HealthStream Regulatory Script

Radiation and MRI Safety
Release Date: June 2009
HLC Version: 603
Revised: November 2010

Lesson 1: Introduction
Lesson 2: Radiation in the Healthcare Setting
Lesson 3: Radiation Safeguards
Lesson 4: Magnetic Resonance Imaging
Lesson 5: MRI Safeguards
Welcome to the introductory lesson on radiation and MRI safety. This lesson provides the course rationale, goals, and outline.

As your partner, HealthStream strives to provide its customers with excellence in regulatory learning solutions. As new guidelines are continually issued by regulatory agencies, we work to update courses, as needed, in a timely manner. Since responsibility for complying with new guidelines remains with your organization, HealthStream encourages you to routinely check all relevant regulatory agencies directly for the latest updates for clinical/organizational guidelines.

If you have concerns about any aspect of the safety or quality of patient care in your organization, be aware that you may report these concerns directly to The Joint Commission.
Radiation and MRI are used commonly in the healthcare setting. Both procedures involve powerful forms of energy. To avoid injury to you or your patients, you must:

- Have a basic understanding of radiation and MRI
- Understand the risks associated with radiation and MRI exposure
- Know the specific best practices to safeguard against potential dangers
# Course Goals

After completing this course, you should be able to:

- Describe how radiation and MRI are used in the healthcare setting
- List and explain the hazards of radiation and MRI
- Describe safeguards for healthcare staff who work with radiation or radioactive patients
- Detail safeguards for healthcare staff and patients involved in MRI
This lesson gave the course rationale and goals.

Lesson 2 will examine the use of radiation in the healthcare setting.

Lesson 3 will discuss radiation safeguards.

Lesson 4 will describe magnetic resonance imaging.

Lesson 5 will cover MRI safeguards.
# Lesson 2: Radiation in the Healthcare Setting

## Introduction & Objectives

Welcome to the lesson on radiation in the healthcare setting.

After completing this lesson, you should be able to:

- List sources of radiation in the healthcare setting
- Discuss characteristics and hazards of:
  - Unsealed source therapeutic radiation
  - Brachytherapy
  - Nuclear medicine
  - External beam radiation

---

**FLASH ANIMATION: 2001.SWF/FLA**

![Lesson Map]( radiation_in_the_healthcare_setting_map.png )

- Radiation
- Radiation risks
- Radiation sources
Radiation is a powerful form of energy.
In the healthcare setting, this energy may be used to:
- Visualize internal structures of the body
- Diagnose disease
- Treat certain diseases

Procedures using radiation can save a patient's life.

Procedures using radiation can also endanger a patient's life. It can endanger the healthcare worker.
The primary health risk associated with radiation exposure is an increased incidence of cancer.

If radiation increases the risk of cancer, it may seem odd that we use radiation to diagnose and treat disease.

Most procedures expose patients to relatively small doses of radiation. This dose is equal to the amount of radiation a person would naturally receive over a few:
- Weeks
- Months
- Years

Single radiation procedures do not generally pose a significant risk for patients.
A single procedure also poses little risk to healthcare personnel. However, some healthcare personnel perform many radiation procedures. If they do not take appropriate precautions, their long-term exposure to radiation may reach dangerous levels. This can pose significant health risks.
Radiation used to diagnose or treat disease can be divided into four categories:

- Unsealed source therapeutic radiation
- Brachytherapy
- Nuclear medicine
- External radiation beams

Let’s take a closer look at each.
An unsealed source therapeutic radiation procedure is used to treat certain diseases. The patient swallows or is injected with a dosed amount of radioactive material.

Doses of radiation are relatively high.

The radiation used in an unsealed procedure travels all over the patient’s system. It can contaminate all bodily fluids.

Radiation may be eliminated with the patient’s:
- Feces
- Urine
- Perspiration
### Unsealed Source Therapeutic Radiation: Examples

Examples of unsealed source therapeutic radiation include:
- Iodine-131 (I-131) for thyroid disease
- Radioimmunotherapy for cancer

---

**IMAGE: 2007.JPG**

Radiation may be present in the patient's:
- Feces
- Urine
- Perspiration
- Breath (moisture)
- Blood
- Spilled IV fluids
**Gamma particles**
Iodine-131 emits powerful gamma particles. These radioactive particles destroy nearby cells.

Gamma particles are so powerful and energetic that they can pass through the patient's body. They can affect YOU, if you are not shielded.

**Beta particles**
Beta particles are also capable of destroying nearby cells. Beta particles cannot pass through soft tissue. Beta particles cannot exit the patient's body and hit you.

**Remember!**

Beta particles may not be able to pass through soft tissues to exit the patient's body through the skin. All forms of unsealed radiation, however, are carried out of the patient's body with feces, urine, and perspiration. Both gamma radiation and beta particles can hit you if you have direct exposure to contaminated body fluids or excretions.
Brachytherapy is a form of cancer treatment. Small sources of radiation are implanted into the cancerous area of a patient’s body.

The radiation is sealed in a seed. It cannot leak into the patient’s system. The patient’s bodily fluids are *not* contaminated.

Seeds may be implanted on a short-term or long-term basis:
- Short-term implants are referred to as fletcher or syed implants. They are implanted for one to two days.
- Long-term implants are considered permanent.
<table>
<thead>
<tr>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brachytherapy: Uses</td>
</tr>
</tbody>
</table>

Brachytherapy is common in the treatment of prostate cancer. It also may be used in the treatment of other forms of cancer.
Nuclear medicine procedures use radioactivity to examine body anatomy. They can also look at body function.

The patient swallows or is injected with a radioactive tracer. Specific tracers are designed to accumulate in specific organs.

Once in the organ, the tracer emits high-energy gamma particles. As these particles exit the patient's body, they are detected by a gamma camera.

The detected energy is analyzed by a computer.

<table>
<thead>
<tr>
<th>Four Categories of Medical Radiation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Unsealed source therapeutic radiation</td>
</tr>
<tr>
<td>2. Brachytherapy</td>
</tr>
<tr>
<td>3. Nuclear medicine</td>
</tr>
<tr>
<td>4. External radiation beams</td>
</tr>
</tbody>
</table>
Nuclear medicine uses relatively low doses of radiation. However, this radiation is powerful. The radiation is not contained. It may be carried out of the patient’s body with:

- Feces
- Urine
- Perspiration
- Breath (moisture)
- Blood
- Spilled IV fluids

Radiation may be present in the patient’s:

- Feces
- Urine
- Perspiration
- Breath (moisture)
- Blood
- Spilled IV fluids
<table>
<thead>
<tr>
<th>Tracers used in nuclear medicine have short half-lives.</th>
</tr>
</thead>
<tbody>
<tr>
<td>This means that the patient will soon be non-radioactive.</td>
</tr>
<tr>
<td>Treat all of the patient's bodily fluids as potentially radioactive until proven otherwise.</td>
</tr>
</tbody>
</table>
An example of nuclear medicine is positron emission tomography (PET).

For example, a PET scan can be used to examine brain function. Radioactive glucose is used as a tracer.
External beam radiation may be used for diagnosis or treatment.

In these procedures, the patient is exposed to a beam of radiation from an external source. This means that:

- Radioactivity is not administered to the patient.
- The patient does not become radioactive.
- The patient does not contaminate objects or body fluids.
External Radiation Beams: Risks

In external beam procedures:
- The highest dose of radiation comes from the primary beam aimed at the patient.
- Secondary beams may scatter off the patient’s body.

As a healthcare professional, you risk exposure:
- To a high dose of radiation if you are exposed to the primary beam
- To a lower dose of radiation if you are exposed to scattered secondary beams
Common procedures involving external beam radiation include:
- **X-rays**
- **Mammography**
- **Bone densitometry**
- **Computed tomography**
- **Fluoroscopy**
- **External beam radiation therapy**

Click on each item in the list to learn more.

In a simple **X-ray**, a beam of radioactive particles is allowed to pass through the body, to a sheet of highly sensitive film. Structures such as bone absorb the energy of the radioactive particles. They appear white on the film. Other structures allow most of the radioactive particles to pass through. They appear black or gray.

**Mammography** uses low dose x-ray to examine the breasts.

**Bone densitometry** uses an enhanced form of x-ray technology to measure bone mineral density.

**Computed tomography** (CT or CAT scan) is used to obtain x-ray image data from different angles around the body. A computer then processes the data. A cross-section of the body is shown.

**Fluoroscopy** uses x-rays to capture real-time, moving images of organs as they function. This technique also uses a **contrast material**. [glossary]

**External beam radiation therapy** is used to kill cancer cells.
Which of the following are true?
   a. Radiation may be harmful if precautions are not taken.
   b. Radiation is used to treat cancer.
   c. Radiation is used to help diagnose disease.
   d. All of the above

**MULTIPLE CHOICE INTERACTION**

Correct answer: D

Feedback for A: Not quite. All of these statements are true.

Feedback for B: Not quite. All of these statements are true.

Feedback for C: Not quite. All of these statements are true.

Feedback for D: Correct. All of these statements are true.
Complete the table using the words from the word bank.

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Radioactivity Location in Patient</th>
<th>Exposure Hazard for Healthcare Worker</th>
<th>Contamination of the Patient's Body Fluids</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unsealed Source</td>
<td>Throughout the body</td>
<td>Body fluids</td>
<td>Yes</td>
</tr>
<tr>
<td>Brachytherapy</td>
<td>Placed in cancerous area</td>
<td>Radioactive seed</td>
<td>No</td>
</tr>
<tr>
<td>Nuclear Medicine</td>
<td>Accumulated in specific organs</td>
<td>Tracer material and body fluids</td>
<td>Yes</td>
</tr>
<tr>
<td>External Beams</td>
<td>Targeting to cancerous area</td>
<td>Radiation beam</td>
<td>No</td>
</tr>
</tbody>
</table>
You have completed the lesson on radiation in the healthcare setting.

Remember:

- Sources of radiation in the healthcare setting include unsealed source therapeutic radiation, brachytherapy, nuclear medicine, and external beam radiation.
- In an unsealed source procedure, the patient swallows or is injected with radioactive material.
- Brachytherapy involves implantation of small sources of radiation.
- Nuclear medicine uses a radioactive tracer.
- Patients also may be exposed to a beam of radiation from an external source.
- Each procedure may pose a risk to healthcare personnel.
Welcome to the lesson on radiation safeguards.

After completing this lesson, you should be able to:

- Detail the “time, distance, shielding” method of reducing radiation exposure
- Describe general precautions for working with radioactivity and radioactive patients
- Recognize specific precautions for working with patients during and after:
  - Unsealed source therapeutic radiation
  - Brachytherapy
  - Nuclear medicine
  - External beam radiation
You must be trained and qualified to care for radioactive patients.

If you are not trained or qualified, do **NOT** enter patient rooms marked with the yellow-and-maroon radiation sign.

If you care for radioactive patients, you should:
- Limit your exposure to radiation
- Continue to provide quality patient care

This lesson will describe how to limit your exposure to radiation.
The three key factors for limiting your exposure to radiation are time, distance, and shielding:

- Minimize the amount of time that you are exposed to the source
- Maximize the distance between yourself and the source
- Use appropriate shielding to absorb the energy of radioactive particles, and prevent them from hitting YOU

If you use time, distance, and shielding effectively, you will keep your radiation exposure **As Low As Reasonably Achievable (ALARA)**.
In general:
- Try to reduce the amount of time you are exposed to a source of radiation
- Wear gloves and a lab coat at all times when handling radioactive materials or potentially contaminated materials
- Wash hands after removing gloves
- Always work at the greatest distance possible from a source of radiation
- Use shielding whenever possible
- Wear a radiation dosimetry badge to measure your radiation exposure

**Key Thought**

Wear a radiation dosimetry badge between your waist and shoulder at all times when at work, to measure your radiation exposure.

When the badge is collected and analyzed, you will be informed if your radiation exposure has been high.

This can give you the opportunity to correct the problem before you suffer any adverse effects.
Additional General Precautions

Additional general precautions for working with radioactivity include:

- Use a chemical fume hood certified for radioactive materials when preparing tracers or other radiopharmaceutical agents
- Where radioactive materials are present, do not:
  - Eat
  - Drink
  - Smoke
  - Apply cosmetics
- Never store food or drinks in a refrigerator designated for radioactive materials
- Never mouth-pipette radioactive materials
- Dispose of contaminated sharps appropriately

Let's now discuss specific precautions for each type of radiation exposure.
When working with a patient who has received unsealed source therapeutic radiation:

- Wear gloves
- Use shoe covers
- Treat all objects in the patient’s room as potentially contaminated
- Place all waste into radioactive waste bins

Check with your supervisor or radiation safety department regarding other precautions you may need to take.
<table>
<thead>
<tr>
<th>Brachytherapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prostate seeds are very low-level radiation implants. They do not typically require extra precautions.</td>
</tr>
<tr>
<td>Short-term brachytherapy implants are high-energy. They require extra precautions.</td>
</tr>
<tr>
<td>Typical precautions for these implants are listed on the next two screens. These may or may not be fully applicable in your facility. Check with your supervisor or radiation safety department.</td>
</tr>
</tbody>
</table>

**IMAGE: 3007.JPG**
When working with patients who have received high-energy brachytherapy:

- Minimize trips into the patient’s room
- Avoid going completely into the patient’s room, if possible
- Per facility policy, adhere to stay-time restrictions [glossary] posted on the patient’s door and/or listed in the patient’s chart
- Provide patient care from behind a lead shield
- Keep the patient’s door closed

Note

Many of these precautions also may be applicable to patients who have received high-energy (gamma-emitting) unsealed therapeutic radiation. Check with your supervisor or the radiation safety officer.
### High-Energy Brachytherapy: Additional Precautions

<table>
<thead>
<tr>
<th>If a source seed dislodges from the patient’s body:</th>
<th>![Image: 3009.JPG](image: 3009.JPG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pick the source up with forceps, NOT your bare hands</td>
<td><strong>Key Thought</strong></td>
</tr>
<tr>
<td>• Place it in a lead container</td>
<td>Use forceps to pick up dislodged source seeds.</td>
</tr>
</tbody>
</table>
Typical precautions associated with nuclear medicine include:

- Wear gloves at all times when handling radioactive tracers
- Wear gloves during patient contact
- Treat all IV and patient fluids as radioactive until you know they are not
- Consult your supervisor or radiation safety officer regarding where and how to dispose of potentially radioactive fluids
- Store unused tracers in a room separate from work or waiting areas
External beam radiation does not make a patient radioactive. No precautions are necessary for interacting with the patient after the procedure.

**During** a procedure try to:

- Use the shortest exposure time compatible with high-quality patient care
- Minimize the amount of time your hand spends in the active radiation beam during fluoroscopy.
- Leave the room while an x-ray machine or fluoroscopy unit is operating
- Wear a lead apron when working around active x-ray, CT, or fluoroscopy equipment
**Special Precautions: Pregnancy**

Young children and developing fetuses are especially sensitive to the effects of radiation.

Before performing any radiation-based procedure on a female patient, ask if she is or might be pregnant.

If you are pregnant and routinely work with radioactive materials or radiation, consult your supervisor or radiation safety department regarding:

- Any concerns you might have
- Any special precautions you might need to take
<table>
<thead>
<tr>
<th>3013</th>
<th>Radiation Spills</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Do NOT attempt to clean up spills of radioactive materials.</strong></td>
<td></td>
</tr>
<tr>
<td>Immediately contact your supervisor or the radiation safety department.</td>
<td></td>
</tr>
<tr>
<td>Keep all staff and patients away from the area until the clean-up crew arrives.</td>
<td></td>
</tr>
</tbody>
</table>

IMAGE: 3013.JPG

DO NOT attempt to clean up spills of radioactive materials.
### Review

Your radiation dosimetry badge is collected for analysis. Analysis reveals that you have been exposed to unacceptably high levels of occupational radiation. You might have:

- a. Gotten too close to a source of radiation
- b. Spent too much time around radioactive materials
- c. Not used appropriate shielding when working with or around radiation
- d. Any of these

### MULTIPLE CHOICE INTERACTION

Correct answer: D

Feedback for A: Not quite. The correct answer is D. The three key factors for limiting your exposure to radiation are time, distance, and shielding.

Feedback for B: Not quite. The correct answer is D. The three key factors for limiting your exposure to radiation are time, distance, and shielding.

Feedback for C: Not quite. The correct answer is D. The three key factors for limiting your exposure to radiation are time, distance, and shielding.

Feedback for D: Correct. The three key factors for limiting your exposure to radiation are time, distance, and shielding.
<table>
<thead>
<tr>
<th>Fetuses are not sensitive to the effects of radiation because they are shielded by their mother's uterus.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. True</td>
</tr>
<tr>
<td>b. False</td>
</tr>
</tbody>
</table>

**TRUE / FALSE INTERACTION**

Correct answer: B

Feedback for A: Incorrect. Children and fetuses are especially sensitive to the effects of radiation.

Feedback for B: Correct. Children and fetuses are especially sensitive to the effects of radiation.
You have completed the lesson on radiation safeguards. Remember:

- Never enter a radioactive patient room unless trained and qualified to do so.
- The three key factors for limiting your exposure to radiation are time, distance, and shielding.
- Take appropriate precautions when working with patients undergoing radioactive procedures.
- Take appropriate precautions when working around active x-ray, CT, or fluoroscopy equipment.
- If you are pregnant and routinely work with radiation, consult your supervisor or radiation safety department regarding any special precautions you might need to take.
- Report radioactive spills/leakage immediately.
- Wear a radiation dosimetry badge between your waist and shoulders at all times when at work.
Lesson 4: Magnetic Resonance Imaging

Introduction & Objectives

Welcome to the lesson on magnetic resonance imaging (MRI).

After completing this lesson, you should be able to:

- Recall the basic function and use of an MRI system
- Discuss the hazards associated with magnetic resonance imaging
Magnetic resonance imaging (MRI) is a form of imaging. It does not involve ionizing radiation. MRI uses powerful magnetic and radiofrequency [link to glossary] fields.

MRI is a very useful technique. It provides:
- Excellent soft tissue contrast
- Three-dimensional reconstruction of anatomical structures

This course does not cover the specific uses for the MRI, it discusses the hazards associated with this form of imaging.
From 1995 to 2005, 389 reports of MRI-related events (including nine deaths) were reported to the FDA.

In addition, five MRI-related events (four resulting in death) were reported to the Joint Commission's Sentinel Event database.

Most of these injuries resulted from:

- Objects that heat during MRI
- Ferromagnetic objects
- Electronic device malfunction

Let's take a closer look at each on the next screens.

The magnetic fields used in MRI are not harmful. The hazards of MRI relate to its effects on objects and electronic devices in or near the magnetic field.
Burns are the most common patient injury in the MRI suite. During an MRI, burns can result if the patient contacts objects that heat during the procedure.

Objects that can undergo significant heating include:
- Metal implants
- Cables such as ECG leads
- Pulse oximeter sensors
- Metal clamps
- Surgical staples
- Drug delivery patches containing metallic foil
- Safety pins
- Tattoos containing iron oxide pigment

IMAGE: 4004.JPG

Caution: Patients can be burned by objects that heat during the MRI scan.
MRI Risks: Objects That May Heat During the MRI (2)

Greater than 70% of the 389 MRI injuries reported to the FDA were from burns. Wires and leads are the most common objects to cause injury.

Examples of burns resulting from excess heating during an MRI include:
- Burns from an ECG cable
- Extensive burns from an ECG gating cable
- Blistered burns from a pulse oximeter
- Burns from the patient’s body touching the inside of the scanner during the MRI
Injury can result if ferromagnetic objects or electronic devices enter the magnetic field of the MRI system. Metal implants and wires can also cause injury during an MRI procedure.

Ferromagnetic objects:
- Are attracted to the magnet at the center of the MRI system
- Can become dangerous projectiles

Most people do not realize that the magnets in the scanner are always ON. Ferromagnetic objects will be attracted to the magnet even if it is not in use.

Ferromagnetic objects are attracted to the core of the MRI magnet, and may travel toward it at high speeds. Both patients and staff should remove all metal objects before entering the MRI field.

Don’t forget:
- coins
- tape measures
- car and house keys
- pens and pencils
- earrings
- watches and timepieces
Examples of injury resulting from the attraction of ferromagnetic objects include:

- Tearing of soft tissues in the brain due to movement of an aneurysm clip
- Blindness due to movement of metallic fragments in or near the eye
- Injury to a patient when an IV pole slid and struck the patient
- Injury to a patient when scissors were pulled out of a nurse’s hand and struck the patient
- Injury to a technician when steel tines (of a forklift) struck the technician
- Death of a pediatric patient when a metal oxygen tank fractured the patient’s skull

Note: Only equipment, including fire extinguishers and oxygen tanks, that have been tested and approved for use during MRI scans should be used.
An MRI system can disrupt the function of battery-powered equipment and devices.

For example:
- Pacemakers may not function as programmed. Patients with pacemakers have died during, or shortly after, MRI exams.
- Programmable infusion pumps may not function consistently.
- Other devices may suddenly fail to operate.

Hospital staff with pacemakers or other implanted electronic devices also can be affected.
Ferromagnetic objects can become dangerous projectiles when they:

- Interact with gamma rays
- Are bombarded with beta particles.
- Encounter interference.
- Accelerate toward the center of an MRI system.

**MULTIPLE CHOICE INTERACTION**

Correct answer: D

Response for A: Incorrect. A ferromagnetic object is attracted to a magnet. This sort of object can become a dangerous projectile during an MRI procedure. It can accelerate toward the center of the MRI system.

Response for B: Incorrect. A ferromagnetic object is attracted to a magnet. This sort of object can become a dangerous projectile during an MRI procedure. It can accelerate toward the center of the MRI system.

Response for C: Incorrect. A ferromagnetic object is attracted to a magnet. This sort of object can become a dangerous projectile during an MRI procedure. It can accelerate toward the center of the MRI system.

Response for D: Correct. A ferromagnetic object is attracted to a magnet. This sort of object can become a dangerous projectile during an MRI procedure. It can accelerate toward the center of the MRI system.
You have completed the lesson on magnetic resonance imaging.

Remember:

- Magnetic resonance imaging (MRI) is a form of imaging that does not involve ionizing radiation. It uses powerful magnetic and radiofrequency fields.
- MRI provides excellent soft tissue contrast and three-dimensional reconstructions of body structures.
- Injury during an MRI can result from:
  - Heating of objects such as wires and leads
  - Ferromagnetic objects that become projectiles
  - Electronic device malfunction
Welcome to the lesson on MRI safety.

After completing this lesson, you should be able to:

- List MRI safeguards
- Describe a “patient screening” for MRI
MRI Safety: Overview

MRI is very safe as long as precautions are taken.

You must ensure that objects and devices remain outside the strong-magnetic-field area of the MRI system at all times.

Remember, the magnets are always on.

The dangers of MRI have been recognized by:
- The American College of Radiology (ACR)
- The Joint Commission

Both of these organizations have published recommended safeguards for the prevention of accidents and injuries in the MRI suite.

Specific MRI Safeguards

Specific safeguards include:
- Controlling access to the strong-magnetic-field area of the MRI system
- Posting warning signs
- Removal of metallic objects from clothing and pockets prior to entering the area
- Screening of patients prior to MRI
- Proper positioning of patients for MRI
- Using equipment approved for MRI

Let's take a closer look at each of these on the next screens.
Controlling Access

ACR recommends that access to the MRI suite be restricted. There should be four progressive restriction zones:
- Zone I: General public
- Zone II: Unscreened MRI patients
- Zone III: Screened MRI patients and personnel
- Zone IV: Screened MRI patients under constant direct supervision of trained MR personnel

Specially trained staff should accompany patients, visitors, and other untrained staff inside the MRI suite.

The entrances should be:
- Lockable
- Visible to the MRI system operator
Posting Warning Signs

Signs should be posted outside the strong-magnetic-field area.

These signs should warn of the:

- Projectile effect
- Danger to people with pacemakers or other electronic implants
Anyone entering the high-magnetic-field area should first remove items such as:

- Purse, wallet, or money clip
- Credit cards
- Other cards with magnetic stripes
- Hearing aids
- Metal jewelry or watches
- Pens
- Paper clips and safety pins
- Keys and coins
- Hair barrettes/hairpins
Also remove:

- Any article of clothing with metal:
  - Zippers
  - Buttons
  - Snaps
  - Hooks
  - Underwires
  - Threads
- Shoes
- Belt buckles

Visitors and untrained staff members should be screened before entering the high-magnetic-field area.
Thorough Patient Screening

Patients should be screened thoroughly prior to an MRI exam. Two screenings should be performed.

A thorough patient screening/questionnaire should establish:
- The nature of any previous surgeries
- The presence of any implants
- The presence of any foreign metallic bodies or prostheses
- Any special medical conditions
- Any potential exposure to metal fragments

A complete and accurate medical history should be available to the technologist.
MRI cannot be performed if screening reveals:

- An active electronic device in the body:
  - Cardiac pacemaker or internal cardiac defibrillator
  - Cochlear implant
  - Nerve or bone stimulator
- Cerebral aneurysm clip
- Metal fragments in the eyes
- Ferromagnetic foreign bodies
- Any unfamiliar device

**Important!**
Patients are not the only ones at risk. Medical personnel with metallic/electronic implants face the same risks as patients, when they enter the strong-magnetic-field area of an MRI system: device failure and/or soft tissue tearing.
## Patient Screening: Safe Metallic Implants

Some metallic implants may be safe during an MRI procedure. These include:
- Orthopedic hardware
- Extracranial surgical clips
- Staples and wires
- Intravascular stents, coils, and filters
- Dental devices
- Metal heart valves or aneurysm clips implanted after 1996

Check with the device vendor to verify safety before the MRI is performed.

### Important Note

Although generally safe for MRI, these devices might produce artifacts that make it impossible to accurately diagnose disease near the device.
Proper Patient Positioning

To guard against burns, the patient should be:
- Positioned with neither the hands nor the calves touching one another
- Insulated from skin-to-skin contact

In addition, any monitoring leads or cables should be:
- Positioned so that they do not form electrically conductive loops
- Insulated from contact with bare skin

A few notes about patient care during an MRI:
- Manage critically ill patients to assure that their needs are being met during the MRI scan.
- Provide patients with ear plugs to make them more comfortable and protect their hearing.
- Never resuscitate a patient or run a cardio-pulmonary arrest code in the MRI room.
Proper Equipment

Use only equipment and devices that have been approved for use during an MRI scan.

This includes:
- Fire extinguishers
- Oxygen tanks
- Physiologic monitors
- Aneurysm clips
Which of the following items should you remove from your pockets prior to entering the strong-magnetic-field area of an MRI system?

- a. A penny
- b. A safety pin
- c. Your house key
- d. All of these

**MUTIPLE CHOICE INTERACTION**

Correct answer: D

Feedback for A: Not quite. The correct answer is D. Any of these items may be ferromagnetic and should be removed.

Feedback for B: Not quite. The correct answer is D. Any of these items may be ferromagnetic and should be removed.

Feedback for C: Not quite. The correct answer is D. Any of these items may be ferromagnetic and should be removed.

Feedback for D: Correct. Any of these items may be ferromagnetic and should be removed.
You are screening a patient prior to an MRI exam. Each of the following implants may be acceptable if their MRI-safety is verified by the device vendor EXCEPT:

- a. Intravascular stent
- b. Orthodontic braces
- c. Orthopedic hardware
- d. Cerebral aneurysm clip

### MULTIPLE CHOICE INTERACTION

**Correct answer: D**

Feedback for A: Incorrect. The correct answer is D. A cerebral aneurysm clip is more likely to move. Patients with a cerebral aneurysm clip cannot have an MRI procedure.

Feedback for B: Incorrect. The correct answer is D. A cerebral aneurysm clip is more likely to move. Patients with a cerebral aneurysm clip cannot have an MRI procedure.

Feedback for C: Incorrect. The correct answer is D. A cerebral aneurysm clip is more likely to move. Patients with a cerebral aneurysm clip cannot have an MRI procedure.

Feedback for D: Correct. A cerebral aneurysm clip is more likely to move. Patients with a cerebral aneurysm clip cannot have an MRI procedure.
You have completed the lesson on MRI safety.

Remember:

- Access to the strong magnetic-field-area of the MRI system should be limited. Only trained personnel and screened patients/visitors accompanied by trained personnel should be allowed to enter.
- Signs posted outside the strong-magnetic-field area should warn of the projectile effect and danger to electronic devices.
- Anyone entering the strong-magnetic-field area should first remove any metallic object that may be ferromagnetic.
- Patients should be thoroughly screened two times prior to an MRI exam.
- MRI procedures cannot be performed on patients with certain electronic and/or metallic implants.
- Other metallic implants may be safe. Verify their safety with the device vendor.
- Patients and monitoring leads and cables should not form electrically conductive loops.
<table>
<thead>
<tr>
<th>#</th>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Contrast material</td>
<td>a substance that will appear white on x-ray films</td>
</tr>
<tr>
<td></td>
<td>radiofrequency</td>
<td>energy of a certain wavelength in the electromagnetic spectrum</td>
</tr>
<tr>
<td></td>
<td>ferromagnetic</td>
<td>able to be attracted by a magnet</td>
</tr>
<tr>
<td></td>
<td>gradient</td>
<td>growing larger or smaller over space or time</td>
</tr>
<tr>
<td></td>
<td>projectile</td>
<td>an object (as a weapon) that is thrown, sent, or cast forward</td>
</tr>
<tr>
<td></td>
<td>stay-time restriction</td>
<td>limit on the amount of time healthcare staff and visitors can safely remain with a radioactive patient; usually established by the radiation safety department, based on the type and dosage of radiation the patient received</td>
</tr>
<tr>
<td></td>
<td>Ferromagnetic object</td>
<td>An object that is attracted to a magnet</td>
</tr>
</tbody>
</table>
[Radiation and MRI Safety]

Pre-Assessment

1. Which of the following is a source of radiation in the healthcare setting?
   a. Body fluids from a patient treated with external beam radiation
   b. Body fluids from a patient treated with unsealed source radiation
   c. Body fluids from a patient treated with long-term brachytherapy implants
   d. Body fluids from a patient treated with short-term brachytherapy implants

   Correct answer: B
   Rationale: Patient body fluids become contaminated in the case of unsealed source radiation or nuclear medicine. Brachytherapy and external beam radiation do not result in contamination of bodily fluids.

2. You administer therapeutic iodine-131 to a patient. After the patient has taken the I-131 and returned to her room:
   a. Radioactivity will accumulate in her spleen.
   b. You will not need to wear gloves when caring for her.
   c. You should treat all objects in her room as potentially contaminated.
   d. Her eighteen-month-old son will be able to visit her without restriction.

   Correct answer: C
   Rationale: I-131 is an unsealed source, and may be present in any of the patient’s secretions or excretions. Therefore, you should treat all objects in the room as potentially contaminated, and handle them only with gloves.

3. Tracers used in nuclear medicine have short half-lives. This means that:
   a. The radiation in tracers decays rapidly.
   b. The radiation in tracers is not very powerful.
   c. Patients who undergo nuclear medicine procedures never become radioactive.
   d. It is safe to handle the excretions of nuclear-medicine patients as if they are not radioactive.

   Correct Answer: The radiation in tracers decays rapidly.
   Rationale: Tracers used in nuclear medicine have short-half lives. This means that their radioactivity decays rapidly. The patient will soon be non-radioactive.

4. A patient is receiving external beam radiation. You are assisting. Choose the true statement.
   a. The patient's body fluids will become contaminated.
   b. Radioactivity is administered to the patient by mouth.
   c. A long exposure time does not increase the risk of potential problems such as cancer.
d. You are at risk of radiation exposure from both the primary beam and scattered secondary beams.

Correct answer: D
Rationale: The highest dose of radiation comes from the primary beam. Secondary beams also may scatter off the patient’s body and strike nearby caregivers.

5. What are the three key factors for limiting exposure to radiation?
   a. Alerts, alarms, and action
   b. Time, distance, and shielding
   c. Aprons, gloves, and surgical masks
   d. Dosage, monitoring, and intervention

Correct answer: B
Rationale: The three key factors are time, distance, and shielding.

6. What is the purpose of a radiation dosimetry badge?
   a. To identify patients as radioactive.
   b. To measure occupational exposure to radiation.
   c. To identify workers who are qualified to care for radioactive patients.
   d. To determine the proper dose of radiation for a treatment procedure.

Correct answer: B
Rationale: Healthcare personnel who work with radiation should wear a radiation dosimetry badge at all times. It should be placed between the waist and shoulder. The badge measures occupational radiation exposure.

7. When should healthcare workers provide patient care from behind a lead shield?
   a. After a patient has had a mammogram
   b. After a patient has had bone densitometry
   c. After a patient has received high-energy brachytherapy
   d. After a patient has received external beam radiation therapy

Correct answer: C
Rationale: High-energy brachytherapy implants require extra precautions, such as providing patient care from behind a lead shield. The other procedures listed here are all external beam radiation, which does not make the patient radioactive after the procedure.

8. What makes MRI a useful technique?
   a. MRI shows bone density.
   b. MRI uses ionizing radiation.
   c. MRI uses beta and gamma particles.
   d. MRI gives excellent soft-tissue contrast.
Correct answer: D
Rationale: MRI is a very useful technique. It does not use ionizing radiation, and provides excellent soft tissue contrast.

9. Which of the following is a risk during an MRI procedure?
   a. Plastic objects can become dangerous projectiles.
   b. Objects that heat during MRI can cause severe burns.
   c. Exposure to radiation used during MRI increases the risk of cancer later in life.
   d. Exposure to strong magnetic fields used in MRI increases the risk of cancer later in life.

Correct answer: B
Rationale: During an MRI, burns can result if the patient contacts objects that heat during the procedure.

10. You are screening a visitor to the MRI area. Prior to entering the MRI system, you should ask this visitor to remove her:
   a. Cloth shoelaces
   b. Plastic barrettes
   c. Blazer with brass buttons
   d. Necklace made of glass beads

Correct answer: C
Rationale: All clothing with metallic buttons should be removed.

11. Several patients have been screened for MRI. Which patient may proceed with the MRI procedure?
   a. A patient with a cochlear implant
   b. A patient with a cardiac pacemaker
   c. A patient with metal fragments in the eyes
   d. A patient with no history of previous surgeries

Correct: D
Rationale: MRI must not be performed if patient screening reveals a cardiac pacemaker or ICD, cochlear implant, nerve or bone stimulator, cerebral aneurysm clip, metal fragments in the eyes, ferromagnetic foreign bodies, or any unfamiliar device.
Final Exam

1. Which of the following is a source of radiation in the healthcare setting?
   a. X-ray films
   b. Nuclear medicine
   c. Chemical solvents
   d. Patients treated with antibiotics

Correct: B
Rationale: Radiation used to diagnose or treat disease can be divided into four categories: unsealed source radiation, brachytherapy, nuclear medicine, and external beam radiation.

2. A patient has an unsealed source radiation procedure. Which of the following statements is true?
   a. The dose of radiation used is relatively low.
   b. The radiation is administered in the form of an enclosed pellet.
   c. After the procedure, the patient's leftover lunch should be considered radioactive.
   d. After the procedure, radiation accumulates only in a specific organ and remains there.

Correct answer: C
Rationale: These procedures use high doses of radiation. It travels all through the patient's body. All of the objects in the patient's room should be considered radioactive.

3. When should a patient's body fluids be considered radioactive?
   a. After an X-ray
   b. After a CT scan
   c. After high-energy brachytherapy
   d. After a nuclear medicine procedure

Correct answer: D
Rationale: Nuclear medicine uses radiation that is not contained. It may be carried out of the patient's body with feces, urine, perspiration, blood, etc.

4. Which of the following involves external beam radiation?
   a. Fluoroscopy
   b. Brachytherapy
   c. Nuclear medicine
   d. Unsealed source radiation

Correct answer: A
Rationale: Fluoroscopy is an external beam procedure.

5. The three key factors for limiting your exposure to radiation are:
   a. Lead, latex, and lids
   b. Time, distance, and shielding
   c. Care, caution, and containment
   d. Standard, Universal, and Contact Precautions

Correct answer: B
Rationale: The three key factors are time, distance, and shielding.

6. Which of the following is a safe and appropriate way to handle radioactive materials?
   a. Mouth-pipetting radioactive materials
   b. Using a certified chemical fume hood when preparing tracers
   c. Eating lunch in an area where radioactive materials are present
   d. Storing your lunch in a refrigerator designated for radioactive materials

Correct answer: B
Rationale: Use a chemical fume hood certified for radioactive materials when preparing tracers or other radiopharmaceuticals.

7. What should you do if a brachytherapy source seed dislodges from a patient's body?
   a. Place it in a lead container.
   b. Pick it up with a paper towel.
   c. Pick it up with your bare hands.
   d. Place it in a plastic sharps container.

Correct answer: A
Rationale: If a source seed dislodges from a patient's body, pick the source up with forceps, NOT your bare hands. Place the seed in a lead container.

8. Why is MRI a useful technique?
   a. MRI does not have any risks.
   b. MRI uses external beam radiation.
   c. MRI gives good images of soft tissues.
   d. MRI is the best way to see broken bones.

Correct answer: C
Rationale: MRI is a very useful technique, providing excellent soft-tissue contrast without the use of ionizing radiation.

9. Why can an ECG cable be problematic during an MRI?
a. ECG cables can heat up and cause burns.
b. ECG cables can become dangerous projectiles.
c. Magnetic fields can cause ECG cables to electrocute patients.
d. Radiofrequency fields can cause ECG cables to damage the MRI magnet.

Correct: A
Rationale: During an MRI, burns can result if the patient contacts objects that heat during the procedure. Wires and leads are the most common objects to cause injury; for example, ECG cables can heat up and cause burns.

10. What is the danger of a brain aneurysm clip during an MRI?
   a. The clip could interfere with the MRI's radiofrequency fields.
   b. The clip could be melted by the MRI's powerful electromagnet.
   c. The clip could move in the magnetic field and tear brain tissue.
   d. The clip could become radioactive and cause damage to nearby cells.

Correct: C
Rationale: Injury can result if ferromagnetic objects or electronic devices enter the magnetic field of the MRI system. For example, tearing of soft tissues in the brain can happen as a result of movement of an aneurysm clip in the magnetic field.

11. Who should be allowed in zone IV of an MRI area?
   a. The general public
   b. Unscreened MRI patients
   c. Unscreened visitors under the supervision of specially trained staff
   d. Screened MRI patients under constant, direct supervision of trained staff

Correct: D
Rationale: Access to an MRI area should be restricted, with four progressive restriction zones: zone I (general public), zone II (unscreened MRI patients), zone III (screened MRI patients and personnel), zone IV (screened MRI patients under constant, direct supervision of trained personnel).

12. You are screening a patient prior to MRI. Which question would be most useful for identifying MRI risks?
   a. Do you eat a healthy diet?
   b. Have you ever had a CT scan?
   c. Do you have any metal implants?
   d. Are you allergic to any medications?

Correct: C
Rationale: Patients should be screened thoroughly prior to an MRI exam. A thorough screening should establish the presence of any metal implants, among other key items.