Participation of Nuclear Medicine Technologists in Radiation Accident Management

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Even though the probability for a serious radiation accident is extremely small, the reality of such accidents demands serious consideration and preparation. Generally, nuclear medicine technologists are better qualified than any other hospital staff members in dealing with such practical problems as (A) how to detect and measure radiation, (B) how to prevent the spread of radioactive contamination, (C) how to reduce the radiation dose to the persons involved, and (D) how to assist the physician and the health physicist in caring for radioactivity contaminated accident victims. To be prepared to assume this dormant responsibility, the nuclear medicine technologist needs to test his familiarity with the necessary basic practices which must be executed immediately after a radiation accident victim is brought to the hospital. The skills needed for the prompt and decisive response of emergency personnel have to be tested and practiced frequently. Nuclear medicine technologists have an unusual advantage here in that many of the skills and instruments that are required are used daily by the technologist in nuclear medicine laboratory practice. This article discusses how nuclear medicine instruments can be quickly modified for radiation emergencies, and how simulated accident drills can test the readiness of the nuclear medicine team.

It has been predicted by some experts that by the year 2000 about one-half of the country's electrical power will be generated at nuclear power stations *(1)*. When one considers the expansion and development of nuclear energy related industries in this country, it is quite probable that many nuclear medicine technologists will some day be called upon to help in incidents involving radiation and radioactive materials.

Fortunately, by combining the basic skills of the nuclear medicine technologist along with some of the instruments found in the nuclear medicine departments of most hospitals, a good technologist can provide the essential data needed by the attending physician. Doing this requires having the minimum working equipment at hand, the knowledge of how to use it, knowing what samples to collect, when to collect them, and how to translate the data.

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Obtaining Samples for Measuring Radioactivity Present (Radioassay)

Procedures for collecting samples for radioassay should be preplanned but allowed to vary depending on the immediate condition of the radiation accident victim. Life-saving first aid should be provided first; however, victims with injuries should not be given definitive treatment until the level of radioactive contamination is determined and adequate protection against radiation exposure to both the victim and hospital personnel is provided. Contamination of the hospital should be prevented but not if the delays entailed will jeopardize the victim. Quick and decisive action to prevent death from hemorrhage, shock, or suffocation is of utmost importance.

A brief history of the accident is most helpful in identifying initially radioactive contaminants and their hazard. For example, induced radioactivity from neutron exposure has never presented sufficient hazard to those caring for a patient and can be ignored because the predominantly induced radionuclide is ^{24}Na, whose concentration has to be high enough to kill a victim before it presents a hazard to personnel *(2)*. On the other hand, gamma and some beta radioactivity from contaminaton can be a serious hazard to patients and personnel and must be dealt with rapidly. A quick check of the victim with a survey meter, or an external counting probe (if a survey meter is not available), should always be done immediately to determine the magnitude of radioactivity present. Protective clothing, such as a surgeon's gown, should always be worn by all assisting personnel to reduce their risk of contamination. The clothing of all accident victims should be placed in separate plastic bags, sealed, and stored for later radioassay. After the immediate first aid and contamination problems are surveyed, it becomes urgent to determine both the contaminant and the radiation dose. Blood, urine, nasal swabs, and hair samples are needed for radioassay along with skin smears, sputum, and feces. All samples are collected and placed in clearly labeled vials. Once these samples have been taken and assayed, decontamination should be completed and definitive care, if any is required, should be provided.

The radioassay results from the samples should indicate whether internal or external radioactive contamination is present, and can be used as a clue for determining the identity of an unknown contaminant *(3)*. If radionuclides are present internally, a whole-body count and gamma spectrum are needed to identify the radionuclide involved. A rectilinear or profile scanner may be used to determine radioactivity distribution within the body provided there is sufficient concentration in the organs, and the sensitivity of the scanner is adequate.

Instrumentation

Equipment such as a whole-body counter or a geometry-independent well counter, specifically designed to do all the suggested studies on radiation accident victims and the samples taken from them, are usually not locally available simply because this type of equipment is rarely used by nuclear medicine departments in most hospitals. How then can existing instruments that are designed for specific clinical purposes and are common to most nuclear medicine departments work in a radiation accident emergency situation? Where there is no well counter for doing radioassays on samples such as blood, urine, stools, etc., one can conveniently use the detector–spectrometer setup which is normally used for doing thyroid uptakes. Just invert the collimated detector, cover the collimator with a small thin piece of Plexiglas, and place the sample to be assayed on top. This setup provides good counting geometry for all samples and standards (Fig. 1).

To check the sample for the presence of radiation, the spectrometer window control ΔE is set on integral (out) and the threshold E as close to zero as the electronic noise

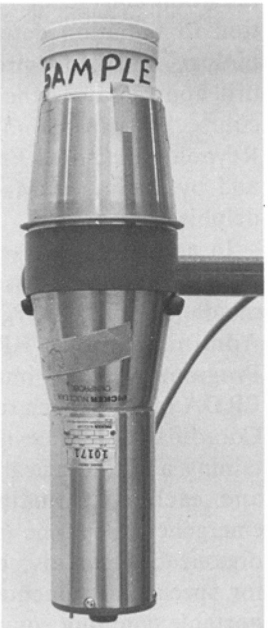

FIG. 1. Collimated 2 × 2-in. NaI detector normally used for thyroid uptakes is inverted and covered with plastic petri dish for doing radioassays on small samples.

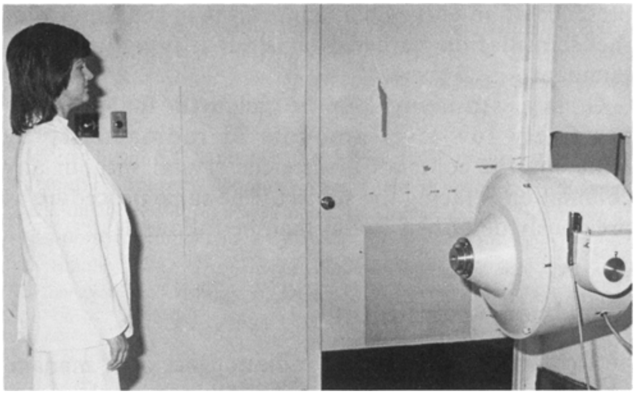

FIG. 2. Scintillation camera with pinhole collimator used as whole-body monitor.

level of the system will allow. Record the background and sample count. This will provide an approximate idea of total gamma activity present. To identify the radionuclides present, if any, the window control is set on differential (in) with a narrow window (about 20 keV or 5%). The threshold is slowly increased and the counting rate on the scaler is recorded. Increases and subsequent decreases in the counting rate indicate that a photopeak has passed through the window. By noting the threshold setting when the counting rate reaches a maximum as observed on the scaler and then decreases, the approximate energies of the photopeaks present can be determined and radionuclides present can be tentatively identified by consulting a list of nuclides and gamma energy *(4)*. Of course, if a multichannel pulse-height analyzer is available, one could determine immediately what energy was being emitted without the tedious procedure just described.

Whole-Body Count with the Scintillation Camera

If internal radioactive contaminants are suspected, a whole-body count is in order. This can be done with remarkable success by using any scintillation camera with a pinhole collimator (Fig. 2). The pinhole collimator is positioned approximately 36–40 in. from the floor at a distance of 7 ft from the victim. A whole-body count is done by setting of 20% window on the scintillation camera and beginning with the 50-keV range, increasing the range in a step-by-step fashion until an energy band is seen in the window. This procedure is continued through the 550-keV range. A record of this procedure may be made on film by advancing the range while the cathode ray tube (CRT) display is in the normal mode, and then opening the Polaroid camera filter and switching the CRT display to the spectrum mode for 0.1 s and returning it back to the normal mode. The filter should be closed and the exposed film pulled. The procedure is then repeated at the next range. By continuing through the 550-keV range, you provide a sequential record which covers the 50- to 550-keV energy range, allowing the study of the exposed film for the presence of an energy band appearing in the window of the scintillation camera, thus identifying the contaminant.

Greater sensitivity can be achieved for detecting extremely low-level amounts of radioactivity by removing the collimator, since the crystal without any collimation is facing the subject. The same procedure as previously described would then be followed.

Simulated Accident Drill

Detailed procedures on radiation accident management are indeed beyond the scope of this article; however, Figs. 3–5 were taken during a simulated radiation

FIG. 3. Radiation accident victim being monitored with a survey meter before removal from ambulance.

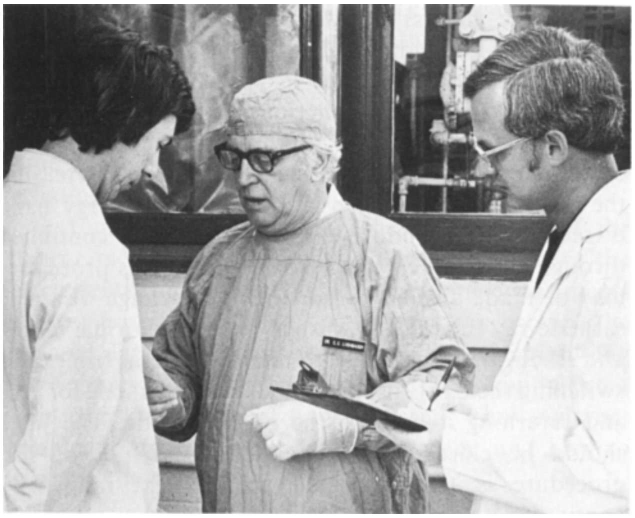

FIG. 4. Employee who witnessed a radiation accident is interrogated by physician in charge.

FIG. 5. Low-level whole-body count on accident victim for the identification and quantitation of unknown radionuclide.

accident drill at the Radiation Emergency Assistance Center and Training Site (REAC/TS) in Oak Ridge, TN. Such drills at yearly intervals should be basic to all facilities in their preparation for radiation accident management.

It would be advantageous for all technologists to supplement their training and knowledge of the techniques in radiation accident management. A course entitled "Handling of Radiation Accidents by Paramedical Personnel" is offered at the Medical and Health Sciences Division of Oak Ridge Associated Universities. This one-week course for occupational nurses, paramedical personnel, and nuclear medicine technologists responsible for first aid at nuclear power plants and hospitals is intended to train them to handle a radiation emergency until a full emergency team can be assembled. The training program is recommended for hospital personnel who expect to be called upon to assist during a radiation emergency. The course includes an introduction to radiation detection and monitoring, radiation biology, emergency procedures, and a realistic accident drill appropriate to the scope of the responsibilities of the course participants *(5)*. A similar course is given by Reynolds Electrical Engineering Company, Las Vegas, and by Radiation Management Corporation in Philadelphia.

In addition to these, there are other agencies which offer training or assistance in handling radiologic incidents. The Energy Research and Development Administration's (ERDA) Radiological Assistance Program is divided into eight geographical regions. An ERDA office in each region, designated as the Regional Coordinating Office (RCO), is responsible for maintaining a Radiological Assistance plan for that region and each RCO maintains a continuously manned emergency telephone *(6)*. State and local Civil Defense organization can also be called upon for assistance and for special instrumentation such as survey meters and portable counting equipment.

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