MRI Safety Training for First Responders

By Sandip Basak, MD
University Radiology Group
2021

Objectives

- Explain what an MRI is and how it works
- Describe the hazards of MRI
- Explain the safety zones of an MRI facility
- Describe the hazards related to first responders working around an MRI
- Review precautions that must be taken when responding to an emergency at a facility with an MRI

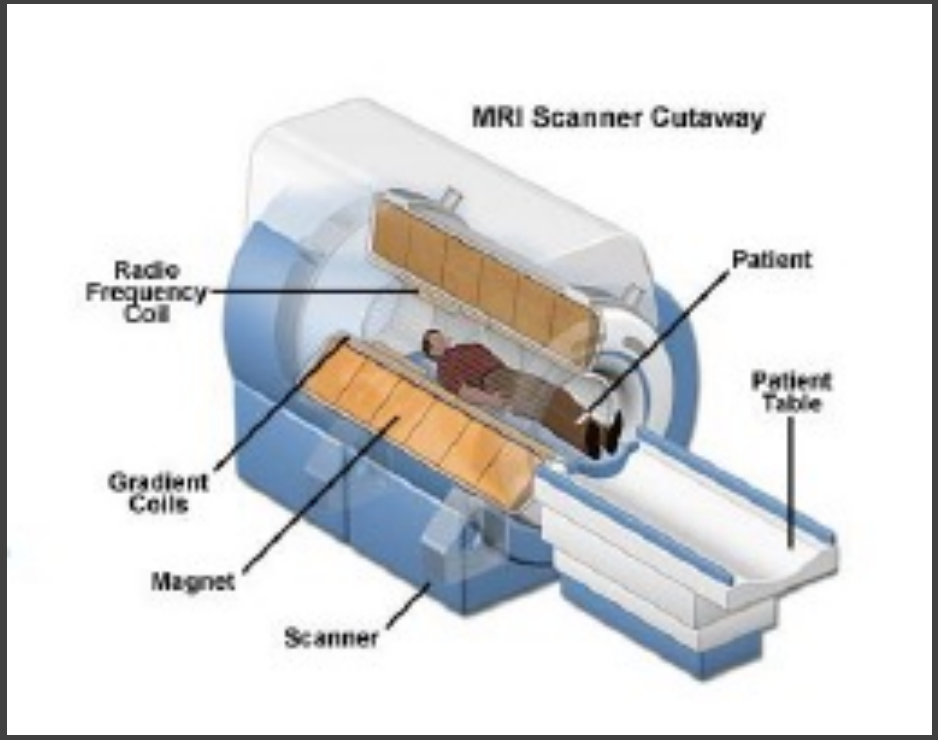
What is MRI?

- Found in hospitals, private imaging centers, and mobile units.
- There are potential serious hazards in the MRI environment.
- Emergency responders need to know what to do and what not to do at these facilities.



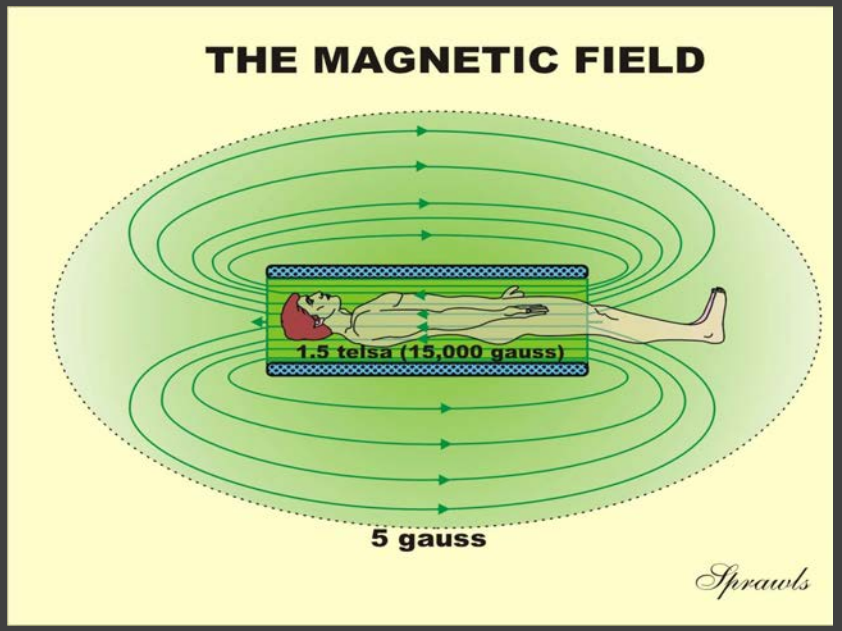
What is MRI?

- Magnetic Resonance Imaging or MRI is a large device that allow radiologists to see inside a patient's body.
- These are large cube like machines with sizes of about seven feet by seven feet by ten feet.
- The MRI is essentially a large, strong magnet with a circular open core or "bore".
- When a patients is placed in the bore, a computer and the MRI takes radiofrequency waves to turn them into images that allow the radiologist to diagnose disease in all parts of the body.
- An MRI does not use radiation like x-rays but uses radiofrequency pulses.



Magnetic Field

- Magnetic field is measured in gauss (G) or Tesla (T) units.
- 1 T = 10,000 G.
- The earth's magnetic field is about 0.5 G (0.00005T).
- Typically an MRI will have field strength between 1.5T and 3T as measured in the center of the MRI.
- So, the magnet is very powerful. A 3T magnet is 60,000 times stronger than the earth's magnetic field (0.5G)
- The MRI's magnetic field strength decreases as you move away from the magnet.
- Outside of the room which houses the MRI, there are no magnetic effects.



Magnetic Field

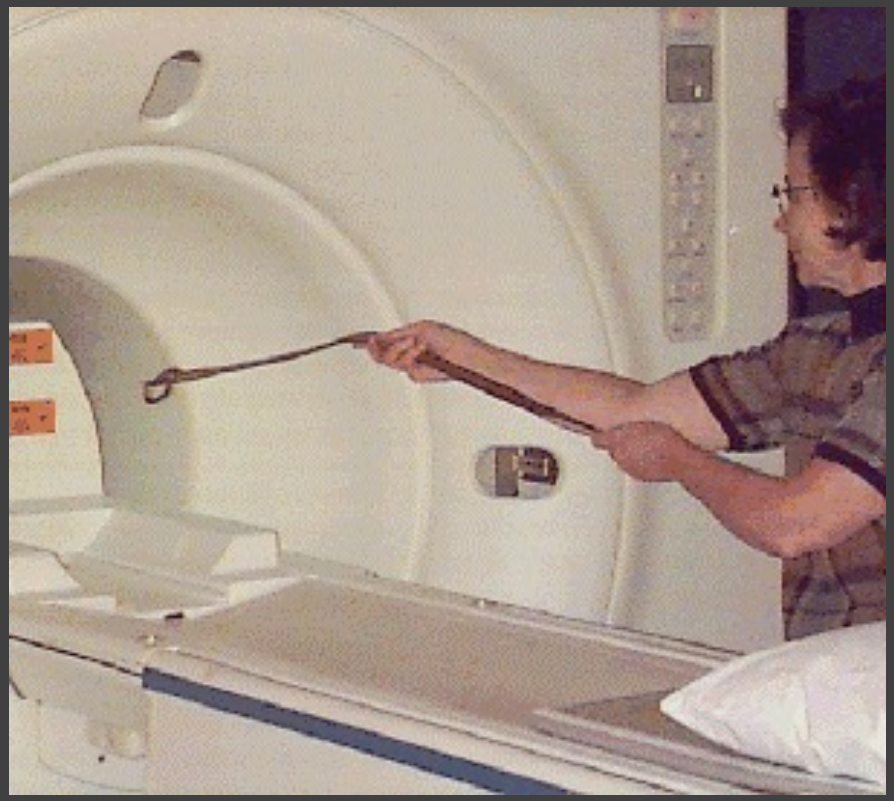
- REMEMBER … THE MAGNET IS ALWAYS ON.
- 24/7, 365 DAYS A YEAR





MRI Hazards

- The magnetic field can draw or pull metallic objects toward it and as such are considered ferromagnetic.
- The more dense the ferromagnetic material, the more it is attracted to the MRI.
- Any item containing ferromagnetic metal (iron, cobalt, nickel, some types of stainless steel) must never be brought anywhere near MRI, especially in room housing the MRI.
- The magnetic field can pull a ferromagnetic object out of someone's hands and propel it into the bore of the MRI as a dangerous projectile, also known as the missile effect.
- So, even small items such as pens, eye glasses, watches, etc., can become dangerous projectiles.



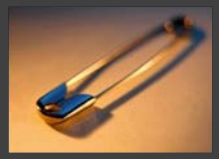
MRI Hazards

- Examples of ferromagnetic objects
  - Paper clips
  - Pens
  - Clipboards
  - Scissors
  - Tool boxes
  - Screwdrivers
  - ladders
  - Hair pins
  - Blood pressure cuffs
  - Flashlights
  - Stethoscopes
  - Keys
  - Thumbtacks
  - Fingernail clippers
  - Some eye glasses
  - Cell phones
  - Fire extinguishers









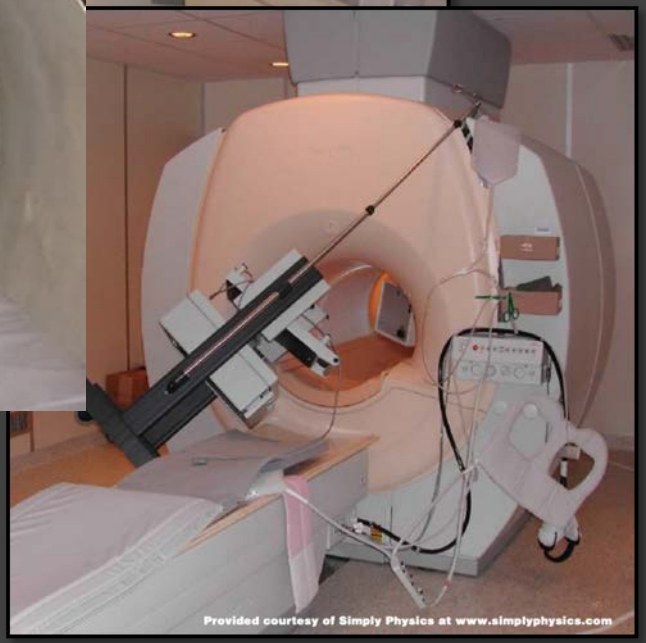
MRI Hazards

- Due to the strength of the magnet, large objects such as chairs, IV poles, cleaning machinery, oxygen tanks, and even axes can become projectiles and get stuck in the magnet



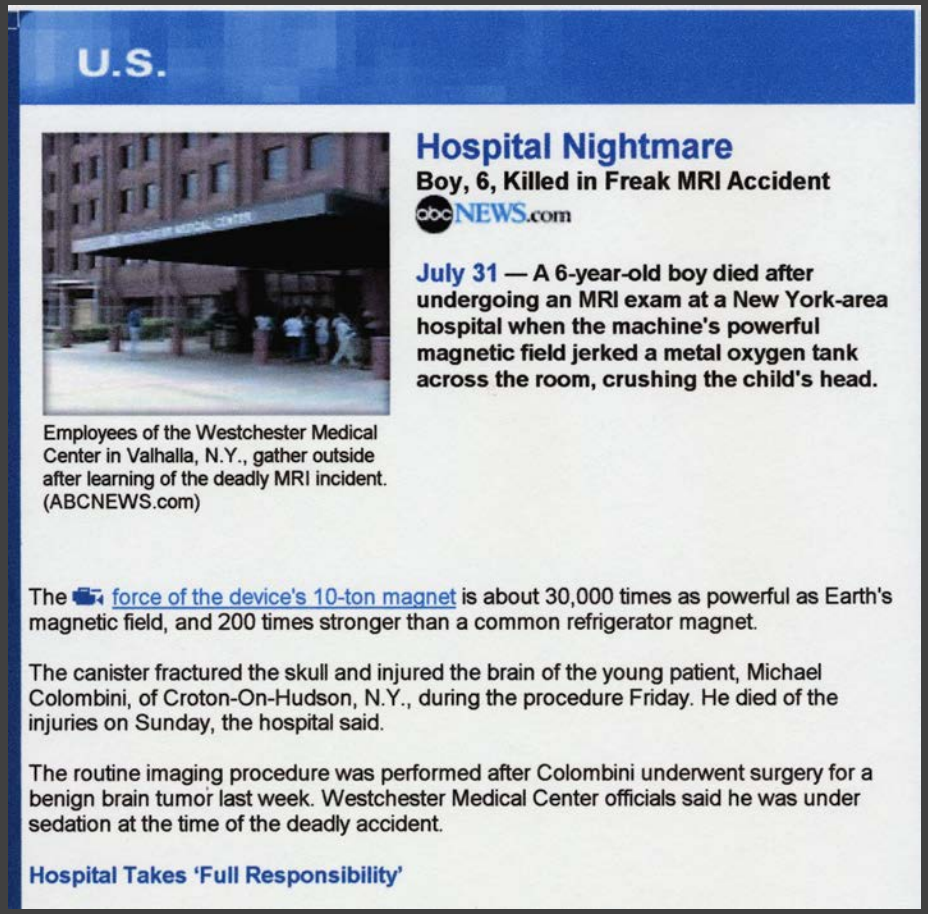






MRI Hazards

- On July 27, 2001, a 6 year old boy was killed when a metal oxygen bottle was pulled into the bore of an MRI.
- The canister fractured his skull.



U.S.

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 benign brain tumor last week. Westchester Medical Center officials said he was under sedation at the time of the deadly accident.

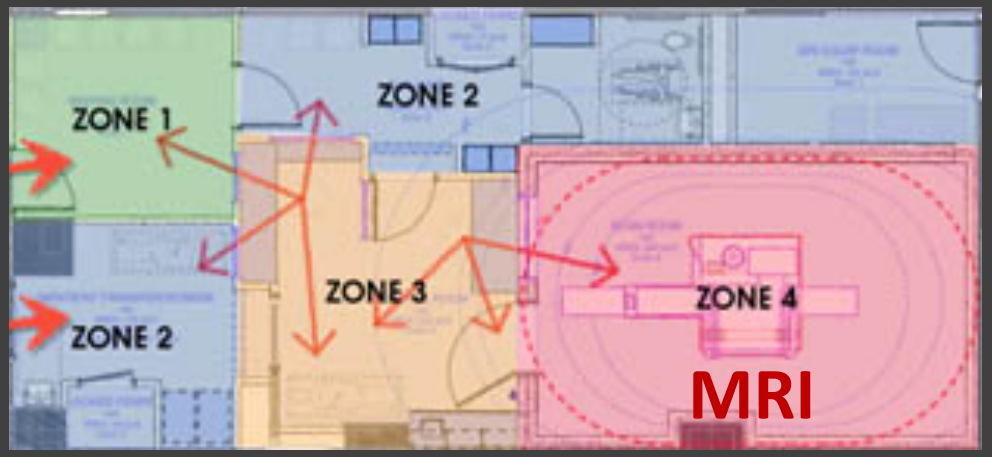
Hospital Takes 'Full Responsibility'

MRI Hazards

- Also, you cannot go into the MRI room if you have …
  - Pacemaker
  - Neurostimulator
  - Internal defibrillator
  - Some Cochlear implants
  - Some Aneurysm clips
  - Metal, shrapnel, or unidentified foreign body near the eye or vital organs

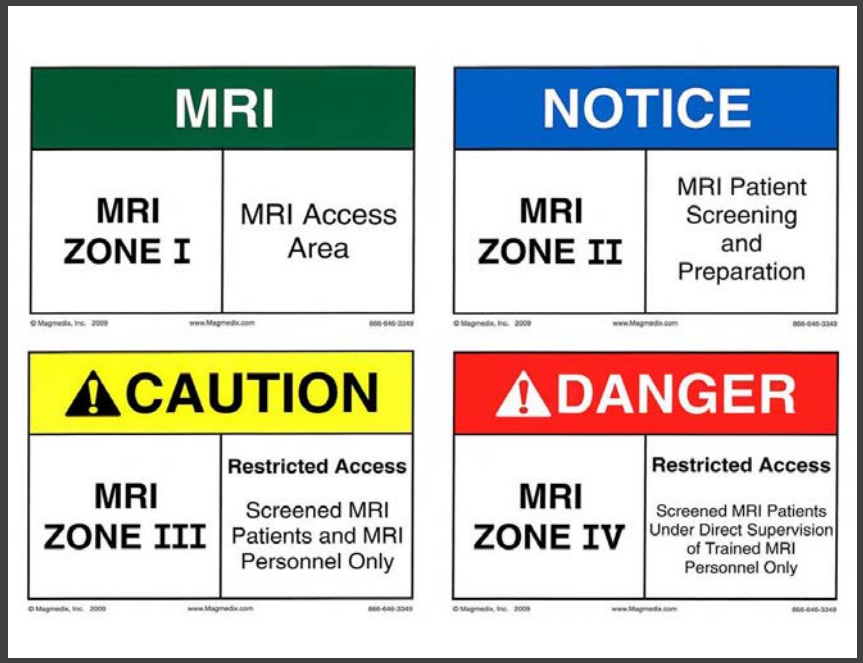
Safety Zones

- The MR imaging environment is divided in 4 distinct, clearly labeled zones which allow for control of access of people in the MRI setting.
- Zones are labeled I through IV.
- There is progressive restriction of entry and increased supervision for higher zones.



Safety Zones

- Zone I: Freely accessible to the general public.
- Zone II: Typically the area where MRI patients are greeted. Acts as an interface between unrestricted areas and Zone III.
- Zone III: Area where free-access by unscreened non-MR personnel or ferromagnetic objects or equipment can result in serous injury or death as a result of interactions between individuals or equipment and the MRI. Access to Zone III is limited to people accompanied by a technologist.
- Zone IV: The MRI scanner room



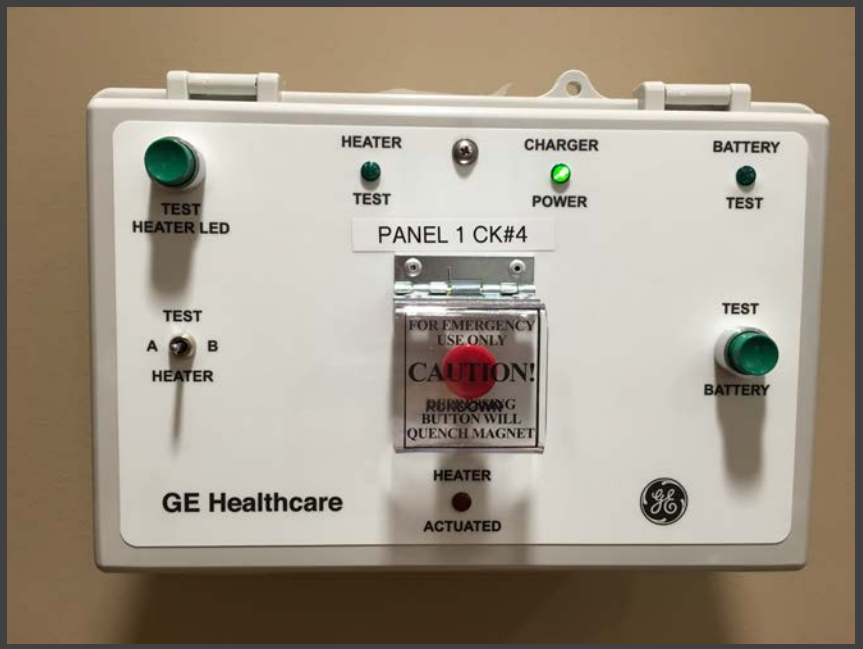
Emergency Shut Off of Power

- Pressing this button will disable electrical power to equipment in the MRI room.
- BUT, it will not shut off the magnetic field of the MRI.
- This button may be pressed for
  - Fire in the computer room
  - Fire, sparks, loud noises emanating from the scan room
  - Flooding or if there is activation of the sprinkler system
  - Catastrophic equipment failure



Quench

- MRI units (magnet) are super-cooled with the inert gas helium (cryogen gas).
- When this gas is boiled off (either intentionally or unintentionally), a quench has occurred.
- Quenching SHUTS OFF THE MAGNETIC FIELD in minutes.
- Quenching a magnet renders it useless so the decision to quench is serious.
- Quenching causes severe damage to the MRI and therefore should only be performed in extreme cases.
- When to quench?
  - When someone is pinned against the magnet by a ferromagnetic object and is being crushed.
  - If there is a fire located in the room housing the MRI.
- For every MRI there is a button to manually quench the magnet which may be found in the control room or in the room with the MRI.



Quench

- Magnet rooms are generally equipped with a quench pipe that is intended to vent this boil-off safely out of the building.
- During a quench, a noise may be heard which is the gas venting to the outside. A plume of helium venting through piping in the roof will be seen from outside.
- However, if the pipe fails, a sudden large volume of helium gas (cryogen gas), resembling fog (therefore reducing visibility), can fill the MR room and act as an asphyxiant, depleting oxygen in the room.
- If the scan room door is closed when a quench occurs and helium escapes into the scan room, the depletion of oxygen causes a critical increase in pressure in the room compared with the control area.
- This produces high pressure in the scan room, which may prevent opening of the door.
- If this should happen, the glass partition between the scan and control rooms should be broken to release the pressure.
- The scan room door can then be opened as usual and the patient evacuated.
- In such a case the patient should be immediately evacuated and evaluated for asphyxia, hypothermia (helium gas is frigid) and ruptured eardrums.



Emergencies

- If a patient needs to be removed from an MRI unit in an emergency, only trained MRI personnel can remove the patient using an MRI compatible backboard, stretcher, wheelchair.
- Once outside the MRI room, the patient may be transferred to the EMS stretcher or brought to a different room to be cared for.
- It is very important to remember not to bring a stretcher which is not MRI safe into the MRI room.
- There are large signs on the MRI room warning people about the serious dangers inside the room.



Emergencies - FIRE

- DO NOT bring any firefighting equipment, such as metallic fire extinguishers, hoses, halligan bars, axes, and portable radios into the magnet room prior to quenching the magnet.
- DO NOT enter the MRI room unless you are completely metal free.
- If the magnet is at full strength, any of these items can be pulled into the machine, damaging the item or the magnet and possibly injuring a person.
- MRI compatible fire extinguishers (Blue or White) are available outside of the MRI room for use on fires inside of the scan room.





Emergencies - Police

- Same precautions apply.
- DO NOT bring any metal into the magnet room prior to quenching the magnet.
- DO NOT enter the MRI room unless you are completely metal free.
- If the magnet is at full strength, any of these items can be pulled into the machine, damaging the item or the magnet and possibly injuring a person.



Case Report

Spontaneous Discharge of a Firearm in an MR Imaging Environment

Anton Oscar Beitia[1], Steven P. Meyers[1], Emanuel Kanal[2], William Bartell[3]

Once the officer was inside the MR suite, the gun was pulled from his hand as he attempted to place the gun on top of a cabinet 3 ft (0.9 m) away from the magnet bore. The gun was immediately pulled into the bore, where it struck the left side and spontaneously discharged a round into the wall of the room at the rear of the magnet. Fortunately, no one was injured. Although the gun struck the magnet bore, only minimal cosmetic damage occurred to the magnet itself. The MR unit had full functional capability immediately after the gun discharged. The weapon's thumb safety was reportedly engaged when the gun discharged.

Emergencies - EMS

- Never bring an automatic electronic defibrillator, a crash cart, or any other medical instrument into the magnet room.
- The instrument might get ruined or become a projectile.
- Every effort should be made to move the patient and all personnel outside zone IV while preliminary resuscitation or stabilization is started.
- Never attempt to resuscitate a patient in the MRI room.



Emergencies – Pinned Person

- If an object pins someone to an MRI machine, determine the severity of the victim's injuries and whether he/she can be removed.
- If the injury is severe or the person's condition deteriorates before the object can be removed, it may be necessary to quench the magnet.
- However, if the object can be safely removed from around the patient without quenching the magnet, that is preferred.



Summary

- The MRI is a powerful magnet.
- THE MAGNET IS ALWAYS ON.
- Ferromagnetic objects have the potential to become projectiles.
- Upon arrival to the facility, emergency personnel should work with the MRI technologist, officer manager, or radiologist during an emergency event.

Summary

- There is a free video available online for your viewing. It is about 6 minutes and specifically addresses first responders.

https://youtu.be/faUBXrJ9PGk