Radiation Safety in the Nuclear Medicine Laboratory

Harold D. Hodges

Oak Ridge Associated Universities, Oak Ridge, Tennessee

Roy E. Aldridge

Memorial Hospital, Colorado Springs, Colorado

Those of us who are actively engaged in handling and manipulation of radioactivity in either solid, liquid, or gaseous forms must strive constantly to maintain the delicate balance between providing maximum efficiency and preventing error. Technologists who work in the nuclear medicine laboratory preparing doses, assaying samples, or doing RIA procedures should not concentrate only on accident prevention but should know also the procedures to be followed in the event of a radiation spill in their laboratory. We review and discuss six aspects directly related to radiation spills and suggest appropriate actions that could be taken should an accident occur.

As nuclear medicine technologists, we are all very much aware of ionizing radiation's proclaimed hazards to the various tissues of the body and consequently we adhere to the practice of radiation safety to the best of our abilities. Most of us have participated in some type of radiation safety training program to learn how to prevent or reduce the number of incidents involving mishandling of radioactive materials.

Unfortunately, not many of us have been instructed in the proper methods of cleaning up after a radiation spill in our laboratories. This article discusses six aspects directly concerned with radiation spills in the laboratory. Our goal is twofold. First, we aim our suggestions toward preventing radiation spills in the laboratory. Secondly, in the event that an accident does occur, we suggest appropriate actions that could be taken.

Hazards

We have found at our institutions that the highest incidence of laboratory accidents involving spills of radioactive materials or overexposure is associated with three procedures:

- ☐ eluting a technetium-99m generator;
- ☐ making withdrawals from bottles containing relatively high concentrations of radioactive solutions; and
- ☐ preparing dilutions for standards or reference sources.

In an effort to reduce the number of such incidents, we first asked our technologists to study carefully the instructions for doing a given procedure prior to beginning the task. This familiarizes the technologist with the step-by-step procedures required to complete the job successfully. The technologists were also requested to plan ahead—to give them ample time to perform these tasks without undue scheduling pressure. We emphasized that the most basic protection principles that can be used to reduce exposure from external radioactivity could be summed up in three words—*time, distance,* and *shielding.*

- ☐ *Time:* avoid delay. Complete the task as quickly as possible.
- ☐ *Distance:* use tongs when handling source bottles and syringe shields when making withdrawals.
- ☐ *Shielding:* work behind shielding whenever possible and keep all radioactive materials stored in properly designed containers.

Upon compliance with our requests, we noted a marked reduction in accidental spills and mishandling of radioactive materials.

General Procedures to Follow after a Radioactive Material Spill

First notify your supervisor immediately. Then rope off the areas of suspected contamination, e.g., counter tops, floors, walls, and post warning signs. Determine the type and quantity of radioactive material involved and isolate all suspected contaminated equipment. Always reroute

For reprints contact: Harold D. Hodges, Medical and Health Sciences Div., Oak Ridge Associated Universities, PO Box 117, Oak Ridge, TN 37830.

traffic away from the spill area to prevent tracking or spreading contamination to other parts of the building. Send for a health physics officer to assist and advise in the cleanup operations.

Cleanup

It is very important to try to identify the radioisotope involved; the mode of clean-up operations is dependent upon the energy, chemical properties, and half life of the contaminant. Use a survey meter to check the area and determine the magnitude of the spill and the precise locations of contamination. Always wear protective clothing and gloves before starting cleanup. You can use absorbent pads such as gauze, paper towel, or sanitary napkins for soaking up liquids. Do not forget to place all used absorbers in a plastic bag; label and seal securely. Place any contaminated equipment in a plastic bag. Store all sealed plastic bags containing contaminated cleanup materials in an isolated area until the proper method of disposal has been determined. We suggest using a steam-cleaning carpet vacuum cleaner to remove the spilled radioactive material working from the outer areas toward the center. Through controlled experiments, it has been determined that the steam-type vacuum cleaner can remove up to 90% of radioactive material with the first cleaning on all types of surfaces, including walls. One should clean until the area is determined to have only two times the normal background. Empty the vacuum cleaner in the proper container and place in decay storage (*1*).

Postcleanup

Use filter paper to take smears for radioassay from counter tops, walls, floors, equipment, and any other possibly contaminated objects. These measurements will tell you how well you have removed the contamination. Declare the spill area "off limits" until completely clean (consult a health physics officer). Monitor all personnel involved in the cleanup and place all contaminated clothing in decay storage.

Personnel Decontamination

If someone involved either in an accident or in the cleanup procedures is found to be contaminated, locate contaminated areas on his skin or clothing using a survey meter. Carefully remove all contaminated clothing, seal in a plastic bag, and remonitor skin. We recommend removing clothing in a wrong-side-out manner to help confine any contaminants. Wash contaminated skin with soap and cool water (be careful not to let these materials run over other parts of the body). If skin contamination persists, use soft pads such as sanitary napkins to scrub gently with a 50% solution of Clorox bleach as a cleansing agent. Again, remonitor the cleaned area using a G-M survey meter. Repeat these decontamination procedures until the surface contamination on the skin is negligible.

Useful Electronic Equipment

Much of the electronic equipment that is very helpful in locating and measuring radioactivity can be found in most hospitals. For instance, the sodium iodide detector-spectrometer normally used for measuring thyroid uptakes is an excellent instrument for detecting skin contamination. Slow movement of this detector over suspected areas of contamination on the body would reveal the presence of any significant amounts of radioactivity. This instrument can also double as a sample counter; just invert the collimated detector, cover the collimator with a small thin piece of Plexiglas and place the sample to be assayed on the Plexiglas. This arrangement provides good counting geometry for all physically small samples and standards.

Hospitals with nuclear medicine departments are equipped with scintillation cameras, another very useful type of instrument for measuring radioactivity. It can be used as a whole-body counter to detect contamination on any part of the body. This can be done with remarkable success by using any scintillation camera with a pinhole collimator. The pinhole collimator is positioned approximately 36–40 in. from the floor at a distance of 7 ft from the individual (standing) suspected of being contaminated. Removing the collimator will yield greater sensitivity; this is useful to detect extremely low-level amounts of radioactivity—because in the absence of the collimator, the crystal is facing the subject. This technique increases the sensitivity of the camera by a factor of 1,000 (*2*).

The last but most important instrument we need to consider is the G-M survey meter. This is probably the most common of all the survey instruments. The typical full scale readings range from 0.2 to 20 mR/hr or 800 to 80,000 counts/min. It can measure beta, x, and gamma energies ranging from 20 keV for x-rays to 150 keV for betas. It is a very sensitive rapidly responding instrument and should be as common in the nuclear medicine laboratory as the fire extinguisher. If you do not have a G-M survey meter in your laboratory, we suggest that you make a serious attempt to acquire one. Ask your local civil defense organization for their assistance in obtaining a G-M survey meter for your laboratory.

We strongly recommend that all technologists working in laboratories dealing with radioactive materials get together on a regular basis to discuss some of the common causes of accidents involving radioactive contaminants and ways to improve conditions in order to prevent many of these mishaps from recurring.

Unfortunately, those of us who work with hazardous materials on a daily basis tend to develop a false sense of security. We rarely experience a serious accident and so become complacent. This is the real danger to ourselves and to those who work with us.

Please review the following questions to see how well your laboratory complies:

1. Do you have written procedures to follow in an emergency? Are they posted in general view?

2. Are all personnel tested or reviewed periodically on the emergency procedures?
3. Is a radiation accident crash cart available? Does it include protective clothing, monitoring instruments, and a self-reading dosimeter? (A self-reading dosimeter will allow instant reading instead of waiting for the film badges or TLD to be sent off to be read.)
4. Do you hold classes for nurses? We in nuclear medicine should hold in-service training periodically for the nurses to let them know how to handle patients who have body burdens of radioactive material. Nurses should also be given guidelines for the proper preparation of patients for various scans.
5. Do you hold special training for maintenance and housekeeping personnel? Such training is required by the NRC and 110CFR 20 regulations. These personnel should attend classes periodically to learn what hazards may exist when they are cleaning up after a spill in your department. By using their equipment, they can be a great asset to you in the event of a major accident or spill.
6. Do you know the capabilities of your local police and fire departments in case there is a fire in your department? Does the fire department know exactly what hazardous materials you have in your "hot lab" and where they are located? Have you offered training assistance to these local departments in order to increase their capabilities?
7. Are the personnel in your RIA laboratory allowed to pipet nonradioactive materials such as water and certain reagents by mouth? These technologists must know that the radioactive materials they are handling, even though in minute amounts, can still contaminate them with a long-life isotope such as selenium-75 or iodine-125.
8. Are personnel smoking, eating, or drinking in laboratories where they are preparing or administering radiopharmaceuticals?
9. Do personnel wear protective laboratory clothing (lab coats, gloves, etc.) while handling radionuclides and RIA materials?
10. Do personnel use syringe shields? The NRC now requires that you certify that all doses will be drawn and administered with the use of a syringe shield.
11. Do personnel perform daily monitoring of laboratory and scanning areas? Do you maintain a log of the background or a radiation log of what radioactive materials are administered in which areas of your department?
12. Do you maintain proper radiation exposure records? All technologists should be informed immediately of the results of monthly readings of their dosimeters whether they be from the wrist, finger, or whole body, and of the site of the exposure (from hot lab, patient, etc.). All technologists should initial or sign the radiation exposure record to indicate that they have been briefed, and then the record should be posted on a bulletin board for all to see. Upon termination of any technologist, these records should be transferred to the new employer.
13. In case of a serious accident in your hospital, do you know how to contact the nearest NRC office or your local Civil Defense organization to assist in cleanup operations? The NRC has several offices throughout the United States. Do you have their telephone numbers available? (*3,4*)

Are you prepared? Remember, complacency affects all of us. Mental attitudes play an extremely important part in the problems of protection. It is a human failing to be very careful at first when working with new materials and instruments and then to become complacent as procedures become more familiar.

Heed this simple rule called "The Three Ms of Nuclear Safety." Expose the *minimum* amount of people to the *minimum* amount of radiation for the *minimum* amount of time. Safety in the nuclear medicine laboratory is our responsibility. The overall expansion of nuclear medicine procedures in hospitals across this country has created an unprecedented growth in nuclear medicine technology. Our potential for daily exposure to radiation is on the increase. With these thoughts in mind, we must motivate ourselves to take a much keener interest in radiation safety and be prepared for the unexpected.

This work is based on work performed under contract number DE-AC05-760R00033 between the Department of Energy, Office of Health and Environmental Research, and Oak Ridge Associated Universities.

The submitted manuscript has been authored by a contractor of the U.S. Government under contract number DE-AC05-760R00033 between the Department of Energy, Office of Health and Environmental Research, and Oak Ridge Associated Universities.

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