

# Radiation Protection

## Review of Contamination and Exposure Hazards Associated with Therapeutic Uses of Radioiodine

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*After careful review of the hazards associated with therapeutic dosages of radioiodine, we have modified our handling procedures. Special care must be taken to guard against contamination, exposure, and airborne concentrations during administration. Use of a specially designed portable Plexiglas iodination hood has greatly reduced personnel exposure to airborne concentrations during administration of high-level dosages in a patient's room.*

Although several decades have elapsed since the first treatment dose was processed from an accelerator target, use of radioiodine remains a popular and effective tool for treatment of thyroid diseases (1-4). With the disappearance of administration of treatment doses of other hazardous radionuclides such as radiogold, radioiodine emerges as perhaps the single most dangerous radionuclide used in nuclear medicine today. We have found through measurement that administration of even the smaller doses in liquid form represents a significant potential hazard for nuclear medicine personnel, requiring carefully planned and executed handling procedures.

In comparison, high-level treatments for cancer present even greater potentials for exposure and contamination of a patient's room, as well as the air.

We present some of our survey findings and a description of our program for handling these problems.

### Hazard Evaluation

Solutions of radioiodine present a significant potential for volatilization (5,6), which can lead to personnel exposure. Following administration of an oral solution containing 15-mCi I-131 to a patient outside of a fume hood, one of our technologists had a measurable thyroid burden of  $1.2 \times 10^{-2}$   $\mu$ Ci. Sampling of the breathing zone air has

indicated that for high-level treatments (75- to 200- mCi I-131), the technologist is exposed to airborne concentration levels several thousand times higher than the maximum permissible concentration of  $9 \times 10^{-9}$   $\mu$ Ci/cc (7). Measurements that we have taken using activated charcoal traps indicate that as much as 2 to 3% of a vial's activity may escape after the cap is removed. For radioiodine in capsule form, the activity escaping after the top is removed appears to be more on the order of 0.01%.

Surveys of patients' rooms following treatment indicate a significant potential for contamination. Figure 1 illustrates those areas of the patient's room, which are generally contaminated following treatment. Levels of contamination vary considerably depending on the activity administered and the cooperativeness of the patient. Sporadic air sampling during treatment generally indicates

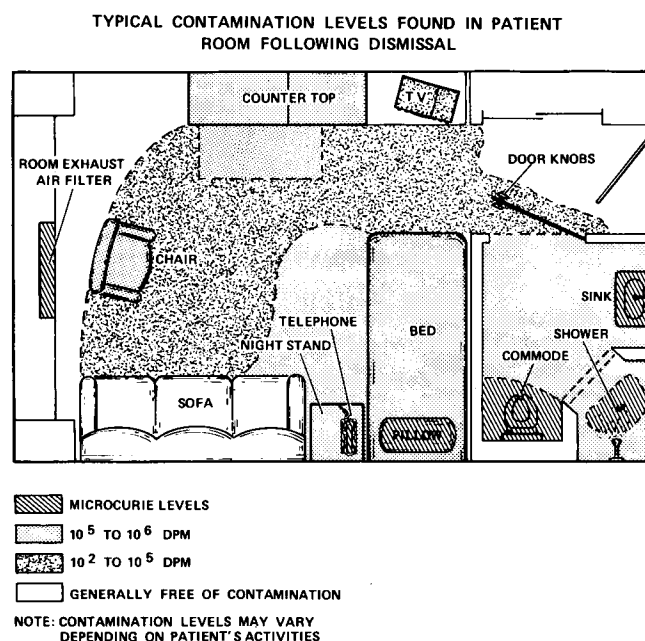
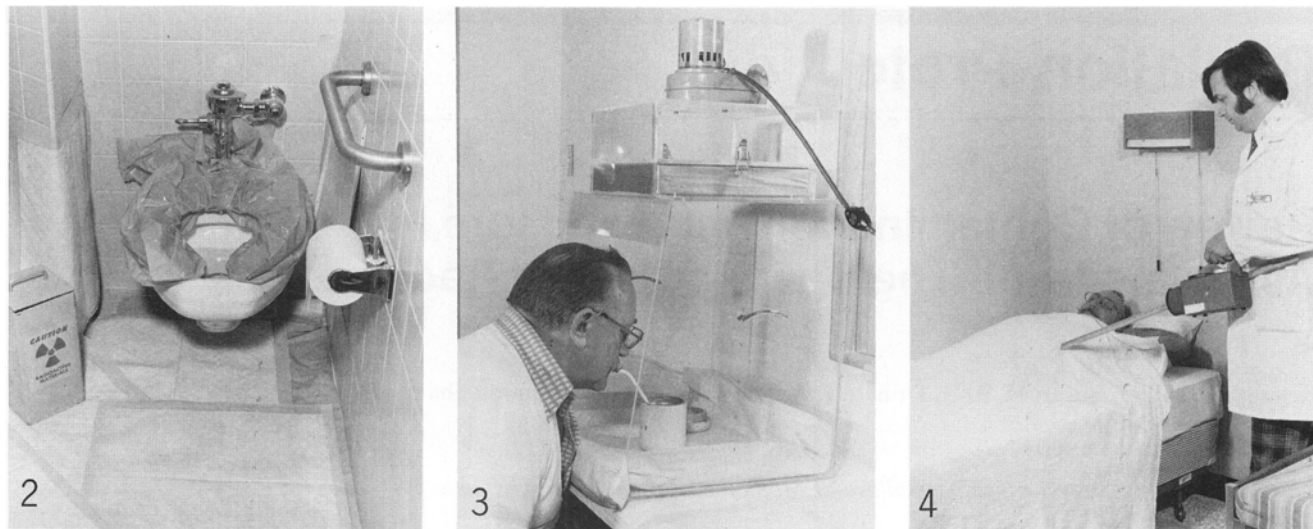


FIG. 1. Typical contamination levels found in patient room following dismissal.

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**FIG. 2.** Bathroom preparation for contamination control; **FIG. 3.** Plexiglas iodination hood for administering oral doses to patients; and **FIG. 4.** Surveying of patient room following administration of radioiodine.

airborne contamination. This is not surprising since we usually find considerable contamination in the room exhaust-air filter following treatment.

#### Preparation of Patient Room and Patient

In order to minimize contamination to a patient's room and facilitate decontamination efforts, special consideration must be given to room preparation before treatment. If the floors are not of a seamless nonporous material, they should be covered. We have used rolled, plastic-backed absorbent paper but find it tends to get rumpled and torn by the patients. We now keep on hand several sheets of heavy plastic that have been cut to the size of the floor in a patient's room. These are used to cover the floor before administering radioiodine. Countertops or eating surfaces are covered with the plastic-backed absorbent paper. The sofa and chairs are covered by bed sheets, and knobs on doors, drawers, television, etc. are covered with plastic wrap. A telephone jack has been installed to simplify phone removal, because phones generally become very contaminated. Extra special attention must be paid to the bathroom (Fig. 2): the commode, commode lid, and sink become excessively contaminated. Here again, we have found that plastic wrap works well. Since we collect all urine, the shielded urine container is placed on double-thick absorbent padding.

During treatment, the cooperative patient is our best method of contamination control. For this reason, we spend as much time as necessary discussing our procedures with him or her before treatment. If properly approached, the patient becomes very receptive and appreciative of the special preparations and attention extended.

#### Receipt, Transportation, and Administration of Treatment Dose

Upon receiving treatment dose, the shipping container


is surveyed immediately for both external contamination and external radiation level. If both are acceptable, we open the package and continue the contamination survey using filter paper wipes, which are counted in a windowless gas flow proportional counter. All surfaces are surveyed including the vial itself. After the vial has been determined to be free of external contamination or decontaminated, the activity is assayed either using a dose calibrator or ion chamber measurements of the radiation levels at several distances from the vial. Results of this receiving survey are logged appropriately. The vial is then repackaged in its shielded shipping container and transported to a patient's room on an absorbent pad lined cart.

Administering the treatment dose in a patient's room eliminates the hazard and contamination that would result if a treated patient vomited during transit from nuclear medicine to his room. This also helps to minimize the number of individuals exposed to the patient's external radiation level or exhaled radioiodine vapors. For administration in the patient's room, we use a portable Plexiglas fume hood (Fig. 3) (Radiation Physics Inc., Silver Spring, MD). This hood is constructed of ¼-in. Plexiglas and contains a 12 in. × 12 in. × 2 in. filter of activated charcoal. Previous studies with I-125 (8) have indicated a trapping efficiency in excess of 90% for this filter. Negative pressure is maintained in the box by a top-mounted 100CFM blower. As much as 4.3 mCi (2.1% of dose) of I-131 has been measured in the filter following administration of a 200-mCi dose.

In addition to reducing the airborne exposure to the technologist, the box contains a waterproof lipped bottom, which would hold contamination should the patient vomit shortly after drinking the oral solution. Use of this box has solved many of the problems that we previously encountered as a result of radioiodine's volatility.

#### Instructions for Hospital Personnel

Confining radioiodine therapy patients to a given room


**THE MILTON S. HERSHEY MEDICAL CENTER HOSPITAL**  
**RADIOACTIVITY PRECAUTIONS**  
 FOR PATIENTS CONTAINING UNSEALED RADIOISOTOPES

PATIENT Name JANE SMITH Number 112429  
 ISOTOPE DESCRIPTION  $^{131}\text{I}$  THYROID RX

Date Administered 7/4/78 By SUSAN BOTT RAMPT

**RADIATION SURVEY** By RE. BRUNCK Date 7/4/78  
 Maximum Exposure Rate:
 

⊙ 1 Ft. from Patient	<u>20</u> mR/hr	Hallway	<u>3</u> mR/hr
⊙ 3 Ft. from Patient	<u>5</u> mR/hr	Adjacent Rooms	<u>1/2</u> mR/hr
⊙ 6 Ft. from Patient	<u>1.5</u> mR/hr	(BY MENS OF BCS)	
		(S. - R/A @ 6' WALL	
		W/ THERAPY PT SITTING	
		ON SOFA.)	

**TIME RESTRICTIONS**  
 Hospital Staff: Maximum of 5 Minutes/Day @ Bedside  
 Visiting: Maximum of NO Minutes/Day @ 3 Ft.  
20 Minutes/Day @ 6 Ft.

**INSTRUCTIONS** (Applicable if checked) (✓) d...  
 Patient must not leave the room.  
 Hospital staff must wear a radiation monitor while in the patient's room.  
 Patient must not be discharged until approved by Health Physics.  
 Director of Nuclear Medicine must be consulted before surgery on patient.  
 The Health Physicist must be consulted immediately for instructions for handling any deceased radioisotope patient.  
 Hospital personnel must wear gloves and shoe covers to enter the patient's room.  
 Samples (urine, blood, etc.) may not leave the room.  
 Disposable eating utensils only.

**SPECIAL PRECAUTIONS** NO VISITORS !!!  
NO SAMPLES TO LEAVE ROOM !!

Signature R.E. Brunck Date 7/4/78  
 Restrictions Removed: \_\_\_\_\_  
 Signature \_\_\_\_\_ Date \_\_\_\_\_





FIG. 5. Radioactivity precaution sheet for patient's chart.

on a given floor facilitates training of nursing personnel. It also permits renovation of the patient's room to permanently reduce the number of porous surfaces that could fix contamination.

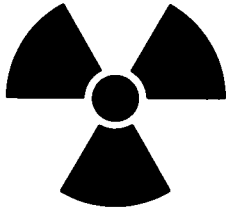
Following administration of the treatment dose, careful surveying with an appropriately calibrated ion chamber or other similar portable survey instrument is necessary (Fig. 4) for determination of safe exposure times for hospital personnel (9). When determining the safe exposure times for personnel, consideration should be given to any concomitant exposures that may be received from other therapy patients. Such measurements may also be used in lieu of urine analysis to determine when patient body burden is below 30 mCi.

The measurements of such surveys will enable specific instructions for hospital personnel to be determined. Such instructions should then be recorded on a very obvious form, such as the one shown in Fig. 5, and placed in the front of the patient's chart. At the same time, a *Caution: Patient Contains Radioactive Material* label should be affixed to the cover of the patient's chart to alert nurses and physicians to the elaborated instructions contained in the chart.

Similarly, the patient's door should be appropriately labeled (Fig. 6) to prevent unauthorized entry. While surveying, consideration should be given to exposure levels to patients in adjacent rooms. Film badge determinations of exposure to a phantom in an adjacent room, at our facil-

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# CAUTION



## RADIOACTIVE MATERIAL

### NO VISITORS ALLOWED

Individuals Under 18 Years of Age or Pregnant Females Not Permitted

MAXIMUM EXPOSURE TIME FOR HOSPITAL STAFF: 5 minutes/day at bedside  
20 minutes/day at 3 feet from patient

by R.E. Brunck date 7/4/78

POST AT ENTRANCE TO PATIENTS ROOM

RAD 30 2 71

FIG. 6. Radioactivity precaution sheet for patient's door.

ity, indicated that a patient next door to a 100-mCi treatment patient might receive as much as 150 mRem.

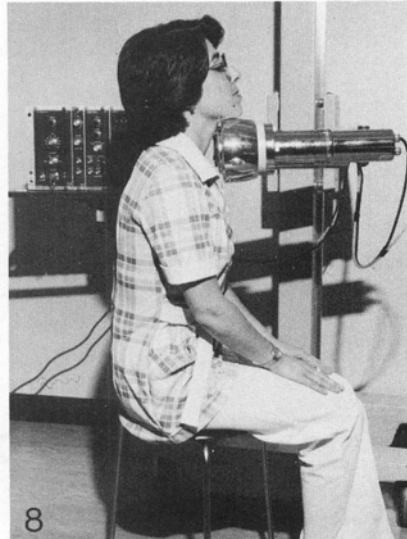
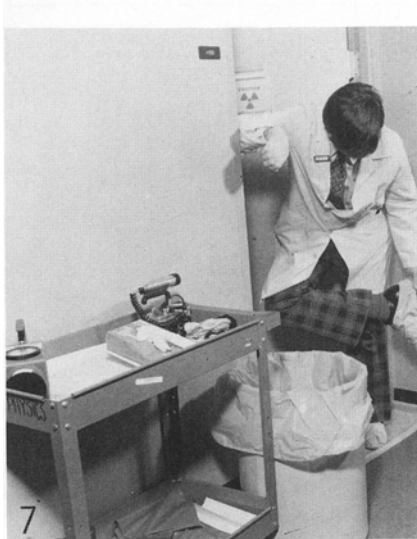
A cart supplied with disposable gloves, shoe covers, geiger counter (Fig. 7), and waste receptacle should be positioned outside the patient's room. This will enable necessary hospital personnel to protect themselves against contamination when they enter the patient's room.

### Personnel Monitoring Procedures

The hazards presented by radioiodine require monitoring beyond the conventional film badge usage. Anyone handling radioiodine in excess of the limits specified in *Regulatory Guide 8.20* (10) should have periodic or postoperational bioassay (either thyroid uptake counts or urine analysis). For certain handling conditions this would also include even the smallest doses administered for hyperthyroidism. Thyroid counting (Fig. 8) is generally easiest for nuclear medicine personnel since it is a routinely performed patient procedure. Where capabilities exist, thyroid counting should also be supplemented with urine analysis. The results of such testing can provide a determination of the efficacy of handling procedures, as well as an indication of unsuspected problem areas.

### Conclusion

The hazards involved with use of radioiodine warrant special well-defined procedures. We have discussed the



**FIG. 7.** Supply cart and waste receptacle positioned outside patient's room; **FIG. 8.** Thyroid counting following handling of radioiodine.

levels of contamination encountered in typical radioiodine therapy procedures, as well as a program designed to minimize the hazards.

### Acknowledgments

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