Radiation safety, oncology

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Introduction

Radiation safety protects health care workers from exposure while caring for patients with cancer who are receiving certain types of radiation therapy. Health care workers must collaborate closely with their facility's radiation safety officer to minimize radiation exposure. The U.S. Nuclear Regulatory Commission and state radiation regulatory agencies have devised radiation protection standards and regulations to outline the necessary precautions.

Radiation safety relies on the principle—commonly referred to as *ALARA* (the acronym for "as low as reasonably achievable")—that everything possible should be done to minimize radiation exposure. Radiation safety also follows three basic concepts: time, distance, and shielding.[1][2][3] (See *Time, distance, and shielding*.)

TIME, DISTANCE, AND SHIELDING
Radiation safety relies on three basic concepts—time, distance, and shielding—to protect health care workers from radiation exposure.[4][5] **Time—**The amount of radiation exposure depends on how much time a person spends near a source of radiation, so you should limit the amount of time you spend near any radioactive source.[4][5] **Distance—**Because the distance from a radiation source determines a person's exposure risk, you should maximize the space between you and the radiation source. As a rule, if you double your distance from the source, you reduce your exposure fourfold.[4][5] **Shielding—**The greater the shielding from a radiation source, the smaller the exposure. Shielding is something that's between you and the radiation source that will absorb radiation; however, using another person to absorb the radiation doesn't constitute shielding. The amount of shielding necessary depends on the length of radiation exposure and the amount of energy the radiation source has.[4]

Radiation therapy kills cancer cells using a radiation source. When used to treat cancer, radiation may be delivered using an implant of encapsulated radioactive material that's placed near the cancer cells (brachytherapy), using a radiation beam that's delivered by an external radiation machine, or using a radioactive compound administered orally or IV (radioimmunotherapy).[6]

Each radionuclide emits radiation in the form of particles, rays, or both, with energies specific to the radionuclide. When emitted, alpha particles have poor penetrating ability; a sheet of paper or a distance of 5 cm from the radiation source is adequate protection. The skin of a patient irradiated with alpha radiation is adequate protection for some; however, contact with body fluids may be

hazardous. Beta particles have greater penetrating abilities than alpha particles but, like alpha particles, they aren't an external hazard. When a patient receives therapy that emits beta particles, the patient's skin or thick plastic shielding is adequate protection against these particles; however, the patient's body fluids are temporarily radioactive after administration of the agent. Gamma rays are high-energy-emitting radionuclides. Protection from these rays requires time, distance, and shielding. Iodine-131 emits high-energy beta particles and gamma rays, so special precautions are necessary; these precautions include time, distance, and shielding practices.[5]

Equipment

- Personal protective equipment according to the type of radiation used (lead shield or apron, heavy gown, gloves)[4][7]
- Radiation dosimeter badge or pocket dosimeter
- RADIATION PRECAUTION sign
- Optional: lead-shielded canister, long-handled forceps, plastic-backed pad for toilet

Preparation of Equipment

Inspect all equipment and supplies. If a product is expired, is defective, or has compromised integrity, remove it from patient use, label it as expired or defective, and report the expiration or defect as directed by your facility.

Implementation

- Review the patient's medical record for the type of radiation used.
- Place a RADIATION PRECAUTION sign on the patient's room door.
- Wear your personally assigned radiation dosimeter whenever a radiation source is present as directed by your facility and as required by regulatory agencies *to know your level of radiation exposure and to be aware when your level is nearing the recommended maximum.*[1][2][3] Wear the dosimeter between your waist and collar in a consistent location. Each person caring for a patient receiving radiation therapy should be assigned a dosimeter badge or pocket dosimeter that's worn only in the work environment, changed when deemed necessary by the facility, and not shared with anyone.
- Perform hand hygiene.[8][9][10][11][12][13]
- Put on personal protective equipment according to the type of radiation used.[1][5]
- Use the principles of time, distance, and shielding *to prevent short- and long-term effects of radiation exposure.*[1][4][5]
- Provide necessary patient care, but try to minimize the time you spend with the patient.[14] Work no closer to the patient than needed.
- Keep the patient's room door closed at all times.
- Explain all procedures to the patient and family (if appropriate) according to their individual communication and learning needs *to increase their understanding, allay their fears, and enhance cooperation.*[15] Answer any questions.
- If the patient received a radiation implant, provide care from the side opposite the implant or from a position that allows you the greatest distance from the patient.
- If an implant becomes dislodged, notify the radiation oncology department and follow the department's instructions. Typically, a dislodged implant is collected with long-handled forceps and placed in a lead-shielded canister.
- If a patient received radioimmunotherapy, follow standard precautions when handling the patient's body fluids, including sweat, saliva, urine, feces, blood, semen, and vaginal

fluid.[5][16][17][18]

- If body fluids are present on the linens of a patient who received radioimmunotherapy, use standard precautions when handling them.[5][16][17][18]
- Keep all linens in the patient's room until they've been scanned and cleared by the radiation safety officer or nuclear pharmacist.[5]
- Instruct the patient to sit down when urinating and to flush the toilet with the lid down. When a lid isn't present, consider covering the open toilet with a plastic-backed pad *to prevent splashing while flushing.* Suggest that the patient also double-flush after using the toilet. *Although research is insufficient, double-flushing might help to reduce contamination, especially with low-volume-per-flush toilets.*[5]
- If a radioactive spill or contamination with the body fluids of a patient recently treated with a radioactive material occurs, restrict access to the area and contact the radiation safety officer. Don't attempt to clean the area.[5]
- Remove and discard your personal protective equipment in appropriate receptacles.[5]
- Perform hand hygiene.[8][9][10][11][12][13]
- Document the procedure.[19][20][21][22]

Special Considerations

- The patient's room should be regularly monitored by the radiation safety officer using a Geiger counter, which reacts to the presence of ionizing particles. The radiation safety officer should test the room, linens, and waste before the room is cleaned after the treatment regimen is complete.[5]
- Use communication devices, such as an intercom or a telephone, to frequently check on the patient while limiting exposure to radioactive material.
- If the patient must be moved out of the room, notify the appropriate department of the patient's status *to give receiving personnel time to make appropriate preparations to receive the patient.* When moving a patient, ensure that the route is clear of equipment and other people and that the elevator (if present) is keyed and ready to receive the patient. Move the patient in a bed or wheelchair accompanied by two caregivers equipped with badges. If the patient is delayed along the way, stand as far away from the bed or wheelchair as possible until you can continue.
- Be aware that orthopedic strain can occur when you wear a lead apron for a prolonged period.[23][24]
- Note that nurses and visitors who are pregnant or trying to conceive or father a child shouldn't care for patients receiving radiation implant therapy *because the gonads and a developing embryo or fetus are highly susceptible to the damaging effects of ionizing radiation.*[14]

Complications

Complications associated with improper radiation safety practices may include:

- radiation exposure.

Documentation

Documentation associated with radiation safety includes:

- precautions taken
- teaching provided to the patient and family (if appropriate)

- understanding of that teaching
- follow-up teaching needed.

Related Procedures

- Perirectal cellulitis management, oncology
- Radiation therapy, external
- Skin care during radiation therapy

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(Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions)

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Rating System for the Hierarchy of Evidence for Intervention/Treatment Questions

The following leveling system is adapted from *Evidence-Based practice in nursing & healthcare: A guide to best practice,* Fifth edition, by Bernadette Mazurek Melnyk and Ellen Fineout-Overholt (2023).

Level I	Evidence from a systematic review or meta-analysis of all relevant randomized controlled trials (RCTs)
Level II	Evidence from well-designed single RCTs (experimental)
Level III	Evidence from well-designed nonrandomized controlled trials (quasi-experimental), systematic reviews of a complete body of evidence, and intervention studies using mixed methods
Level IV	Evidence from well-designed case-control and cohort studies (observational)
Level V	Evidence from systematic reviews of qualitative and descriptive studies

Level VI	Evidence from single descriptive and qualitative studies, evidence-based practice implementation, and quality improvement projects
Level VII	Evidence from expert opinion, expert committee reports, and literature reviews

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