Radiation Safety in Nursing

From NCRP Report #105

Radiation Protection for Medical and Allied Health Personnel
Introduction

- Effective radiation safety practices will keep exposures to medical personnel to a minimum.
- Nurses shall be aware of radiation safety policies regarding their specific work assignments.
Topics of Discussion

- Diagnostic X-ray Procedures
- Diagnostic Nuclear Medicine Studies
- Therapeutic Radiation
  Types of Therapy
  Patient Cooperation
  Identification of Patient
- Employee Restrictions
- Visitor Restrictions
- Additional Precautions
Diagnostic X-Ray Procedures

No individual medical employee should be assigned routinely to hold patients during diagnostic radiology procedures.

Reasonable protection for nurses during these procedures will be maintained provided they:

- Remain at least 2m (6 ft.) from the x-ray beam.
- Wear a leaded apron and gloves when holding a patient or when it is necessary for you to remain closer than 2m (6 ft.) from the beam.
- Hold patient only infrequently.
- Should not hold patients if you are pregnant.
- Where there are frequent portable x-rays being done, staff should wear a film badge.
Diagnostic Nuclear Medicine Studies

- Patients undergoing nuclear medicine studies receive a small amount of a radionuclide.
- The radionuclide used, its activity level and any special precautions should be identified in the patient’s chart.
- There are several factors which influence the exposure rate around the patient.
- Nursing care of these patients seldom requires very close proximity to the patient therefore doses should be minimal.
- Patient care need not be restricted for pregnant nurses.
- Exposure to other patients sharing a room would be minimal.
- Nurses should wear disposable gloves when handling patient’s body fluids.
Radiation is a common treatment for malignant disease. There are three main modes of treatment:

1. External radiation (high energy x-rays and electrons).
2. Permanent or temporary sealed (encapsulated) radionuclides (Sc-137, Ir-192, I-125)
3. Unsealed radionuclides (I-131, Sr-89)
Therapeutic Radiation

- **Types of Therapy**

  Low dose brachytherapy (Ir-192, Cs-137). Applications are placed into a body cavity (intracavitary) or by placing catheters into the tissue (interstially).
  - Placement of applicator or catheter is verified by x-rays.
  - The radioactive source is loaded into the applicators when patient is in his/her room.
  - The patient is hospitalized for 2-3 days.

  High dose rate brachytherapy. The radiation sources are remotely loaded into the applicators or catheters using a computerized system.
  - The source remains in the patient for 20-30 minutes,
  - The patient may return to their room if they are an in-patient or go home if an out-patient.
  - The patient is not radioactive and precautions do not need to be maintained.
Therapeutic Radiation (cont.)

- Types of Therapy (cont.)

Iodine-125 Implant (long term). A permanent interstitial implant which delivers a therapeutic dose of radiation therapy to accessible tumors, such as lung, prostate, head and neck, and rectum. The seeds are placed within the tumor during an operative procedure.

Iodine-131. The treatment of thyroid carcinoma with radioiodine is directed toward the control of metastatic foci and palliation of patients with thyroid carcinoma. The selection of patients for radioiodine therapy necessitates a search for tumors that are likely to develop efficient radioiodine uptake. Capsules of Iodine-131 are administered orally while the patient is confined to a private room

Strontium-89. Intractable pain in patients with bone metastases secondary to breast, lung, prostate, etc. and active uptake in the lesions on bone scan. An intravenous line with normal saline solution will be started and the patient will be given an infusion of Strontium-89 Chloride through the intravenous line over a five-minute period.
Patient Cooperation

Prior to treatment with radionuclides, the patient should be given careful explanation as to the nature of the treatment and the procedures involved. Patient cooperation is very important in minimizing unnecessary incidents and exposure. The need for restricting close contact time and limitations for visitors should be explained.
Therapeutic Radiation (cont.)

- **Identification of Patient**
  - Iodine-125, Strontium-89. No radiation warning signs are necessary.
  - Iridium-192, Cesium-137, Iodine-131. A “CAUTION RADIOACTIVE MATERIALS” sign shall be attached to the cover of, or in the patient’s chart. A “CAUTION- RADIOACTIVE AREA” label shall be attached to patient’s door and a yellow “RADIOACTIVE PRECAUTIONS” label to the patient’s wrist. Information about the radionuclide, its activity, and the exposure rate at 1 meter (plus additional distances for Iodine-131), plus length of treatment (for Iridium 192 and Cesium-137) shall be displayed either on the patient chart or on the wall next to the patient’s room.
Employee Restrictions (CS-137, IR-192, I-131)

Limitations for close contact for nursing and M.D. personnel will be posed when in effect. Other hospital personnel (e.g. dietary, aides, housekeeping) are instructed not to enter the room except when permitted by the Radiation Safety Officer and under the supervision of the head nurse and then only briefly.
Visitor Restrictions (CS-137, IR-192, I-131)

Visitor restrictions are determined by the RSO or the Radiation Oncology Physicist and will be posted. When permitted visitors are to remain as far as possible from the patient.
Additional Precautions

- Iodine-125
  - Patients may be placed in a semi-private room.
  - Film badges are not needed except in special circumstances to be determined by the Radiation Safety Officer.
  - Pregnant women must not care for these patients.
  - If there are any restrictions on the time or proximity of contact with patient, the physics staff will provide information according for each case. Otherwise it should be assumed that there are no restrictions.
  - If a seed becomes dislodged while the patient is in the hospital, pick up the seed with forceps and place it in a container of water then notify the Radiation Safety Officer.
- There are no limitations on visitors
- There is no contamination of body fluids
- Private duty nurses must check with the charge nurse and review the procedure before going to the patient’s room
Therapeutic Radiation (cont.)

- Additional Precautions (cont.)
  - Strontium-89
    The radiation levels outside the patient’s body are minimal; therefore, no radiation signs are necessary either on the patient’s door or the patient’s chart.
    - Film badges for personnel to wear are also not required. The patient may receive visitors.
    - The patient should be instructed to dispose of urine by flushing twice.
    - If the patient is incontinent, an in-dwelling catheter must be placed prior to the infusion therapy and must be kept for the first week. The urinary bag should be emptied frequently and the toilet should be flushed twice.

Patient’s bed sheets and diapers that are contaminated with urine and feces should be placed in a red bag. The Radiation Safety Office should be notified immediately for the proper storage of the bag.
Addition Precautions (cont.)

- Iridium-192 and Cesium-137
  - Patient shall be placed in a private end-room
  - Staff must wear film badge to measure radioactivity when caring for patient.
  - Pregnant women must not care for patients with radioactive sources. Any suspicion that the source has moved in any way is reported to Radiation Oncology.

- Iodine-131
  - Patient shall be placed in a private end-room. Staff must wear film badge when caring for patient.
  - Pregnant women must not care for patient
  - Patient will void in the toilet and be instructed to flush 2-3 times. Excess sputum should be collected for Radiation Safety Officer.
  - If vomiting or urinary incontinence occurs within 8 hours after oral administration, contact the Radiation Safety Officer. In the interim, handle all contaminated material with rubber gloves. Pregnant women and children are not allowed to visit the patient. Disposable utensils will be used for the first 24 hours. They will be monitored by the Radiation Safety Officer and removed for either storage or disposal.
Types of Radiation Used in Medicine

X-Rays → X-Ray Machine

Radioactive Materials:
- Alpha ($\alpha$) Particles
- Beta ($\beta^{-}$) Particles
- Gamma ($\gamma$) Rays
Photons

Electromagnetic Radiation

packets of pure energy like light

x-rays and gamma rays are forms of photon radiation
The Electromagnetic Energy Spectrum

Ionizing
- Cosmic
- X-rays
- γ-rays

Non-Ionizing
- UV, Visible, IR
- Heat
- Microwaves
- Radiowaves

High Energy

Low Energy
Radioactive Materials

solids, liquids or gases composed of unstable atoms that emit photon and/or particle radiation
Photon Radiation
X-Rays and Gamma ($\gamma$) Rays

- X-rays and $\gamma$-rays are identical except for their origin.
- Both are forms of penetrating light.
- Penetrating ability dependent upon energy.
- Best shielding: sufficiently thick lead.
Important Points to Remember

- Radiation producing machines produce radiation only when they are turned on.
- Radioactive sources emit radiation continuously.
- To reduce radiation exposure to yourself and others, use
  
  Time
  Distance
  Appropriate Shielding
Radiation Measuring Units

Roentgens, Rad, Grays, Rem and Sieverts
Exposure

A measure of the amount of radiation to which one has been exposed.

**Units:** Roentgens (R) or milliroentgens (mR)
Absorbed Dose

- Accounts for the fact that the body does not absorb all the radiation to which it is exposed.
  - Units: Rads or Grays
    - (1 Gray = 100 Rads)
Dose Equivalent

- Accounts for the fact that certain types of radiation are more biologically damaging than others

- Units: Rems or Sieverts (Sv)
Radiation Encountered

For 99% of the radiation encountered in medicine,

1R = 1 Rad = 1 Rem
Occupational Dose Limits

- Federal & State Regulations
Legal Classifications of Individuals

I. Occupationally Exposed Individuals
   (e.g., radiologists, x-ray and nuclear medicine technologists, radiation therapists, oncology ward nurses, certain research technicians, etc.)

II. General Public
   (e.g., hospital visitors, security, maintenance, environmental services, non-occupationally exposed nursing staff, patient escorts, etc.)
Annual Dose Limits

Occupationally Exposed Individuals

- **whole body**: 5rem (5000 mrem or 50 mSv*)
- **lens of the eye**: 15rem (15,000 mrem or 150 mSv)
- **hands**: 50rem (50,000 mrem or 500 mSv)
- **forearms**: 50rem (50,000 mrem or 500 mSv)
- **gonads**: 50rem (50,000 mrem or 500 mSv)

* mSv = milliSieverts
1 mSv = 100 mrem
Annual Dose Limits (cont)

- **General Public**
  Annual dose limit (continuous or frequent)
  - **0.1rem** (100mrem or 1mSv)
  Annual dose limit (infrequent)
  - **0.5rem** (500mrem or 5mSv)

- **Dose to Embryo-Fetus**
  - **0.5rem** (500mrem or 5mSv)
  *(evenly distributed over the gestation period)*
Methods to Reduce Exposure From Any Radiation Source

- Reduce your **TIME** spent near radiation sources.
- Increase **DISTANCE** between you and the radiation source.
- Use appropriate **SHIELDING** when available and when practical.
Measuring Your Occupational Dose

Film Badges, TLDs, Bioassays, Film Badge Reports
Who Should Be Monitored??

- “Each licensee shall monitor exposures to radiation...and require the use of individual monitoring devices by adults likely to receive, in 1 year, from external sources, a dose in excess of 10% of the limits.”
- (0.1 x 5 rem or 500 mrem)
- -10CFR20 (§1502)
Who Should Be Monitored?

- “.....declared pregnant women likely to receive, in 1 year, from external sources, a dose in excess of the applicable limits.”

- (.1 x 0.5 rem or 50 mrem)

- 10CFR20 (§1502)
To Assure Accurate Readings with Film Badges

- wear badge at sternum level
- keep badge away from heat sources
- store badge away from radiation sources
- do not wear your badge when having personal medical or dental x-rays
- notify your Radiation Safety Officer (RSO) if anything unusual happens to your badge
- only wear the film badge assigned to you
- assigned badges should be worn at only one institution
How am I informed of my radiation exposure?
# The Film Badge Report

<table>
<thead>
<tr>
<th>Name</th>
<th>Participant Number</th>
<th>Type Of Record</th>
<th>Notes</th>
<th>Radiation Quality</th>
<th>Accumulated Dose Equivalent (MREM) For Periods Shown Below</th>
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<th>Quality Control Release</th>
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Film Badge Exposures

Whenever you have questions regarding radiation safety or your radiation exposure

Contact your Radiation Safety Officer (RSO)!
Topic VII

Radiation Bioeffects

A Dose Comparison
Radiation induced bioeffects were first noted in early radiologists and scientists investigating properties of radiation.
Effects Noted

- erythema
  (i.e., skin-reddening)
- necrosis of exposed tissue
- eye irritation
- increased incidence of cancer
  (e.g., leukemia)
At what radiation dose levels do these bioeffects occur?

- > 100 rads acute exposure (100,000 mrads)
- Rad techs typically < 100 mrads per year
- Nursing typically much less
## Comparative Radiation Doses

<table>
<thead>
<tr>
<th>Activity</th>
<th>Annual Normal Background</th>
<th>6,000 miles by jet</th>
<th>Chest X-ray</th>
<th>CT Chest Exam</th>
<th>Lower GI Exam</th>
<th>$^{201}$TI Cardiac Study</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>~ 300 mrem (3 mSv)</td>
<td>~ 4 mrem (0.04 mSv)</td>
<td>~ 50 mrem (0.5 mSv)</td>
<td>~ 800 mrem (8 mSv)</td>
<td>~ 800 mrem (8 mSv)</td>
<td>~ 1800 mrem (18 mSv)</td>
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</table>

### Typical Average Monthly Doses:

<table>
<thead>
<tr>
<th>Profession</th>
<th>Dose</th>
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<tbody>
<tr>
<td>Radiological Technologist</td>
<td>~ 10 mrem/month</td>
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<tr>
<td>Nuclear Medicine Technologist</td>
<td>~ 25 mrem/month</td>
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<tr>
<td>Brachytherapy Technologist</td>
<td>minimal (&lt;10 rem/month)</td>
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<tr>
<td>Radiation Therapy Nurse</td>
<td>minimal (&lt;10 mrem/month)</td>
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<tr>
<td>Radiation Safety Personnel</td>
<td>~ 20 mrem/month</td>
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</tbody>
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Maximum Dose received by medical personnel treating radiation accident victims (excluding Chernobyl): ~ <75 mrem
If you are assigned a film badge or TLD body badge

- Review film badge reports regularly (e.g., monthly or quarterly)
- Review daily work habits as necessary to reduce one’s radiation exposure using time, distance, and appropriate shielding
- Direct specific questions to your Radiation Safety Officer
Special Consideration

The pregnant or potentially pregnant radiation worker
Current Federal Regulations

State that an employer is not required to take other than normal precautions with a pregnant radiation worker until the worker voluntarily:

- notifies the employer \textit{in writing} of her pregnancy, and
- the estimated date of conception
At that time she becomes

*a declared pregnant woman*
Dose Equivalent Limits

- **0.5 rem (5 mSv) to the fetus** during the gestation period
- **Monthly limit:** 0.05 rem (0.5 mSv)
Precautionary Measures Which May Be Taken to Reduce Fetal Exposure

- work in *low* or no radiation areas
- utilize *appropriate shielding* if available and *practical*
- do not work directly with patients containing radiation sources
- *limit time* spent in radiation areas
As always, any questions should be directed to your Radiation Safety Officer
Topic VIII

Radiation Warning Labels
What Do They Mean?
Radiation Warning Labels
What Do They Mean?
- Found on entrances to work areas
- Indicates the potential presence of radiation sources and/or contamination
- Ingestion of food or drink is strictly prohibited in these areas
- No smoking or application of cosmetics is allowed in these areas
- Indicates the presence of *higher* radiation levels

- Dose Rate > 5 mr/hr up to 100 mr/hr

- More likely to be found in radiation therapy, radiology, or nuclear medicine departments
Each of the signs designates entrance into a Restricted Area.
Restricted Area

- **Areas** are rooms, labs, waste storage areas, etc.

- **Access is restricted** to individuals who work in those areas.
Signs Regarding Patients and Patient Rooms

- indicates an on-going therapy
- indicates the presence of possible contamination and/or radiation exposure
■ indicates the necessity of protective clothing to protect against contamination
indicates to nurses and housekeeping staff that items within the room must be properly surveyed before removal to avoid contamination or lost sources
Other Important Signs

Emergency Procedure Form

- indicates what to do in case of a radiological emergency
- indicates who to contact for assistance
Radiation Protection
Procedures for
Entering or Exiting
Isolation Rooms

- describes proper technique for minimizing contamination
- proper operation of survey instrumentation
- indicates who to call for assistance

TO ENTER ROOM:
- Put on 2 pairs of shoe covers
- Put on 1 pair of shoe covers
- Put on 1 disposable isolation gown
- Put on 2 pairs of disposable gloves
- Put on 1 pair of disposable gloves
- Put on 1 surgical mask

TO EXIT ROOM:
- Remove 1 outer shoe cover and step onto blue pad outside patient room
- Remove the outer shoe cover of other foot and step onto blue pad outside patient room
- Remove outer pair of gloves
- Remove isolation gown
- Remove surgical mask
- Remove final pair of shoe covers and step onto bare floor
- Remove final pair of gloves
- Remove shoe covers and step onto bare floor
- Remove gloves
- Go to nurses station to survey hands and feet with survey meter for possible radioactive contamination

Contamination: If you have skin contamination that cannot be removed with 2 or 3 washings with soap and water, notify the Radiation Safety Division.

Exposure: The Radiation Safety Division performs a survey of the area each day. Time guidelines are prescribed for the staff and visitors. These time guides are posted by the Radiation Safety Division. Follow the time guidelines and there will be no exposure problem.

TO OPERATE SURVEY METER:
1. Turn switch to battery check position, BAT; the needle should be in the area marked BAT TEST. If not, replace batteries.
2. Turn switch to the most sensitive scale (XO.1) position. If the needle goes off scale, turn to the next scale up.
3. Turn response knob to FAST.
4. Observe what the meter reads before you survey yourself. This is the background.
5. Check yourself for contamination with the probe about 1/4 inch away from the surface. If the needle goes over 2 times the background, there is contamination on that area.
6. Wash the contaminated surface and recheck.
7. Turn the meter off.

The Radiation Safety Division operates Monday through Friday, 8:00 a.m. to 5:00 p.m. The extension is 4-4751. Nights and weekends, the Radiation Safety Officer is on call. If he is needed, call Paging, 4-3411, and ask them to page him. Be sure to give them your extension.
Read all signs carefully and take appropriate action.

Direct all questions to your Radiation Safety Officer