Magnetic Resonance Imaging Safety Tips

MRI technique is used in radiology to generate images of organs in the body for diagnostic imaging. MRI scanning is based on the science of NMR using strong magnetic fields, radio waves, and field gradients to generate images of the organs in the body. An MRI scanner consists of a large, powerful magnet that a patient lies in. A radiowave antenna is used to send signals to the body and then receive signals back. These returning signals are converted into images by a computer attached to the scanner. Imaging of almost any part of the body can be obtained in any plane.

Most clinical magnets are superconducting magnets, which require liquid helium.

Because of the potential hazards associated with MRI, anyone accessing the MR environment must be either trained or screened. Patients must undergo a comprehensive screening to ensure that an MR procedure is appropriate for them.

**MRI Safety Considerations**

- Ferromagnetic (e.g., steel, iron) objects are strongly attracted to the magnet and can become lethal projectiles. Personnel can be severely injured and equipment can be damaged if struck by objects that are attracted to the magnet at a high rate of speed. In the case of MRI units, life-threatening situations can occur if a person is pinned against the magnet by a large ferromagnetic object.

- Absolutely no ferromagnetic objects are allowed inside a magnet room or within the predetermined radius of the magnetic field. Objects may be tested for magnetic susceptibility with a hand-held magnet.

- Examples of items that must not enter the magnetic field or room are regular fire extinguishers, air tanks, axes (fire fighters), guns, radios, flashlights, wheelchairs, stretchers, and defibrillators. Smaller metallic items like badges, jewelry, watches, keys, dentures, glasses, hearing aids, and hair accessories must also be removed before a person wearing them enters the magnet room or magnetic field. Credit cards and magnetic storage media can be destroyed by the field.

- Metallic implants and prostheses and foreign metallic bodies (even those that are not ferromagnetic) can move or get dislodged, causing severe injury. Examples include aneurysm clips, implanted pins, shrapnel, insulin pumps, prosthetic limbs, cochlear implants, pacemakers, and cardiac or neural defibrillators.
• Magnets generate strong magnetic fields that can inhibit the operation of magnetically sensitive equipment (certain implants or external devices), resulting in death or serious injury to the user. The most common item in this category is the cardiac pacemaker. A person with a pacemaker must be restricted to areas where the magnetic field is less than 5 gauss.

• The MRI scanner can produce very high acoustic noise levels, which may cause discomfort in some patients. Earplugs can reduce the noise level by at least 25 decibels.

• One of the cryogenic gas hazard is the magnet quench. Quench is the (normally unexpected) loss of superconductivity in an NMR magnet, resulting in rapid heating through increased resistance to the high current. The superconducting magnet contains both liquid helium and liquid nitrogen. A substantial volume of liquid helium will be converted to gas if the magnet quenches. In a magnet quench, the superconducting magnet loses the ability to superconduct and the stored energy is released as heat, which boils off the liquid helium. The helium gas is vented out of the magnet dewar and fills the room from the top down (helium is lighter than air), and forms a cloud near the ceiling. A quench is obvious: a big cloud of helium vapor will form above the magnet, accompanied by a loud whooshing sound that can create an oxygen deficient atmosphere. The quench can violently damage the magnet, and ferrous objects are drawn into the magnet bore.

• There are two emergency buttons located on every magnet:
  1. **Emergency Stop/Shutoff** – Turns off all incoming electrical power to the magnet Power Distribution Unit (PDU). It is used when there is a fire, sparks, loud noises, flooding, or catastrophic equipment failure.

  2. **Quench or Emergency RunDown** – Causes immediate collapse of the superconductive magnetic field. It is used only when a large magnetic object pins a person against the magnet, and no other method can prevent further injury or free the person.

Know the location and function of the two emergency buttons located on every magnet.

**Emergency Procedures**

**Follow these steps if a magnet quench occurs or if the oxygen monitor alarm turns on:**

• Evacuate the room immediately, leave the doors open during egress, activate the fire alarm to evacuate the building

• Call 911.

• No one should be allowed to enter the room until helium has completely boiled off. The emergency responders will assess the oxygen concentration and provide the all-clear when oxygen levels return to normal.

• Assist other individual(s) with getting to safety or call 911
Follow these steps if someone is pinned against the magnet by a ferromagnetic object:

- Emergency responders planning to enter the magnet room must remove ALL metal without exception. Access to the room is prohibited for anyone with non-removable metal such as a pacemaker or implanted device. Limit entry to necessary personnel only.

- Determine whether the object pinning the victim can be removed without causing further injury. If removal is successful, immediately evacuate the victim to an area outside the magnet room and restrict others from entering the room. Resuscitation aided by ferromagnetic devices can be administered once the victim is outside the magnet room.

- If a life-threatening emergency exists and there is no other way to free the victim without eliminating the magnetic field, then it will be necessary to initiate a magnet quench by pressing the Quench or Emergency RunDown button.

- The magnet quench procedure will create a dangerous environment. Expect a loud noise from the escape of cryogens and a release of dense white fog. There is a high risk of asphyxiation and potential for frostbite. As the magnetic field decreases, the object pinning the victim may fall and could cause further damage. Also, any liquid dripping from surfaces should be presumed to be enriched oxygen and treated as a fire hazard.

- Do not perform this procedure unless you are prepared to immediately evacuate yourself and the victim if oxygen is displaced from the room.

Follow these remaining steps only if a quench is required:

- Prop open the magnet room door, as the pressure generated by the quench may prevent doors from opening. Do not allow others to enter the room through the open door.

- All personnel must know to leave the room and not return until the helium has dissipated and the room is safe to reoccupy.

- Under no circumstances should ferromagnetic objects be brought into the magnet room unless MR-trained personnel verify that the magnetic field is no longer detectable.
Take-Away Safety Tips

- ALWAYS remove metallic objects before entering the magnet room.
- Ensure that ferromagnetic objects are kept outside the magnet room.
- Provide earplugs to patients before they undergo an MRI procedure.
- Know the location and function of the two emergency buttons located on every magnet.
- Wear safety glasses or goggles, cryogenic gloves, and body protection when handling cryogenic liquids, namely, the liquid helium and/or nitrogen in superconducting magnets. Prolonged exposure to helium vapor can cause frostbite.
- Use cryogen level sensors to avoid a “quench”; always refill or de-energize the magnet if low cryogen levels are indicated on the sensors, oxygen displacement during quench is a serious concern.
- Do not operate equipment with protective panels opened or removed.