HealthStream Regulatory Script

Radiation and MRI Safety

Version: May 2007

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Lesson 2: Radiation in the Healthcare Setting
Lesson 3: Radiation Safeguards
Lesson 4: Magnetic Resonance Imaging
Lesson 5: MRI Safeguards
Lesson 1: Introduction

Introduction

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.

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## Course Rationale

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

![Image: 1002.JPG](IMAGE: 1002.JPG)
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
Lesson 1 provided 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

2001

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
### Radiation

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.

**Mammography**, a common radiological procedure, delivers a radiation dose equivalent to three months of background radiation.
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.

**Healthcare workers who risk exposure to radiation on a regular basis include:**

- Physicians, nurses, and technicians who work in departments such as:
  - Radiology
  - Nuclear medicine
  - Nuclear cardiology
  - Radiation oncology
  - Cardiac catheterization

- Nurses who care for patients who have been treated with radioactive implants or radioactive medications
Radiation Sources

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

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><strong>Brachytherapy: Uses</strong></td>
</tr>
<tr>
<td>Brachytherapy is common in the treatment of prostate cancer.</td>
</tr>
<tr>
<td>It also may be used in the treatment of other forms of cancer.</td>
</tr>
</tbody>
</table>
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.
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>2013</th>
<th>Nuclear Medicine: Half-Life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracers used in nuclear medicine have short half-lives. This means that the patient will soon be non-radioactive. Treat all of the patient's bodily fluids as potentially radioactive until proven otherwise.</td>
<td></td>
</tr>
</tbody>
</table>

![Image: 2013.JPG](image)

Treat all patients' body fluids as potentially radioactive until you know otherwise.
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

![Image: 2016.jpg]
## External Beams: Examples

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.

**CLICK TO REVEAL**

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.
All of the following statements are true EXCEPT:
   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.
### Introduction & Objectives

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

**FLASH ANIMATION: 3001.SWF/FLA**
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)**.
### General Precautions

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.
<table>
<thead>
<tr>
<th>Unsealed Source Therapeutic Radiation: Typical Precautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>When working with a patient who has received unsealed source therapeutic radiation:</td>
</tr>
<tr>
<td>• Wear gloves</td>
</tr>
<tr>
<td>• Use shoe covers</td>
</tr>
<tr>
<td>• Treat all objects in the patient’s room as potentially contaminated</td>
</tr>
<tr>
<td>• Place all waste into radioactive waste bins</td>
</tr>
<tr>
<td>Check with your supervisor or radiation safety department regarding other precautions you may need to take.</td>
</tr>
</tbody>
</table>

**IMAGE: 3006.GIF**

- Use shoe covers.
- Use gloves.
- Dispose of waste properly.
<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>
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.
If a source seed dislodges from the patient’s body:
  - Pick the source up with forceps, NOT your bare hands
  - Place it in a lead container

**Key Thought**

Use forceps to pick up dislodged source seeds.
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
**3013**

Radiation Spills

| Do NOT attempt to clean up spills of radioactive materials. |
| Immediately contact your supervisor or the radiation safety department. |
| Keep all staff and patients away from the area until the clean-up crew arrives. |
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.
Fetuses are not sensitive to the effects of radiation because they are shielded by their mother's uterus.
   a. True
   b. False

**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.
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

FLASH ANIMATION: 4001.SWF/FLA
Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a form of imaging. It does not involve ionizing radiation. MRI uses powerful magnetic and radiofrequency 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.
The magnetic fields used in MRI are not harmful.

The hazards of MRI relate to its effects on ferromagnetic objects and electronic devices.

Photos of an MRI machine and images that it produces.
**MRI: Risks**

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

Electronic devices can malfunction due to interference.

Metal implants or wires can conduct electrical currents resulting in burns.

**Injury during an MRI can result from:**
- Ferromagnetic objects that become projectiles
- Electronic device malfunction
- Electrical currents in metal implants or wires
### MRI Risks: Ferromagnetic objects

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

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**IMAGE: 4005.JPG**

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:

- Earrings
- Pens and pencils
- Coins
- Watches and timepieces
- Tape measures
- Car and house keys
MRI Risks: Electronic Device Malfunction

An MRI system can disrupt the function of a pacemaker. Patients with pacemakers have died during, or shortly after, MRI exams.

Hospital staff with pacemakers or other implanted electronic devices also can be affected.
During an MRI, electrical currents can be induced in:
- Metal implants
- Cables such as ECG leads.

These currents can produce heat, resulting in severe patient burns.
Examples of patient injury caused by electrical currents include:
- Burns from an ECG cable
- Extensive burns from an ECG gating cable
- Blistered burns from a pulse oximeter

**CAUTION**

Electrical currents in metal implants can cause severe burns.
Ferromagnetic objects can become dangerous projectiles when they:

a. Interact with gamma rays
b. Are bombarded with beta particles.
c. Encounter interference.
d. Accelerate toward the center of an MRI system.

<table>
<thead>
<tr>
<th>MULTIPLE CHOICE INTERACTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Correct answer: D</td>
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</tbody>
</table>

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:
  - Ferromagnetic objects that become projectiles
  - Electronic device malfunction
  - Electrical currents in metal implants or wires
Lesson 5: MRI Safety

5001

Introduction & Objectives

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.

<table>
<thead>
<tr>
<th>Key Thought</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI is very safe as long as precautions are taken!</td>
</tr>
</tbody>
</table>
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

Let’s take a closer look at each of these safeguards.
Access to the high-magnetic-field area of the MRI system should be limited to:

- Trained personnel
- Screened patients/visitors accompanied by trained personnel

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
Removal of Metallic Objects

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
Removal of Metallic Objects (Cont.)

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.
Patients should be screened thoroughly prior to an MRI exam.

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
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.
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
- All dental devices
- Metal heart valves or aneurysm clips implanted after 1996

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

**MULTIPLE 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:

- Intravascular stent
- Orthodontic braces
- Orthopedic hardware
- 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 screened thoroughly 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.
## Course Glossary

<table>
<thead>
<tr>
<th>#</th>
<th>Term</th>
<th>Definition</th>
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<tbody>
<tr>
<td></td>
<td>Contrast material</td>
<td>a substance that will appear white on x-ray films</td>
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<tr>
<td></td>
<td>radiofrequency</td>
<td>energy of a certain wavelength in the electromagnetic spectrum</td>
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<tr>
<td></td>
<td>ferromagnetic</td>
<td>able to be attracted by a magnet</td>
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<tr>
<td></td>
<td>gradient</td>
<td>growing larger or smaller over space or time</td>
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<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. All of the following statements are true EXCEPT:
   a. Radiation is used to diagnose and treat disease.
   b. Exposure to radiation can increase the risk of cancer.
   c. All forms of radiation are equally powerful.
   d. All of the above are true.

Correct answer: C
Rationale: Ionizing radiation varies in energy.

2. A metal oxygen tank can be a hazard in an MRI system.
   a. True
   b. False

Correct answer: A
Rationale: In at least one case, a metal oxygen tank has caused a fatality in an MRI system. The tank accelerated toward the center of the MRI magnetic field and struck a pediatric patient, fracturing his skull.

3. You are preparing to administer therapeutic iodine-131 to a patient. While administering the medication, you wear gloves and a lab coat. You work behind a lead shield. After the patient has taken the I-131 and returned to her room:
   a. You will not need to work behind a shield when caring for her.
   b. Radioactivity will accumulate in her liver.
   c. You should treat all objects in her room as contaminated. Handle them only with gloves.
   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.

4. You are assisting during an external beam procedure. You are unshielded. You only risk radiation exposure if you place a part of your body directly in the path of the primary beam.
   a. True
   b. False
Correct answer: B
Rationale: The highest dose of radiation comes from the primary beam. Secondary beams may scatter off the patient’s body and strike nearby caregivers.

5. 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

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

6. Radiation dosimetry badges are used to:
   a. Protect healthcare workers from exposure to radiation.
   b. Identify patients as radioactive.
   c. Identify workers who are qualified to care for radioactive patients.
   d. Measure occupational exposure to radiation.

Correct answer: D
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. Radiation can be especially damaging to:
   a. The elderly
   b. Young children
   c. Females
   d. Diabetics and patients with heart disease

Correct answer: B
Rationale: Young children and fetuses are especially sensitive to the effects of radiation.

8. Which of the following have occurred during an MRI procedure?
   a. Blindness
   b. Cerebral hemorrhage
   c. Pacemaker malfunction
   d. All of these
   e. None of these
Correct answer: D
Rationale: All of these have been documented. Movement of metal objects in the eyes or brain can damage soft tissues. Pacemakers can malfunction.

9. You are screening a visitor to the MRI area. Prior to entering the MRI system, you should ask this visitor to remove her:
   a. Plastic barrettes
   b. Cloth shoelaces
   c. Blazer with brass buttons
   d. Beaded necklace

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

10. Tracers used in nuclear medicine have short half-lives. This means that:
    a. The radiation in tracers decays rapidly.
    b. Patients who undergo nuclear medicine procedures never become radioactive.
    c. It is safe to handle the bodily fluids and excretions of nuclear-medicine patients as if these fluids and excretions are not radioactive.
    d. All of these are true.
    e. None of these is true.

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.
Final Exam

1. MRI uses powerful magnetic and radiofrequency fields to visualize internal structures of the body.
   a. True
   b. False

Correct Answer: True
Rationale: This statement is true.

2. Tracers used in nuclear medicine have short half-lives. This means that:
   a. The radiation in tracers decays rapidly.
   b. Patients who undergo nuclear medicine procedures never become radioactive.
   c. It is safe to handle the bodily fluids and excretions of nuclear-medicine patients as if these fluids and excretions are not radioactive.
   d. All of these are true.
   e. None of these is true.

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.

3. Radiation can be especially damaging to:
   a. The elderly
   b. Young children
   c. Females
   d. Diabetics and patients with heart disease

Correct answer: B
Rationale: Radiation is especially damaging to children and fetuses.

4. The three key factors for limiting your exposure to radiation are:
   a. Time, Dose, Shielding
   b. Beta emitters, Dose, Shielding
   c. Distance, Shielding, Dose
   d. Shielding, Time, Distance
   e. None of these

Correct answer: D
Rationale: The three key factors are time, distance, and shielding.
5. A patient is having an unsealed source therapeutic procedure. Which of the following is(are) true?
   a. The doses of radiation used are relatively low.
   b. Radiation accumulates only in a specific organ and remains there.
   c. A patient’s leftover lunch should be considered radioactive.
   d. All of these statements are true.
   e. None of these statements are true.

Correct answer: C A patient’s leftover lunch should be considered radioactive.
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.

6. _____ radioactive particles destroy nearby cells. They can pass through the patient and hit you.
   a. Beta particles
   b. Gamma particles
   c. Both A and B
   d. Both A and C

Correct answer: B Gamma particles
Rationale: Both beta and gamma particles destroy nearby cells. However, beta particles are not able to exit the patient’s body.

7. Each of the procedures below involves external beam radiation EXCEPT:
   a. X-rays
   b. Mammography
   c. Fluoroscopy
   d. Brachytherapy

Correct answer: D Brachytherapy
Rationale: Brachytherapy involves implanting radioactive seeds into the patient’s body.

8. You are not qualified to care for radioactive patients. You should not enter patient rooms marked with a yellow-and-maroon radiation sign.
   a. True
   b. False

Correct answer: A True
Rationale: You must be trained and qualified to care for radioactive patients. Do not enter rooms with the yellow-and-maroon radiation signs.

9. You may need to take special precautions if:
   a. You are pregnant and assist patients having X-rays.
   b. You have a pacemaker and routinely work with radioactive patients.
c. You are pregnant and may be required to enter the room where MRI procedures are being performed.
d. All of these situations may require special precautions.
e. None of these situations may require special precautions.

Correct answer: A You are pregnant and assist patients having X-rays.
Rationale: Pregnant women may need to take extra precautions against radiation exposure. People with a pacemaker must be careful during MRI procedures. MRI procedures do not pose special health concerns for people. They can cause injury if an object becomes a projectile or a device malfunctions.

10. You find a spill outside of a radioactive patient room. You should:
   a. Not attempt to clean-up the spill
   b. Keep staff and patients away from the area
   c. Contact your supervisor or radiation safety department
   d. All of the above
   e. None of the above

Correct answer: D All of the above
Rationale: Do not clean-up potentially radioactive spills. Contact your supervisor or radiation safety department. Keep staff and staff away from the area until a clean-up crew arrives.

11. All of the following statements are true EXCEPT:
   a. Radiation is used to diagnose and treat disease.
   b. Exposure to radiation can increase the risk of cancer.
   c. All forms of radiation are equally powerful.
   d. All of the above are true.

Correct answer: C
Rationale: Ionizing radiation varies in energy. Gamma radiation, for example, has very high energy. Beta particles are less energetic, and cannot travel as far through solid materials.