UMASS Medical School
Advanced MRI Center
SAFETY TRAINING

Level 1

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, and for staff who will not work around and inside the MRI magnet rooms, but will involve in the recruitment and interview of subjects.

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 or watching the level 1 MRI safety video
3. Passing the MRI safety quiz

MRI Screening Form

- To ensure subject 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 subjects.
- The form consists of a series of questions intended to identify any metallic objects within your or subject's body that could be affected by the magnetic field.

MRI Screening Sheet

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

Ideally, the form should be filled out by:

a. **The Subject**

If the subject cannot fill it out:

b. **Family Members**

If there are no family members:

c. **Referring MD**

Remember this is a *legal* document. All sections, dates, names, signatures must be completed *before* the subject enters the scan room. If it is incomplete it is not valid for a subject to be scanned and you could be liable for any damages or injury incurred by the subject.

UMASS Advanced MRI Center

APPENDIX F: Screening Form

Department of Radiology
UMASS Medical School
55 Lake Avenue North
Worcester, MA 01655
Tel: 508-334-0409

PI's name: _____ IRB Docket #:_____

Subject name (Print):_____ Subject ID:_____

ATTENTION: MR PATIENTS AND ACCOMPANYING FAMILY MEMBERS

The MR room contains a very strong magnet. Before you are allowed to enter, we must know if you have any metal in your body. Some metal objects can interfere with your scan or even be dangerous, so please answer all the following questions carefully.

☐ Yes ☐ No Have you ever had an operation or surgical procedure of any kind? Please list all with dates:

_____
_____
_____
_____

☐ Yes ☐ No Have you ever been a machinist, welder, or metalworker?

☐ Yes ☐ No Have you ever been hit in the face or eye with a piece of metal (including metal shavings, slivers, bullets, or BBs)?

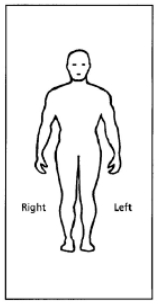
☐ Yes ☐ No Have you ever had a piece of metal removed from your eye?

☐ Yes ☐ No Are you pregnant, possibly pregnant, or breastfeeding?

DO YOU HAVE ANY OF THESE ITEMS IN YOUR BODY?

☐ Yes ☐ No Pacemaker, wires, or defribrilator
☐ Yes ☐ No Brain/aneurysm clip
☐ Yes ☐ No Ear implant
☐ Yes ☐ No Eye implant
☐ Yes ☐ No Electrical stimulator for nerves or bone
☐ Yes ☐ No Bullets, BBs, or pellets
☐ Yes ☐ No Metal shrapnel or fragments
☐ Yes ☐ No Magnetic implant anywhere
☐ Yes ☐ No Infusion pump
☐ Yes ☐ No Coil, filter, or wire in blood vessel
☐ Yes ☐ No Artificial limb or joint
☐ Yes ☐ No Tattoo eyeliner
☐ Yes ☐ No Implanted catheter or tube (except Foley, IV Cath or PIC line)
☐ Yes ☐ No Artificial heart valve
☐ Yes ☐ No Penile prosthesis
☐ Yes ☐ No Shunt
☐ Yes ☐ No False teeth, retainers, or magnetic braces
☐ Yes ☐ No Surgical clips, staples, wires, mesh, or sutures
☐ Yes ☐ No Diaphragm or intrauterine device
☐ Yes ☐ No Orthopedic hardware (plates, screws, pins, rods, wires)
☐ Yes ☐ No Tissue expander
☐ Yes ☐ No Pessary

Please mark on this drawing the location of any metal inside your body



The following items may become damaged or cause injury to others in a strong magnetic field. THEY MUST NOT BE TAKEN INTO THE MR SCAN ROOM. Place an "x" by any item you have with you on the list below.

☐ Hearing Aid
☐ Glasses
☐ Watch
☐ Safety Pins
☐ Hairpins/barrettes
☐ Wigs/hair pieces
☐ Jewelry (rings, earrings, etc.)
☐ Wallet/money clip
☐ Purse/pocketbook
☐ Pens/pencils
☐ Keys
☐ Coins
☐ Pocket knife
☐ Credit or bank cards
☐ Artificial limb/prosthesis
☐ Dentures/partial plates/retainers
☐ Belt buckle
☐ Bra/girdle/sanitary belt
☐ Metal zippers/buttons

INFORMATION CONCERNING GADOLINIUM CONTRAST MATERIAL

As part of your examination, the MR radiologist may deem it advisable to give you an I.V. injection of a contrast agent containing gadolinium. This injection may help the physician more accurately diagnose your condition. Although gadolinium contrast agents have been used safely in millions of cases, minor reactions (principally headaches and nausea) occur in about 2% of patients, whereas serious or life-threatening reactions have been reported in about one in 400,000 patients.

Have you ever had a previous reaction to gadolinium contrast material? ☐ Yes ☐ No

Do you have a history of asthma or emphysema? ☐ Yes ☐ No

I attest that the answers I have provided to questions on this form are correct to the best of my knowledge. I have read and understand the entire contents of this form and have had the opportunity to ask questions regarding the information on this form.

Signature (Patient or Guardian) _____ Date: _____

Witnessed by _____ Date: _____

- Implants, devices and other objects within or on Participants or other Individuals intending on entering the magnetic environment must be investigated by the manufacturer label and this investigation must be documented **prior** to the Individual or Participants entering the MR environment and the scanner magnet room
- Manufacturer documentation which includes the FDA approval must be obtained to ensure safety of implants, devices or other objects **at 3.0 Tesla**. All Individuals should never assume MR compatibility or safety information about a device if it is not clearly documented in **writing**

- **the fact that the participant has already undergone a prior MRI study is not sufficient for assessing the safety of the procedure**

EMPLOYEE SAFETY

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

NO EXCEPTIONS.

subject 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 or electronic or magnetically activated devices

Subject 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.

SAFETY SIGNAGE

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.

ACR Zone Recommendations

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 subjects 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. Subjects 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 MR staff. MR safe practice guidelines must be adhered to for the safety of the subjects and other non-MR staff.

ZONE 4 : This zone is the MR scan room 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


MRI
MRI ZONE I
MRI Access Area
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349

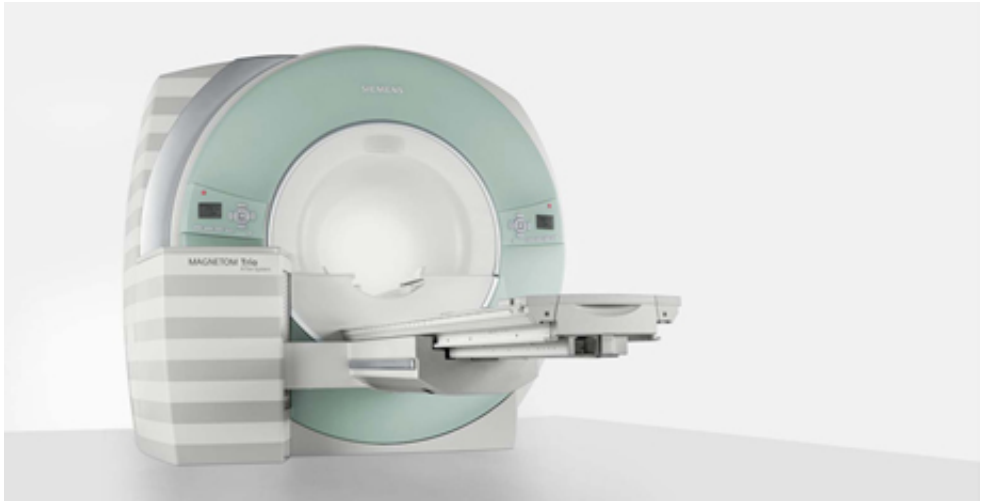

NOTICE
MRI ZONE II
MRI Patient Screening and Preparation
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349


CAUTION
MRI ZONE III
Restricted Access
Screened MRI Patients and MRI Personnel Only
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349


DANGER
MRI ZONE IV
Restricted Access
Screened MRI Patients Under Direct Supervision of Trained MRI Personnel Only
© Magmedix, Inc. 2009
www.Magmedix.com
866-646-3349

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
- Earths magnetic field ~ 0.5 gauss



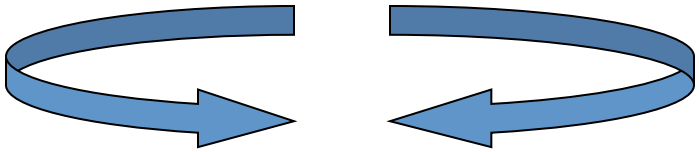
Forces in the MR Environment

- 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
  - Titanium
  - Plastic

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

Magnetic Field

- What "objects" can you take into a magnetic field?

Anything that doesn't contain iron.

To be safe…TAKE NOTHING INTO 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.
- 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)

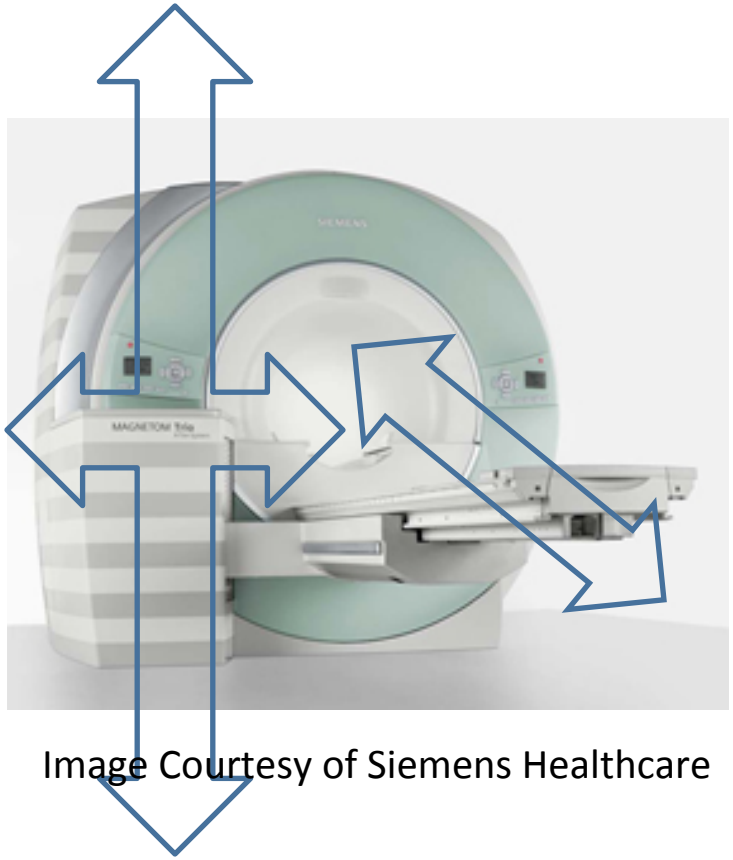
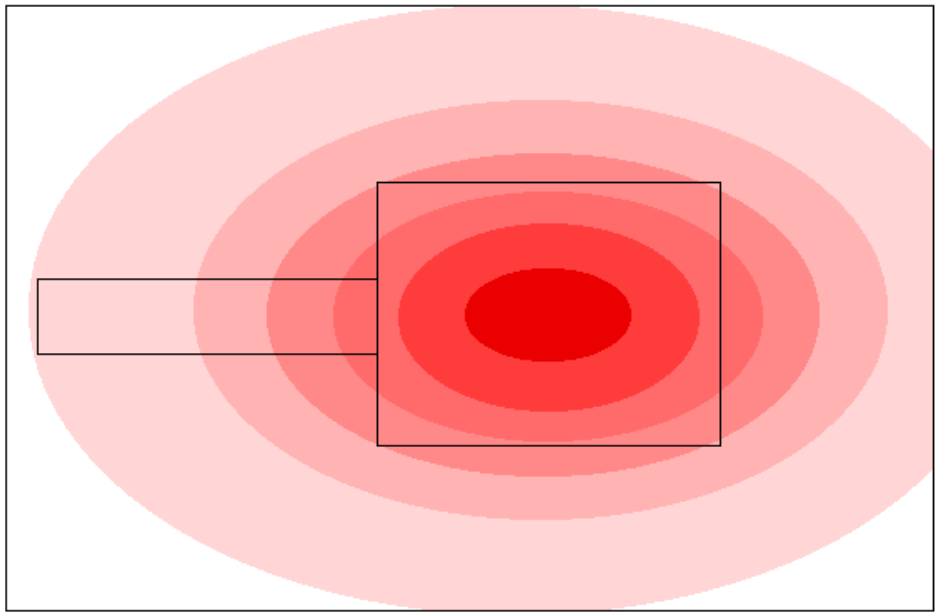


Image Courtesy of Siemens Healthcare

Static Magnetic 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**
- **The 5 Gauss line is at the scan room door for the 3.0T scanner.**

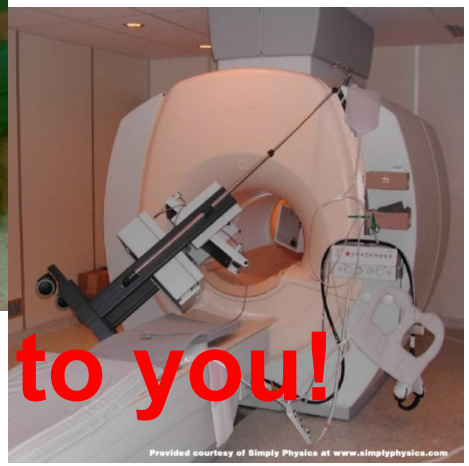


Projectile Accidents

- 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

Static Magnetic Field

---Potential Projectiles—Large Objects



Don’t let this happen to you!

Static Magnetic Field

---Potential Projectiles—Large Objects

Don’t let this happen to you!

Static Magnetic Field

---Potential Projectiles—Small Objects

- Cell phone
- Keys
- Glasses
- Hair pins / barrettes
- Jewelry
- Safety pins
- Paper clips
- Coins
- Pens
- Pocket knife
- Nail clippers
- Steel-toed boots / shoes
- Tools
- Clipboards







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

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

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 subjects to get 1st, 2nd, or even 3rd degree burns in an MRI if items such as ECG cables are looped and are touching the subjects skin (even if these devices are MRI compatible).
  - All “cables” should not touch the subjects 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 subjects undergoing an MRI procedure on a high-field MRI system (1.5T and 3.0T).
  - Noise attenuating ear-plugs and/or head phones are routinely used in MRI

Safety (continued)

-FDA Safety Guidelines for MR Devices

-Acoustic noise level

International standard: 140 dB relative to 20 mPa

Electrical Shut Down Button

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

Located on the wall next to the door in the control room

Another danger in MRI:

QUENCH!

- MR scanners are supercooled 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 in order to remove a projectile/subject from the scanner in extreme emergencies.
- If a quench occurs, remove all staff from the room immediately

Emergency Magnet Quench

Two quench buttons are located inside scan room and in the control room.

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

IMPORTANCE OF PROPER SAFETY

Why is proper MRI safety so important?

- To protect your 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 all the time
- Do not let people into the MR control area or scan room
- Monitor your subjects while they are in the MRI area

Emergency Situations

- In the event of an emergency, you should first help to remove the subject from the MRI scan room to hall way (zone 2)
- NO CODE OR CODE LIKE PROCEDURES WILL BE RUN IN THE MRI ROOM.
- No emergency carts or oxygen tanks are allowed 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

THE MAGNETIC FIELD IS AT FULL POWER ALWAYS ….IT IS ALWAYS “ON”.

You Have Completed the Level 1 MRI Safety Training Module

Proceed to the MRI Safety Training Quiz. You must pass with at least 80%.