for a pulse oximeter was attracted to the magnet (1994 Jun 22).

- M526280. A vendor carried a helium cylinder into the magnet room, and the cylinder was attracted to the magnet (1994 Jul 15).
- M376631. An IV pole was pulled off a cot and drawn to the magnet (1993 Mar 4).
- M362867. A stainless steel mop bucket was attracted to the magnet (1993 Jan 6).
- M345725. A ferrous (i.e., composed of or containing iron) laundry cart was attracted to the magnet (1992 Aug 27).
- M308257. A chair was attracted to the magnet (1992 Jul 9).
- M305054. The ferrous braces of an aluminum ladder were attracted to the magnet (1992 Jun 8).
- M271989. An oxygen bottle was attracted to the magnet (1992 Mar 1).
- M247320. A floor buffer was attracted to the magnet (1991 Sep 24).
- M232626. A weight bag was attracted to the magnet (1991 Jun 12).
- M231855. Ferrous BBs from a sandbag that had sprung a leak were attracted to the magnet (1991 May 7).
- M179495. A light fixture in a mobile scan room fell from the ceiling and was attracted to the magnet (1989 Nov 15).
- M178048. A ferrous part from a patient lift was attracted to the magnet (1989 Nov 17).
- M143702. A magnetic tool brought into the room by a workman was attracted to the magnet (1987 Sep 23).

Fowler JR, terPenning B, Syverud SA, et al. Magnetic field hazard [letter]. *N Engl J Med* 1986 Jun 5;314(23):1517.

Jones AA, Arena MJ, Zoller JH 3rd, et al. Potential hazard: traction weights and magnetic resonance imaging. *Spine* 1991 Mar;16(3):364-5.

Mani RL. Potential hazard of metal-filled sandbags in MR imaging [letter]. *Radiology* 1992 Jan;182(1):286-7.

Medical Devices Agency, U.K. MRI static magnetic field safety considerations — the projectile effect caused by the influence of the static magnetic field of magnetic resonance imaging systems [bulletin]. 1998 Apr. ♦

## About ECRI

ECRI is an independent, nonprofit health services research agency dedicated to improving the safety, efficacy, and cost-effectiveness of healthcare. ECRI's focus is healthcare technology, healthcare risk and quality management, and healthcare environmental management.

ECRI provides information services and technical assistance to more than 5,000 hospitals, healthcare organizations, ministries of health, government and planning agencies, and other organizations worldwide. Its more than 30 databases, publications, information services, and technical assistance services alert readers to technology-related hazards; disseminate the results of medical product evaluations and technology assessments; provide expert advice on technology acquisitions, staffing, and management; report on hazardous materials management policy and practices; and supply authoritative information on risk control in healthcare facilities and on clinical practice guidelines and standards. ♦