Survey of Radium Sources in Offices of Private Physicians

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RADIUM SOURCES have been used extensively by the medical professions for the treatment of disease since the early part of the 20th century. Through experimental research and actual use, or misuse, various pioneers in the field (*1–6*) soon determined the gross somatic effects of radiation exposure on biological systems. As a result some limited radiation protection practices in the manufacture and use of radium sources were instituted (*7, 8*).

Through the years, as more experimental evidence concerning the biological effects of radiation was gathered, various national and international committees set up standards to limit exposure to ionizing radiation (*7, 8*). Governmental regulations concerning radiation protection were not instituted in the United States until the 1950's. They were a direct result of the increased use of artificially produced radioisotopes and of the studies of the National Academy of Science which focused attention on the genetic effects of radiation.

The Pennsylvania Department of Health's occupational health staff began inspecting and evaluating users of radium and other radioactive material in the 1930's. In 1956 the first Pennsylvania State radiation protection regulations were promulgated. A comprehensive program of inspection, survey, and control was instituted at that time. Personnel of the department of health now routinely inspect and survey all medical and industrial X-ray and radioisotope installations in the State.

This paper reports results of a survey by the Pennsylvania Department of Health on radiation protection measures in the offices of the 54 private physicians practicing in the State who possess radium sources.

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Survey Procedure

Personnel of the radiological health section visited these physicians' offices to evaluate their radiation protection practices. Each visit included an interview with the physician, a radiation survey, and a contamination survey. At the completion of the visit the personnel verbally summarized for each physician results of the survey and ensuing recommendations. The health department subsequently reiterated these results and recommendations in a letter fixing a deadline for correction of the listed deficiencies.

During the interview with the physician, information was obtained on the type, age, and strength of radium sources, frequency and purpose of use, handling and treatment practices, sterilization procedures, types of personnel monitoring equipment, and any tests conducted for leakage. Applicable sections of the regulations (*9*) were also discussed.

The radiation survey consisted of monitoring the radium storage area with an ionization

chamber survey meter (NUCOR model CS–40A or a Nuclear Chicago model 2586). Gamma levels at contact, at 1 foot, and at 1 yard from the storage container were determined. The type and thickness of the storage container were noted. All adjacent uncontrolled areas were monitored. If gamma levels were excessive, the department representative at this point often suggested ways to reduce personnel exposure dose rates by use of another storage area or by obtaining better storage containers.

An alpha contamination survey of the storage container, storage area, and handling equipment was made with either a gas flow proportional-type survey meter (Eberline PAC–3G) or a scintillation-type survey meter (Victoreen Scintillac model 645). Filter paper wipes (3 centimeter Whatman No. 41) of the inside and outside of the storage container, the storage area, and the handling equipment were collected. The number of wipes collected depended on the levels of alpha activity measured with the alpha survey meters. Personnel wore plastic gloves and used 36-inch-long tongs to remotely wipe the inside of the storage container and the radium source itself. The wipes were checked during the visit with the portable survey instruments and then were re-examined at the radiation laboratory for a more precise measurement in a gas flow proportional counter.

Actual leak tests (*2*, *9*) were conducted of the radium sources of the first two physicians surveyed. Such tests, however, were abandoned for the rest of the field survey because of numerous technical problems. Each leak test required at least a 24-hour period, necessitating two visits by inspection personnel. The lead shielding available was usually not sufficient to contain adequately the leak-testing apparatus, especially if more than one source was involved. The problem of cross-contamination of sources also required that each source be cleaned before the leak test. Since the State regulations require annual leak tests, it was believed that a gross contamination survey would be sufficient to locate serious leakage.

In the absence of standards for allowable alpha contamination limits, limits for the wipe test had to be selected rather arbitrarily. Since the survey did not actually constitute a leak test, it was necessary to determine levels at which to take action. Any survey which produced a wipe with alpha activity exceeding 200 disintegrations per minute resulted in a written notice to the physician that his radium was a possible source of contamination in its present condition and that a leak test by a qualified expert should be performed within 30 days. If a source was found to be leaking, the physician was notified that the source must be re-encapsulated or transferred to a competent firm for disposition.

Results

Fifty-four private practicing physicians, possessing a total of 1,833 milligrams of radium, were surveyed. Individual sources of radium such as needles, plaques, applicators, and capsules varied in strength from 1 to 50 milligrams. Although the offices surveyed were located in all parts of the State, 37 percent were concentrated in Philadelphia and Pittsburgh. Eye, ear, nose, and throat specialists and dermatologists were the predominant radium users. Radiologists, surgeons and gynecologists, as a rule, store their radium in hospitals and were not part of this study.

The physicians all requested more information on the radiation protection aspects of radium use and storage. Many stated that the State health department representatives were the first persons to inform them about the health hazards associated with using radium. Some physicians had read in medical journals about the health hazards of radium and, as a result, had provided additional shielding for radium storage or had purchased new handling equipment to reduce exposure. Most physicians had been told by the manufacturer that the radium sources were sealed and free from leakage. There had been no mention of routine leak tests to insure that the seal was not broken.

The field survey revealed the following deficiencies (*9*) in radium use that required correction.

	Number of users	*Percent of total users*
No annual leak test	54	100
Inadequately labeled source	54	100
Suspected source leakage	25	46
Inadequate storage	24	44
Source not reregistered	11	20

Failure to reregister was corrected by having the physician fill out and return all necessary forms to the health department representative during the visit. Personnel pointed out that radioactive materials should be reregistered every 2 years.

Inadequate storage of radium sources was found in 44 percent of the inspections. Gamma radiation levels at 3 feet from the storage containers varied from less than 1 milliroentgen per hour to 50 milliroentgens per hour. Storage container thicknesses varied from $\frac{1}{16}$ inch of lead to a maximum of 6 inches.

Storage locations included safes, desks, closets, basements, attics, garages, spare rooms, and file cabinets. Some radium storage locations were in private homes in areas frequented by other members of the physician's family; thus additional persons were subjected to unsuspected and unnecessary gamma exposures.

Inadequate shielding was found most frequently in radium sources purchased before World War II whose containers were designed to reduce radiation only to levels acceptable at that time. Following World War II, maximum permissible radiation exposure levels were substantially reduced through government regulations, with a subsequent reduction in allowable gamma radiation levels at the surface of containers. The purchase of new containers solved this problem.

Corrections in labels were necessary for every container surveyed. Most containers did not even have the minimum identification indicating that they contained radium or radioactive material. Health department representatives explained at the time of the visit that the purpose of labeling is to call the attention of unsuspecting persons to the presence of radioactive material. The representatives stressed that not only emergency workers such as firemen but also estate trustees inventorying after a physician's death would be endangered by improperly labeled radium containers and storage facilities.

Two physicians had died before the scheduled survey visit could be made. The widow of one of these did not remember where the radium was stored. A search with a survey meter revealed its location in a closet. The location of the radium of the second deceased physician, in a covered pit in the garage, was known, but the radium source was not labeled and was found to be leaking considerably.

Eleven physicians used personnel radiation monitoring devices: 8 used film badges; 2, dosimeters; and 1, both types of devices. Personnel monitoring equipment was usually introduced when X-ray units were operated in the same office where personnel worked. More cautious handling and use of radium was observed in offices which had personnel monitoring than in those without it.

Leaking radium sources were the most serious deficiences encountered. Only nine physicians had ever performed leak tests since acquiring their radium, and no leak tests had been performed on any of the physicians' sources within the year before the survey. This failure to test for leakage is particularly disturbing considering that some of the radium sources dated back to 1921. Twenty-five physicians were notified by letter that their sources were possibly leaking (on the basis of a wipe exceeding 200 disintegrations per minute) and that a leak test must be accomplished within 30 days and before further use of the sources. The remaining 29 physicians were notified to have leak tests performed immediately and, in compliance with the State regulations, on an annual basis henceforth.

Several radium sources were ruptured. One of these was stored in a triple-lead container; alpha readings exceeded 1,700,000 disintegrations per minute per 100 square centimeters inside the second container. Wipes of another source removed enough radium to merit registration with the health department as an unsealed source (greater than 0.1 microcurie).

The causes of leakage are many (*2, 6, 10*). A buildup of pressure from the radon daughter and helium gases can break the hermetic seal. Careless handling can severely injure the containment. Heat sterilization, which may damage the seal, was suspected in at least one case. The actual number of leaking sources was not determined because during our visits some of the physicians told us they had decided to dispose of their sources, and so no leak tests were performed.

Health department personnel found contamination of the storage facility, handling tools, and office equipment in 22 facilities. Decontamination was required before future use, or

disposal through a reputable disposal firm was recommended.

Two facilities were found to be grossly contaminated as a result of a ruptured 10-milligram plaque that was 33 years old and a ruptured 10-milligram capsule of unknown age. Walls, floors, file cabinets (including patients' records), telephones, furniture, books, and magazines were contaminated, as well as personal items such as shoes, a pocket comb, a fingernail file, and pens. Surgical instruments, heat sterilizers, gauze packs, and hypodermic needle syringe cases were contaminated up to 160,000 disintegrations per minute per 100 square centimeters. The contamination had spread to adjoining rooms of the physicians' suites. Decontamination was ordered immediately and was carried out by a health physics consulting firm. In neither instance had the source been leak-tested.

Response to Survey

As a result of the survey, six physicians elected to dispose of their sources by donating them to local hospitals. The health department subsequently notified these hospitals of the leak-testing, storage, and registration requirements. Fifteen physicians disposed of their radium through a waste disposal company or by return to the manufacturer. It should be noted that there is almost no market at the present time for radium—none at all for leaking radium sources. Some manufacturers will give credit for an old source provided a new one is purchased.

Thirty-three of the 54 physicians still have radium sources, either the ones we surveyed or replacements.

This limited study indicates the need for increased educational efforts to promote better radiation protection in the use and storage of radium and the urgent necessity for enforcement of applicable regulations.

Summary

A survey of 54 private practitioners in Pennsylvania using radium revealed a need for control procedures. Failure to provide for periodic leak-testing was the most common deficiency. None of the 54 had conducted annual leak tests. The radium of 24 physicians was improperly stored, and many facilities required extensive decontamination. Health department personnel had to conduct a search to locate the radium source of one deceased physician. These results reaffirm the need for continuing and scheduled surveillance of radium and radium users.

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