THE MAGNETIC FIELD IS AT FULL POWER

ALWAYS ….

IT IS ALWAYS “ON”.

Who is this training for?

MRI safety training is required for all faculty, staff and students who will work around and inside the MRI magnet rooms or will need access to the area.

Overview of Topics

1. Safety training schedule
2. Potential dangers of MRI
3. Safety Signage
4. Importance of proper safety
5. Regulating those around you
6. Emergency situations

Safety training schedule

Safety training should be completed annually and will consist of:

1. Filling out a personal MRI Screening Form
2. Reviewing safety PowerPoint
3. Watching the MRI safety video
4. Passing the MRI safety quiz

MRI Screening Form

- To ensure patient safety, completion of the MRI screening form is required prior to every MRI scan.
- The MRI Screening Form is used to help identify any potential dangers for you and your patients / subjects.
- The form consists of a series of questions intended to identify any metallic objects within your body that could be affected by the magnetic field.
- 2 screening forms are required:
  - During the consent process (RA)
  - Before the MRI (MRI Operator)

MRI Screening Sheet

All Patients will need this form filled out before an MRI can be done.

Ideally, the form should be filled out by:

a. **The Patient**

If the patient cannot fill it out:

b. **Family Members**

If there are no family members:

c. **Referring MD**

EMPLOYEE SAFETY

ALL EMPLOYEES MUST BE SCREENED TO WORK IN A MAGNETIC FIELD ENVIRONMENT JUST LIKE THE PATIENTS.

NO EXCEPTIONS.

Patient Screening and Contraindications

▣ NO ONE should enter the scan room without first being cleared by an MRI operator.

▣ Some implants/devices are contraindications for an MRI scan

▣ If a subject answers “yes” to any question on the MRI screening form, that issue must be addressed and resolved prior to entering the scan room

▣ NO cardiac pacemakers, defibrillators, aneurysm clips or electronic or magnetically activated devices

Patient Screening and Contraindications (Continued)

•Any injury from a foreign metallic body may be a contraindication for an MRI scan

•If someone has worked as a machinist, grinder, or welder and cannot absolutely confirm they always wore eye protection, they must first have orbital x-rays to confirm that there are no loose metallic bodies in the eye

•Any person who was injured by a metallic foreign body such as a bullet, BB, or shrapnel may not be able to proceed with an MRI scan unless there is proof that any remaining metal in the body is not in a location where it may move and cause injury/death.

Safety Signage

- FDA Guidance for the Submission of Premarket Notifications for Magnetic Resonance Diagnostic Devices states:
- "The controlled access area should be labeled "Danger - High Magnetic Field" at all entries."
- The term "warning" does not convey the importance of a situation that may not only be potentially hazardous but has been responsible for serious injuries and deaths.

Look for the warning signs!


WARNING
NO PACEMAKERS
NO METALLIC IMPLANT
NO NEUROSTIMULATORS
Serious injury may result.


DANGER!
RESTRICTED ACCESS
STRONG MAGNETIC FIELD
The Magnet is Always On!
• NO CARDIAC PACEMAKERS OR IMPLANTABLE CARDIOVERTER DEFIBRILLATORS (ICDs)
Persons with certain metallic, electronic, magnetic, or mechanical implants, devices, or objects may not enter this area.
Serious injury may result.
Do not enter this area if you have any question regarding an implant, device, or object. Consult the MRI Technologist or Radiologist.
• NO LOOSE METAL OBJECTS
Objects made from ferrous materials must not be taken into this area. Serious injury or property damage may result.
Electronic objects such as hearing aids, cell phones, and beepers may also be damaged.

Remember, the magnet is ALWAYS on!

- Even when the MRI Scanner is not in use, the magnet is on.
  Ferromagnetic objects should **NEVER** be taken into the Scan Room.

MRI safety Zones

The MRI suite is divided into 4 safety zones.

ZONE 1: This region includes all areas that are freely accessible to the general public. It is typically outside of the MR environment itself and is the area through which patients and all personnel access the MR suite. This zone is not marked or labeled.

ZONE 2: This area is between the accessible zone 1 and the strictly controlled zones 3 and 4. Patients and other personnel are able to move throughout this area. However they must be mindful of where zone 3 begins. This area is marked with a safety sign.

ZONE 3: This area is the region that non-MR safe equipment can result in serious injury or death if accidentally moved closer or into zone 4. Personnel are not to move freely through this zone. They must be accompanied by level 2 staff. MR safe practice guidelines must be adhered to for the safety of the patients and other non-MR staff.

ZONE 4: This zone is the MR suite itself. Nobody that has not been screened will enter this zone under any circumstances. If the screening process has taken place, you may enter the suite, but you MUST be accompanied by level 2 MR staff.

MRI Safety

Safety Background

- The MRI scanner is a very large and powerful magnet
- Most clinical scanners are 1.5 - 3 Tesla scanners
- 3 Tesla = 30,000 gauss
- Earth's magnetic field ~ 0.5 gauss

Image Courtesy of Siemens Healthcare

Forces in the MR Environment

- Magnetic field

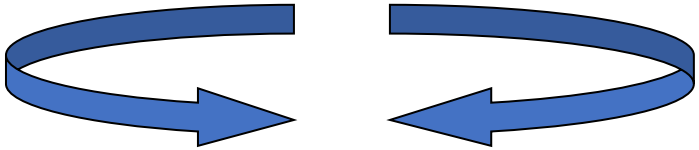
Missile effect: TRANSLATION

Rotational effect: ROTATION/TORQUE

Translational Force

- this term describes the force which attracts ferrous objects to the center of the magnetic field
- may act to transform ferrous objects into missiles as they accelerate toward the magnet
- the force is greatest when the difference in field strength across the object is

Rotational Force



- this force relates to the North - South orientation of the scanner's magnetic field
- ferrous objects will attempt to align their long axes with this orientation
- this force will rotate objects until they are aligned and is greatest at the very center of the field (unlike the translational force which is greatest where the difference in magnetic field across the object is greatest)

Characteristics of the Magnetic Field

- the force of the field is measured in tesla (T); a typical scanner is approximately 1.5- 3.0 tesla

- **the force of the field is greatest at the periphery of the magnet. This FORCE INCREASES as you move closer to the magnet.**

- NOT ALL MAGNETS ARE THE SAME FIELD STRENGTH, THUS THEIR "ATTRACTIVE FORCES" WILL BE DIFFERENT.

What can you take into a magnetic field?

- ONLY ITEMS THAT ARE MRI COMPATIBLE. Such as…

Brass

Aluminum

Plastic

Anything that doesn't contain iron.

IF YOU ARE NOT SURE IF AN OBJECT IS MRI SAFE…DON'T TAKE IT INTO THE ROOM. ASK AN MRI Personnel!!!!!!!!

To be safe…TAKE NOTHINGINTO A MAGNETIC FIELD.

Work closely with the MRI Personnel who works in that type of environment each day. Question Everything.

Safety Background, potential projectiles, and safety reminders

Potential Dangers of MRI Potential Projectiles

- Any ferromagnetic object may be attracted to the MRI scanner and become a projectile – this is known as the missile effect.

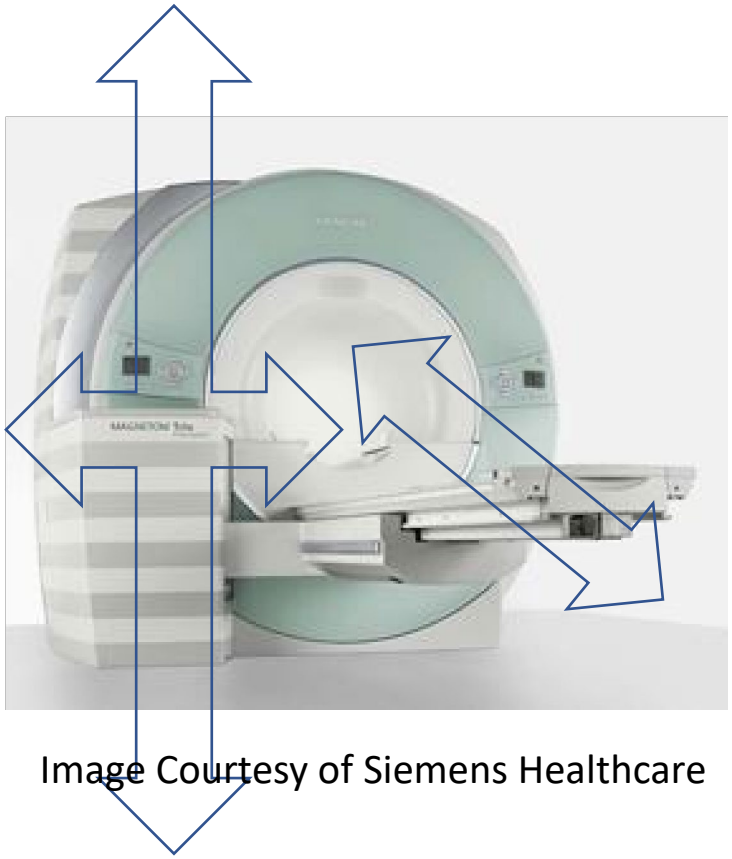


Image Courtesy of Siemens Healthcare

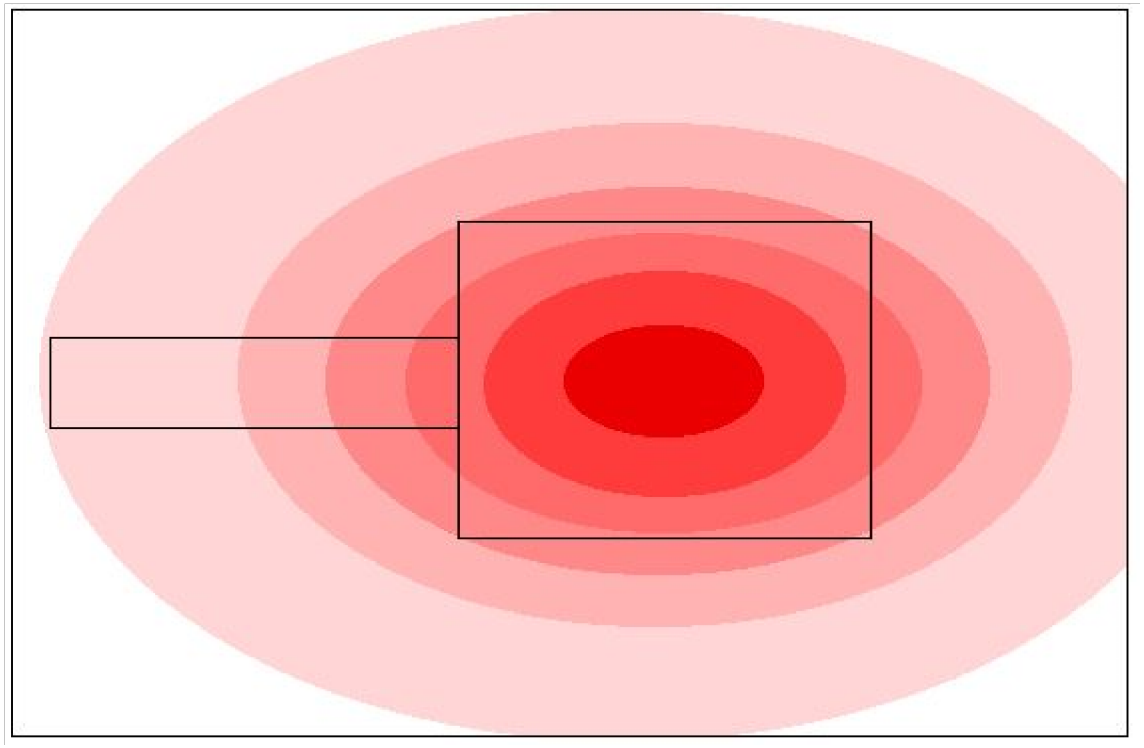
- The greater the amount of ferromagnetic material, the greater the force of attraction.

- The magnetic field extends beyond the bore of the magnet in all directions (fringe field)

Fringe field

•This line specifies the perimeter around a MR scanner within which the static magnetic fields are higher than five gauss. Five gauss and below are considered 'safe' levels of static magnetic field exposure for the general public.

As you approach the magnet, the fringe magnetic field gets STRONGER



Projectile Accidents

•The MRI magnets are ALWAYS on (24 hours/day, 365 days/year)

•There is a STRONG fringe magnetic field around the magnets

•The fringe magnetic field is confined to the scan room

Potential Projectiles – examples Cell phone

Keys/ Clipboards

Glasses

Hair pins / barrettes

Jewelry

Safety pins

Paper clips

Coins

Pens

Pocket knife

Nail clippers

Steel-toed boots / shoes

Tools

No loose metallic objects should be taken into the Scan room!

Potential Projectiles –

Large Objects-Due to the strength of the magnet, large objects such as chairs and IV poles can become projectiles and get stuck in the magnet!

photo credit: www.simplyphysics.com

http://simplyphysics.com/flying_objects.html#

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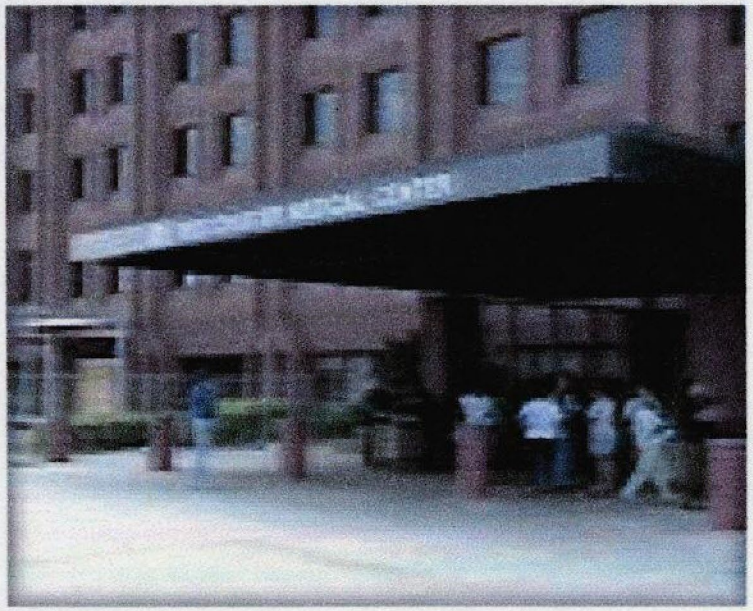

Employees of the Westchester Medical Center in Valhalla, N.Y., gather outside after learning of the deadly MRI incident. (ABCNEWS.com)

Hospital Nightmare

Boy, 6, Killed in Freak MRI Accident

abcNEWS.com

July 31 — A 6-year-old boy died after undergoing an MRI exam at a New York-area hospital when the machine's powerful magnetic field jerked a metal oxygen tank across the room, crushing the child's head.

The force of the device's 10-ton magnet is about 30,000 times as powerful as Earth's magnetic field, and 200 times stronger than a common refrigerator magnet.

The canister fractured the skull and injured the brain of the young patient, Michael Colombini, of Croton-On-Hudson, N.Y., during the procedure Friday. He died of the injuries on Sunday, the hospital said.

The routine imaging procedure was performed after Colombini underwent surgery for a

A Horror Story

Here's one I heard from an Oxford Magnets engineer which was later independently verified by a technologist who had been hired to work at this site.

A brand-new magnet had just finished being installed into a brand new building.

All the acceptance testing had been completed and the magnet was to be turned over to the customer the very next day.

There was only one minor problem to be dealt with first.

One of the sprinklers in the scan room had a tiny leak. A welder was brought in to fix the leak, but somebody forgot to tell him that the magnet was at field.

So..... in walks this welder with his acetylene torch system. His tank flies into the magnet, the valve breaks off, sparks and catches fire.

Since he was in there to fix a leak in the sprinkler system, it had been turned off first.

The brand-new building burned to the ground!

http://simplyphysics.com/flying_objects.html#

Remember this mnemonic:

MRI = Metal Results (in) Injury

Peripheral nerve stimulation (PNS)

The rapid switching on-and-off of the magnetic field gradients is capable of causing nerve stimulation. Volunteers report a twitching sensation when exposed to rapidly switched fields, particularly in their extremities

BURNS

•It is “possible” for patients to get 1st, 2nd, or even 3rd degree burns in an MRI if items such as ECG cables are looped and are touching the patient’s skin (even if these devices are MRI compatible).

All “cables” should not touch the patient’s skin directly, and should NOT be in a LOOPED configuration.

Safety (continued)

- Auditory safety
  - Activation of gradient magnetic fields produces significant vibrations in the gradient coils.
  - MRI acoustical noise has been shown to produce reversible hearing impairment and could potentially produce permanent damage.
  - Hearing protection is recommended for all patients undergoing an MRI procedure on a high-field MRI system (1.5T and 3.0T).

Noise attenuating earplugs or head phones are routinely used in MRI

-FDA Safety Guidelines for MR Devices

-Acoustic noise level Internional standard: 140 dB relative

Emergency Shut Down

- Press this button in the case of a Fire, sparks, smoke
- Disable electrical power to equipment in the scan room.

Another danger in MRI:

QUENCH!

MR scanners are super cooled with inert gases such as helium.

If these cryogens BOIL OFF either intentionally or unintentionally, a quench has occurred. THIS IS EXTREMELY BAD.

When to Quench?

Quench is done in an emergency, to run the magnetic field to ZERO to remove a projectile/patient from the scanner in extreme emergencies.

If a quench occurs, remove all staff from the room immediately

•THE WORRY WITH A QUENCH IS THE POTENTIAL FOR ASPHIXIATION AND FROST-BITE TO THE HEALTH CARE WORKER AND PATIENT.

Importance of Proper Safety

Why is proper MRI safety so important?

- To protect your patient / subject
- To protect your co-workers / colleagues
- To protect yourself

Regulating those around you

Keep the MR control area safe

- Keep doors to the MR control area shut
- Do not let people into the MR control area or scanner rooms
- Do not share access codes
- Monitor your subjects while they are in the MRI area

Emergency Situations

- In the event of an emergency, you should first remove the subject from the MRI scan room
- Stand near the doors to the scan room to insure no unauthorized emergency personnel can enter
- NO CODE OR CODE LIKE PROCEDURES WILL BE RUN IN THE MRI ROOM.

Safety Training summary

- Annually review your safety training
- Always be aware of the potential dangers of MRI
- Never take anything metal into the scan room
- Always make safety a top priority while in the MRI environment

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IT IS ALWAYS “ON”.

The End