University of Virginia

Radiation Safety Manual

FOR NURSING STAFF

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Radioactivity and Radiation

All matter in our environment is made of atoms. Most atoms we encounter on Earth are stable. Some atoms, however, are unstable, giving off energy in the form of radiation in order to reach a stable state. These atoms are said to be **radioactive**. An example is the radionuclide, Carbon-14, produced in the atmosphere when cosmic rays interact with stable nitrogen atoms. When a Carbon-14 atom undergoes radioactive decay, it gives off radiation in the form of a beta particle and then becomes a stable nitrogen atom once again. The existence of Carbon-14 in all living things enables archaeologists to date ancient artifacts.

There are small amounts of naturally occurring radioactive substances in soil, rocks, plants, animals, and in our own bodies, all of which give off radiation. Large amounts of radiation are present in outer space and a small portion of this radiation penetrates the atmosphere. This low level of naturally occurring radiation is known as **background** radiation.

Radiation can only be detected by specially designed instruments. Radiation may pass through an object, or it may be absorbed and cause changes at the site of absorption. Radiation is known to cause cancer and birth defects in animals and humans. The **risk of radiation damage is related to the amount of radiation** absorbed by an individual. With the amounts of radiation encountered by employees of the UVa Health System, the risk is very small.

Radiation exposure can have many benefits for individuals and society. Medical imaging exams that involve radiation are beneficial for determining whether organs are functioning properly, bones are broken and providing information for cancer therapy. **Low levels** of radiation exposure are used for most medical exams involving radiation, although when we are using radiation to treat a disease (e.g., cancer), we use very high doses to actually kill the cancer cells.

Like so many things in our society that have benefits, some also have risks. For instance, aspirin is extremely effective in many indications but, taken in large quantities, can be harmful and even cause death. With radiation, it is similar. The small radiation doses used to conduct medical exams carry little or no risk, while exposure to high levels may cause observable health effects.

Radiation Protection at UVa Health System

To minimize the biological effects of radiation, special rules and regulations are set forth for individuals occupationally exposed to radiation. The amount of radiation received by persons exposed occupationally should not exceed the dose limits specified in the Virginia State Regulations For Protection Against Radiation (12VAC5-481) and the UVa Radiation Safety Guide.

There is, in general, minimal external radiation hazard to hospital personnel from procedures involving radiation. Depending on your specific job duties, you may or may not be classified as a “radiation worker” and may or may not be required to wear personnel monitoring devices.

Radiation protection support services are provided for UVa Health System by the UVa Environmenal Health and Safety Office (EHS). These services include the oversight and administration of the personnel monitoring program, area surveys and in-service training of hospital workers. X-ray equipment inspections are performed by staff in Radiological Physics. Questions regarding the radiation protection program should be directed to the Radiation Safety Office at 982-4919. Radiation Safety can be reached after normal working hours at pager 923-5047.

Medical Radiation Sources

Sources of radiation are used at UVa for diagnosis, therapy and research. The most likely places to find radiation sources are in Radiology, Nuclear Medicine, Nuclear Cardiology and Radiation Oncology. However, mobile radiographic and fluoroscopic units are used frequently throughout the hospital, and many nuclear medicine patients retain radiopharmaceuticals for days or weeks after their procedures are complete. It has also become more common for specialty departments (such as GI Procedures, Urology, OR, etc.) to possess and operate their own diagnostic X-ray equipment. Thus, radiation may be encountered virtually anywhere within the health care system.

Radiation Producing Equipment

In *diagnostic radiography*, X-rays are produced when high-energy electrons collide with a metal target in an X-ray tube. X-rays are produced only when the machine is activated. The patient does not become radioactive from exposure to X-rays.

In *diagnostic fluoroscopy*, X-ray images are viewed on a video monitor rather than on film. Fluoroscopy procedures are the largest source of occupational radiation exposure in medicine. Fluoroscopy is used to study moving structures, and to assess positioning during surgical and radiographic procedures. The portable fluoroscopy unit is often referred to as a "c-arm." All X-ray machines are "registered" with the Virginia Department of Health's X-ray Program.

Radioactive Materials

Radionuclides like Tc-99m, F-18, I-131, P-32, Ir-192, Cs-137, I-125 and Y-90, are frequently used in hospitals. For example, I-131 is used as a diagnostic aid in the evaluation of thyroid function and also as a therapeutic agent in the treatment of thyroid disease. The UVA Radiation Safety Committee oversees and approves all use of radioactive materials at the institution as required by the license agreement. The Radiation Safety section of the Environmental Health and Safety Office acts as an "agent" for this committee, managing the radiation protection program.

Diagnostic Radiopharmaceuticals – Some of the radionuclides used in the Nuclear Medicine and Nuclear Cardiology departments for diagnostic procedures emit gamma rays, which are a penetrating radiation, like X-rays. It is this penetrating quality that allows images of internal structures to be obtained. These radionuclides remain in the patient after the study is over, but have short half-lives, so the patient and the people around him or her are not exposed for a long period of time. A half-life is the time it takes to reduce the radioactivity of a substance by half. Diagnostic radiopharmaceuticals have half-lives from six hours to eight days. Short half-life radionuclides may be intensely radioactive, but for a shorter period of time, i.e.; minutes. After about 10 half-lives, the radioactivity is reduced to near background levels.

Although radiation exposures may arise from the radiation emitted by radionuclides in patients, by accidental contamination of skin with radioactive materials, or by accidental ingestion of these materials (possibly through smoking or eating when hands are contaminated), there is, in general, no radiation hazard to hospital staff from these sources in patients who have received **diagnostic** or tracer doses of radioactive materials.

Potential radiation doses due to nuclear medicine procedures have been widely studied. The general conclusion has been that there is **no need for additional restrictions** when the patient leaves the Nuclear Medicine or Nuclear Cardiology Department. Radiation doses and dose rates form patients who have undergone diagnostic nuclear procedures have been measured. Based on such measurements, physicians, scientists and regulators have unanimously concluded that such radiation doses from patients are extremely small and do not warrant an undue concern or any radiation precautions. Pregnant caregivers should not feel at risk and no protective lead is necessary.

No special precautions are needed in caring for them and no restrictions on patient activities or contact with other people is required. The probability for nursing staff receiving doses higher than dose limits for the public in a single session or working day is negligible.

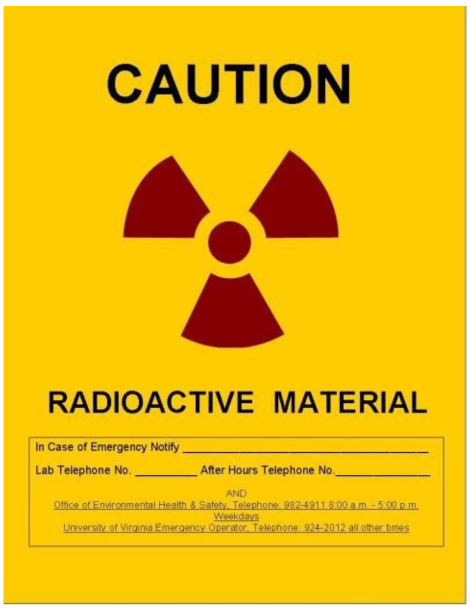
To exceed the limits would require being in close contact with the radioactive patient for several hours following each administration. You should contact Radiation Safety at 2-4919 if you are **routinely** exposed to radioactive patients so that your potential dose can be evaluated.

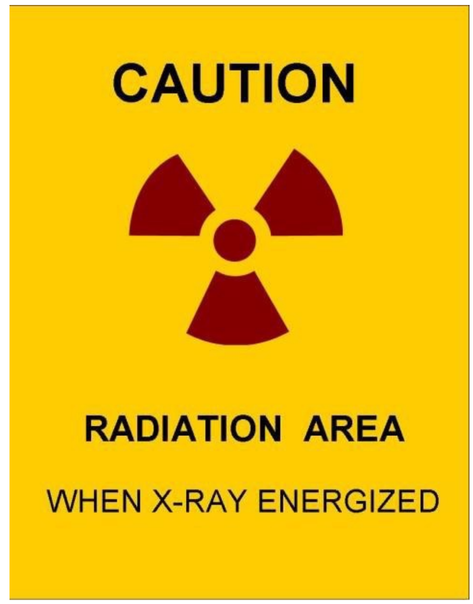
Therapeutic Radionuclides - When **therapeutic** radiopharmaceuticals or sealed sources are used, relatively large doses are involved. The patient can become a significant source of radiation exposure to staff, family and visitors. When procedures require that radiation precautions be put into effect, a **radiation sign** and a precaution sheet will be posted on or near the door to the patient's room.

Because radiation cannot be seen or felt, the 3-blade **radiation symbol** shown below is used to alert you to the presence of radiation and/or radioactive material.

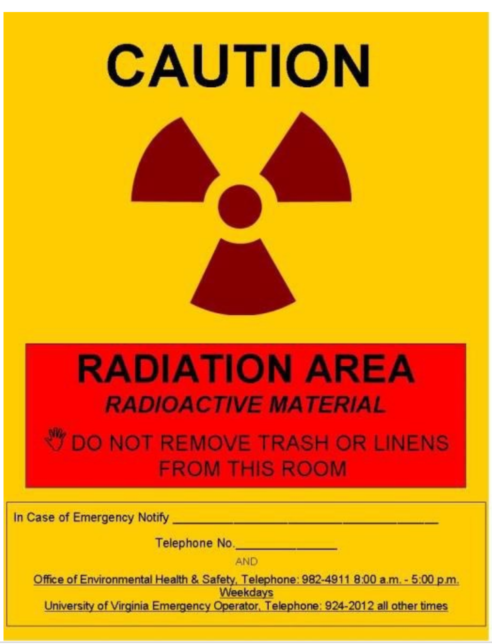
Containers of radioactive material and rooms where radioactive materials are stored or used, are posted with the following label, which when in use is magenta or black with a yellow background:

Rooms or areas where radiation-producing equipment is used are posted with the following sign, also magenta or black with a yellow background:





Rooms where significant radiation exposure can occur from radioactive sealed sources in patients undergoing brachytherapy, or from patients receiving radiopharmaceutical therapy are posted with a "Caution – RADIATION ISOLATION" sign like below. Radiation safety precautions are provided on these signs and include caregiver and visitor instructions, stay times, and Radiation Safety emergency contact information.



Basic Radiation Safety Procedures

The radiation protection program is guided by the concept of keeping radiation exposure As Low As Reasonably Achievable (**ALARA**). The ALARA concept is based on the assumption that any radiation dose, no matter how small, can have some adverse effect. At UVA, radiation exposure of all individuals routinely working with sources of radiation is monitored with a Luxel® OSL (Optically Stimulated Luminescence) dosimeter. The dosimeters are changed out and analyzed on a monthly or quarterly frequency.

Radiation exposure can be minimized by utilizing three basic principles:

1. **Time:** Shorter exposure time means a lower dose.
2. **Distance:** Doubling the distance from a radiation source means one-fourth the dose rate. Tripling the distance gives one-ninth the dose rate.
3. **Shielding:** The use of appropriate shielding greatly reduces the dose rate. Wearing a lead apron when performing a fluoroscopy procedure is one example. The shield material used and its thickness depend on the type and strength of the source of radiation.

Remember that radiation cannot be seen or felt, but can be detected with radiation survey meters.

Radioactive Spills: When a spill of radioactive material is encountered, **do not clean it up**. **Isolate the area and notify the Radiation Safety Office**. Remember that small droplets may have splashed away from the spill. If liquid is running, try to contain it with a paper towel or other absorbent material, taking care not to contaminate yourself. All persons involved in a spill should be monitored for contamination before they are released.

Typical Exposure Levels During X-ray Examinations

An individual located four feet from the patient's bed at the time that a radiographic exposure using a 14 x 17 image receptor is made, may typically receive about 0.010 millirem. To receive 500 millirem, one would have to remain at that distance for 50,000 X-ray exposures. An individual located four feet from a patient undergoing fluoroscopy may typically receive about 0.50 millirems per minute while the machine is "on". To receive 500 millirem, one would have to be in the location for 15-20 hours with the machine operating. Since radiation decreases rapidly with distance, the further one is from the patient during the actual X-ray examination, the smaller the exposure.

Radiation and Risk

Effects of large doses of radiation are well-documented and understood from the study of groups including atomic bomb survivors, radiation accident victims, radiation therapy patients, and early radiation researchers. The effects of the very low doses of radiation expected among workers in the hospital setting are difficult to observe and, therefore, are not as well understood. When a large dose of radiation is increased to an even larger dose, the adverse effects become greater or more prevalent. This dose vs. effect relationship can be thought of as linear, with confirmed and documented effects beginning at a certain "threshold" level of radiation dose.

But since this "threshold" level is far greater than any allowable occupational dose, how is the risk of occupational radiation exposure assessed? Although the effects of very low doses of radiation are not truly known, health physicists "extend" what is known about the health effects of higher doses of radiation down to "zero" dose. In other words, any radiation dose is assumed to have some effect. Most scientists believe that this is a conservative model of the risk. With the amounts of radiation encountered by employees in the UVa Health System, the risk is very small.

Consider that for very low doses of radiation the effect of most concern is cancer. If every member of a population of 1 million were to receive 10 millirem of radiation (average film chest X-ray), it is possible that 5 additional cancer deaths would be observed. Remember however, that out of this population of 1 million, about 200,000 (20%) will die of cancer, making these few additional cancer deaths statistically impossible to detect. Additionally, according to the Biological Effects of Ionizing Radiation (BEIR) committee, the risk of cancer death is 0.08% per rem for doses received rapidly (acute) and might be 2 times (0.04% per rem) less than that for doses received over a long period of time (chronic).

It's important to keep in mind that all activities carry some element of risk. For example, flying in an airplane, driving a car, smoking cigarettes, eating certain foods, and drinking alcoholic beverages are everyday activities that carry some risk. Many of us are willing to accept the risk from these activities.

Fetal Protection Policy

Recent studies have shown that the risk of childhood leukemia and other cancers increases if the mother experienced a **significant** radiation exposure during pregnancy. The National Academy of Sciences has reported that the incidence of leukemia among children from birth to 10 years of age could rise from 3.7 cases in 10,000 children to 5.6 cases in 10,000 children if the children were exposed to 1 rem (1000 millirems) of radiation before birth. The Academy has also estimated that an equal number of other types of cancers could result from this level of radiation. Although other studies have shown a much smaller effect from radiation, each woman should be aware of any possible risk so that she can take steps she thinks are appropriate to protect her offspring.

UVA has adopted a policy (SEC-010) to protect the fetus/embryo of pregnant employees exposed to ionizing radiation in their work. Radiation protection regulations limit the occupational dose to pregnant women to 500 millirems over the course of the pregnancy if the worker declares her pregnancy in writing to the employer.

This value is one-tenth of the permissible annual exposure established for adults. To help put this in perspective, the average annual dose from natural radiation sources is approximately 360 millirem.

If an employee decides to declare her pregnancy, she should notify her supervisor and contact the EHS Radiation Safety Office to discuss possible precautions to limit radiation exposure. Declaration of Pregnancy forms are available from Radiation Safety. The Radiation Safety Officer will review work assignments and radiation exposure history, and may recommend limitations in work assignment if necessary. Dosimeters will be assigned, with radiation exposures to be reviewed monthly. If radioactive materials are used, the employee may also be placed on a periodic bioassay program.

Important!

Report any unusual or unsafe condition involving sources of radiation to the OEHS-Radiation Safety Office at 982-4919. Any non-emergency questions during normal duty hours may be directed to the UVa Office of Environmental Health and Safety (OEHS) at 982-4919 or after normal working hours at pager 923-5047.

Use Time, Distance and Shielding, as well as disposable gloves and lab coats to keep your radiation exposure **As Low As Reasonably Achievable (ALARA)**.

The UVa Radioactive Materials licenses, X-ray registrations, regulations, inspection reports and exposure reports are available for review in the Office of Environmental Health and Safety, Radiation Safety Section.

For information that may not be posted, contact the Radiation Safety Office at 923-4919.