Necropsy of a Cadaver Containing 50 mCi of Sodium ^{131} Iodide

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A patient who received an oral dose of iodine-131 for the treatment of metastatic thyroid carcinoma unexpectedly died with a large total-body retention of the radioiodine. An autopsy was required and the family requested the body to be transported out of state to their home town. Since the radiation intensity near the surface of the cadaver was above 200 mR/hr, advanced planning and special precautions were necessary in order for the autopsy to proceed safely. This required the immediate cooperation of the pathologists, nuclear medicine physicians, health physicists, an endocrine oncologist, and other hospital staff. As a result of team efforts, personnel radiation exposures were kept as low as reasonably achievable, contamination of the autopsy room was minimal, and the radiation level of the cadaver was adequately reduced for safe transport and burial.

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A highly radioactive cadaver is rarely encountered, since radionuclide therapy is not usually given to moribund patients. We have found only one report in the English literature dealing with a cadaver containing significant I-131 (*1*). Following the administration of a therapeutic amount of radiopharmaceutical (orally, intravenously, or intracavitary), death could occur in a few days as a result of the primary disease itself or coincidental disease entities. If death occurs, the precautions to be taken depend on the nature and quantity of the radionuclide present in the cadaver, whether an autopsy is required, and whether the body is to be buried or cremated. Careful analysis of the situation, with prompt organization and planning, are required to carry out an autopsy on a radioactive cadaver and prepare it for release. The case to be presented here is an example of how a highly radioactive cadaver containing I-131 can be promptly handled, while maintaining all personnel exposures as low as reasonably achievable.

CLINICAL HISTORY

A 29-year-old male who had undergone total thyroidectomy and modified right neck dissection for papillary adenocarcinoma of the thyroid developed pulmonary metastases 3 yr later. Radioiodine imaging demonstrated minimal residual functioning thyroid tissue in the neck, with no uptake in the pulmonary metastases. He received an ablative dose of 75 mCi of I-131. Images obtained approximately 16 wk later (off triiodothyronine) did not reveal uptake in the neck or pulmonary metastases, although a chest radiograph demonstrated progression of pulmonary metastases. Hence, chemotherapy consisting of doxorubicin and cisplatin was initiated every 3 wk.

His disease remained stable during the first two courses of chemotherapy. Thereafter, recurrent disease was noted in the neck, with progression of the pulmonary metastases. Excision biopsy of a neck mass revealed anaplastic transformation of papillary carcinoma. During the following two weeks, while off triiodothyronine in preparation for radioiodine imaging, the neck masses grew larger, the pulmonary metastases progressed, and he developed shortness of breath and weight loss. Repeat I-131 imaging revealed a diffuse uptake of radioiodine in the parahilar regions and the medial portions of both lungs.

Since his disease was progressing despite chemotherapy and I-131 uptake was documented in the metastases, he was treated with 84.5 mCi of I-131. During

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the ensuing 48 hr, he excreted only 1.1% of the administered dose in the urine. Radiation measurement of 9 mR/hr at one meter from the patient confirmed high I-131 retention. During the next four days his clinical status deteriorated rapidly, he became markedly dyspneic, with evidence of pleural effusion and poor renal function, and expired on the seventh day following radioiodine therapy.

TABLE 1. CADAVER RADIATION LEVELS SOON AFTER DEATH

Location	Average radiation level at 10 cm
Head	20 mR/hr
Neck	50 mR/hr
Chest	50 mR/hr
Upper abdomen	45 mR/hr
Lower abdomen	10 mR/hr

HANDLING THE RADIOACTIVE CADAVER

Soon after death, the radiation level at 10 cm was measured to be between 10 and 50 mR/hr, from head to symphsis pubis (Table 1). An autopsy was required and the family wanted the body to be transported out of state to their home town. Since the radiation level of the cadaver was high, special precautions had to be taken to keep personnel radiation exposures as low as reasonably achievable and within permissible limits.

The situation called for conjoint efforts of appropriate personnel. Within an hour after death of the patient, a meeting was attended by the following: two nuclear medicine physicians, three health physicists, two pathologists, and an endocrine oncologist. After analyzing the situation, the following goals were set forth:

1. Briefly explain the necessary radiation safety procedures and precautions to involved individuals to minimize exposures.
2. Monitor and document the radiation levels and personnel exposures.
3. Prevent contamination of the cadaver cart, the route from the patient's room to the autopsy room, the autopsy room, and the adjoining areas.
4. Reduce the radioactivity in the cadaver so that the radiation intensity would be low enough for its safe release.
5. Decontaminate the autopsy room and instruments, and properly dispose of all contaminated materials.
6. Monitor personnel for contamination before they leave the area, and measure thyroid I-131 burden within 24 hr.

To accomplish these goals, the whole operation was separated into different phases and the individuals involved alerted. Each phase is described below.

Phase 1. Documentation of personnel radiation exposure. An unused whole-body film badge and ring TLD was worn by each of the pathologists, the nuclear medicine physician, the health physicist, and the autopsy room attendant.

Phase 2. Prevention of autopsy room contamination. The floor of the autopsy room was draped with absorbent surgical sheets. Only absolutely necessary surgical instruments were taken out for use. Controlled entrance to and exit from the autopsy room was established.

Phase 3. Personnel radiation protection. The pathologists and attendant wore lead aprons under protective clothing. Each wore two layers of autopsy gloves, a surgical mask, and shoe covers. In addition, Pathologist # 1 wore eyeglasses.

Phase 4. Controlled in-hospital transport of the cadaver. After the hospital security staff had cleared the transit route of all visitors, patients, and hospital personnel, the body was brought to the autopsy room. It was transported on a cadaver cart lined with absorbent surgical sheets to contain contamination.

Phase 5. Time limit for working on the cadaver. In order to limit personnel exposure to 20 mR, the pathologists were instructed to complete their initial examination within 40 min, taking turns of 20 min each. They were also told to obtain quickly and examine promptly the necessary pathology specimens, and to maintain maximum practical distance from the cadaver during the course of the autopsy.

Phase 6. Removal of highly radioactive organs. As the organs and tissues were removed, the health physicist used an ionization chamber to measure the radiation intensity. Radioactive and essentially nonradioactive items were separated and their storage and disposal were carried out promptly.

Phase 7. Transfer of the cadaver to a funeral home. The cadaver was released to the funeral-home director after it had been cleaned, properly covered, and residual radioactivity estimated. Accompanying were written instructions regarding its radioactivity and precautions for embalming.

Phase 8. Decontamination of the autopsy room. After removal of the body, all the surgical instruments were cleaned in formalin and soap and water, and surveyed for contamination. Instruments with nonremovable contamination were transferred to a shielded storage area for decay of the radioactivity. The disposable surgical sheets, gloves, etc., were monitored and disposed of properly.

Phase 9. Thyroid bioassay for I-131 uptake. After 24 hr, a thyroid count was obtained on each person who participated in the autopsy examination.

TABLE 2. CADAVER RADIATION LEVELS AT AUTOPSY AND RELEASE

Region/organ	Average radiation level at 10 cm
Chest & abdomen after opening	60 mR/hr
Chest after organ removal	6 mR/hr
Abdomen after organ removal	2 mR/hr
Lungs alone	60 mR/hr
Liver alone	5 mR/hr
Kidneys, intestines & omentum	15 mR/hr
Brain alone	2 mR/hr
Cadaver after removal of organs, as released to funeral director	1 mR/hr at 1 m

DISCUSSION

An immediate and proper procedural design was mandatory to perform the autopsy on this highly radioactive cadaver. Under Nuclear Regulatory Commission (NRC) regulations, the permissible average whole-body radiation exposure per calendar quarter is 1.25 R (*2*), corresponding to about 20 mR/day. Since the cadaver's-radiation intensity was as high as 50 mR/hr @ 10 cm, the pathologists were instructed to take turns and limit their exposure time to 20 min each (or <20 mR/person @ 10 cm) while the cadaver was highly radioactive. The intensity increased after the chest and abdomen were opened (Table 2). To reduce personnel exposure, the highly radioactive organs were identified and removed first. The use of two layers of heavy autopsy gloves during the necropsy minimized hand exposure, especially from beta radiation (Table 3). Pathologist #1 worked on the cadaver when the highly radioactive organs were still in the body and were being removed. Consequently, his whole-body and hand exposures were relatively higher than that of Pathologist #2. This might have been prevented by allowing Pathologist #1 to work during the first and last 10 min of the 40-min duration of planned initial examination. The attendant was instructed to stay more than one meter from the cadaver whenever feasible and not spend more than 10 min cleaning the highly radioactive organs in preparation for storage. These steps limited personnel whole-body exposure to well within the planned 20 mR maximum (Table 3).

The maximum occupational exposure of the thyroid to I-131 recommended by the NCRP involves a 0.7 μCi whole-body burden for continuous exposure, which would give a thyroid burden of 0.14 μCi (3,4). The cadaver had contained several thousand times this activity (~50 mCi), so this was of concern. The planned approach to the problems of handling the cadaver prevented the pathologists and other participants from accidental ingestion, inhalation, or absorption of I-131 (Table 3).

Since there are numerous and complicated regulations and restrictions for transport of radioactive material, it was decided that the highly radioactive organs would be removed from the cadaver, leaving a radiation level well within legal limits for transport across state lines. Also, it would enable the funeral director to perform the needed embalming procedures. After removal of these organs, the radiation intensity of the cadaver averaged less than 1 mR/hr at one meter. NCRP Reports were found to be a useful reference in the proper planning and handling of this highly radioactive cadaver (*5,6*).

The autopsy revealed widespread dissemination of thyroid carcinoma, with involvement of the brain, cervical lymph nodes, lungs, mediastinum, pericardium, myocardium, pleura, peritoneum, liver, kidneys, small and large intestines, omentum, subcutaneous tissue in the chest and abdominal wall, and one of the testes. There were pleural, pericardial and peritoneal effusions.

Although the patient in this report was seriously ill with widespread thyroid metastatic disease at the time of radioiodine therapy, his early death was unexpected and unprecedented problems were encountered due to almost total retention of the administered treatment dose. The well-organized conjoint efforts of involved staff members made the situation as uneventful as possible, although with some moments to remember.

TABLE 3. PERSONNEL EXPOSURE AND I-131 BURDEN

Individual	(rem) Whole body	(rem) Hand	(μCi) Thyroid
Pathologist #1	0.022	0.550	0.0
Pathologist #2	0.008	0.012	0.0
Autopsy rm. attend.	0.013	0.059	0.0
Health physicist	0.005	0.000	0.0
Nuc. med. phys.	0.000	0.000	0.0

REFERENCES

1. JOHNSTON AS, MINARCIK J, ROSSI R, et al: Autopsy experience with a radioactive cadaver. *Health Physics* 37: 231-236, 1979
2. 10CFR20.101 Code of Federal Regulations, Title 10, paragraph 20.101. Available from U.S. Government printing office, Washington, DC
3. NBS 59 Maximum permissible body burdens and maximum permissible concentrations of radionuclides in air and water for occupational exposure, 1959, National Bureau of Standards Handbook 69, U.S. Department of Commerce, AFP 160-6-7, 1959
4. NCRP 71 National Council on Radiation Protection and

Measurements, 1971, "Basic Radiation Protection Criteria," Report 39; chapter VIII, "Dose limiting recommendations and guidance for special cases," paragraph 239. Available from NCRP Publications, P.O. Box 30175, Washington, DC 20014

5. NCRP 70 National Council on Radiation Protection and Measurements, 1970, "Precautions in the management of patients who have received therapeutic amounts of radionuclides," Report 37

6. NCRP 76 National Council on Radiation Protection and Measurements, 1976, "Radiation Protection for Medical and Allied Health Personnel," Report 48

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