RADIATION PROTECTION HANDBOOK

UCSF MEDICAL CENTERS

UNIVERSITY OF CALIFORNIA
SAN FRANCISCO

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UCSF RADIATION PROTECTION HANDBOOK

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IN CASE OF RADIATION EMERGENCY

1. CALL UNIVERSITY POLICE 9-911

   Follow Hazardous Materials Emergency Response Guidelines. (See the following page).

2. ALERT PHYSICIANS IN AFFECTED AREA:

   RADIATION ONCOLOGY

   Consult Patient Chart or Call (24 hours) 353-8900 or 353-7175

   NUCLEAR MEDICINE

   UCSF Campuses 353-1693

   (Evening & Weekends) 476-1000

3. RADIATION SAFETY ON-CALL PAGER 24/7 443-6888

HAZARDOUS MATERIALS EMERGENCY RESPONSE

The Environment, Health and Safety Hazardous Materials Emergency Response Program provides 24-hour emergency support to campus and satellite locations.

The on-call HazMat Responder is available seven days a week, 24 hours a day to provide technical assistance to campus units, CRM, the UCPD and the San Francisco Fire Department. The HazMat Responder will immediately reply by phone to all requests for emergency support. If on-site assistance is required, the HazMat Responder will arrive as soon as possible.

ALL REQUESTS FOR EMERGENCY ASSISTANCE SHOULD BE MADE TO THE UCPD.

HAZARDOUS MATERIALS EMERGENCY REPORTING PROCEDURES:

1. Attend to injured or contaminated persons and remove them from exposure. Avoid unnecessary movement in order to prevent the spread of contamination.

2. Alert persons in the immediate area to evacuate.

3. Call UCPD at 9-911 and provide the following information:
   - Your name
   - Call-back phone number
   - Location of incident
   - Identity of spilled material
   - Quantity of material spilled
   - Any other pertinent information

   UCPD will then contact the EH&S HazMat Responder.

4. Close doors and restrict access to affected area.

5. Have a person knowledgeable of the incident and the affected area assist emergency personnel.

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PREFACE

The Radiation Protection Handbook is a reference for radiation safety policy, procedures, and general information concerning specific uses of ionizing radiation and radioactivity in the Medical Center environment. It is recognized that many workers may not directly work with radioactive materials or radiation producing machines, but do work from time to time in controlled areas where radioactivity may be present or in areas where ionizing radiation is being used in a diagnostic or therapeutic procedure. This manual addresses matters of radiation safety of a wide audience: medical staff, nursing, technical and ancillary care staff, authorized users of radioactive materials or licensed radiation producing machine operators. This manual has been formatted in a tabbed binder in order to provide information in a readily accessible, concise manner for the user.

Use of radioactive materials in the Medical Center is done under the license held by the University of California San Francisco from the State of California. The Radiation Safety Committee is charged with the responsibility to establish and maintain a radiation safety program. This handbook is a companion document to the Radiation Safety Manual which outlines the requirements and procedures governing the use of radioactive materials at the UCSF, both which can be accessed online at the EH&S website: www.ehs@ucsf.edu. All authorized users of radioactive materials are expected to be familiar with the content of the Radiation Safety Manual. The Radiation Safety Committee is responsible for the contents of the Radiation Protection Handbook. Clarifications or requests for additional information on the subject matter of this handbook may be sought from the Radiation Safety Officer (476-1300).

All personnel who work with ionizing radiation in the Medical Center are responsible for knowing and adhering to the guidance of this handbook as well as the specific policies and procedures of their respective departments or sections. The guidance set forth in this manual is in accordance with the California Radiation Control Regulations (Title 17 Health), the University of California San Francisco Radiation Safety Manual, and recommendations of the National Council on Radiation Protection and Measurements reports. The terminology used in this handbook follows NCRP guidelines in using the terms "shall" and "should" with strictly defined meanings.

> "Shall" indicates a recommendation that is necessary or essential to meet the currently accepted standards of protection.
>
> "Should" indicates an advisory recommendation that is to be applied when practical. It is equivalent to "is recommended" or "is advisable."

INTRODUCTION

During the course of your duties, you might be assigned to care for patients who have received radioactive material or you might work near an x-ray machine. This handbook has been prepared to provide you with the general principles of radiation protection. The intent is to furnish the information that Medical Center employees need to provide quality patient care. Those who want more information should check the references listed in the Bibliography section following the Appendices or contact the campus Radiation Safety Officer (476-1300).

AS LOW AS REASONABLY ACHIEVABLE (ALARA) PHILOSOPHY

Section 30253 of the California Radiation Control regulations requires each licensee to make every reasonable effort to maintain radiation exposures and releases of radioactive materials in effluents to unrestricted areas As Low As Reasonably Achievable (ALARA), taking into account the state of the technology and the economics of improvements in relation to benefits to the public health and safety. To achieve this goal, the Medical Center addresses dose reduction for both workers and patients.

The success of such a program depends on the cooperation of each employee. Specific radiation safety operating emergency procedures are important elements in any dose reduction program. Recent data throughout the medical community indicates the occupational exposures of less than 10% of the annual maximum permissible dose are readily achievable with proper attention to good practice. The Medical Center has incorporated into its program those procedures, practices and quality assurance checks that can eliminate unnecessary or extraneous radiation exposure to workers and patients without compromising the quality of medical service. Such practices and checks include, but are not limited to:

a. Use of appropriate and well-calibrated instruments and equipment;

b. Use of appropriate films and good processing techniques;

c. Use of organ shields in diagnostic radiology;

d. Staying well within the established dosage limits, unless deviation is absolutely essential in the judgment of the responsible physician.

The Medical Center is committed to an efficient medical use of radioactive materials and radiation producing equipment by limiting their use to clinically indicated procedures; utilizing efficient exposure techniques and optimally operating equipment; limiting doses to those recommended by the manufacturer, unless otherwise necessary; using calibrated diagnostic and related instrumentation; and using appropriately trained personnel.

The Medical Center is committed to a program for keeping occupational, individual and collective doses as low as reasonably achievable (ALARA). Toward this commitment, this Handbook describes the written policies, procedures and instructions to foster the ALARA philosophy within our institution.

The Medical Center's Radiation Safety Committee will review this handbook periodically, and all Medical Center practices will be consistent with the Campus Radiation Safety Committee policies and procedures.

PART I: PRINCIPLES OF RADIATION PROTECTION

A. THREE CONCEPTS TO REDUCE EXPOSURE TO IONIZING RADIATION

1. **Time-** The amount of exposure is directly related to the time that one is exposed to ionizing radiation from a source. In order to reduce exposure, plan work in advance in order to reduce the amount of time spent in a procedure that requires the operator to be exposed.

2. **Distance-** Exposure is related to distance in an inverse square relationship. If one's distance from a source of radiation is doubled, then the exposure rate is reduced to 25% of the original exposure rate. Increase distance from the radiation source when possible.

3. **Shielding-** Appropriate shielding is generally used where possible in order to reduce exposure to ionizing radiation. The appropriateness of a shield is based upon the character of the radiation that is of interest. For example, alpha radiation may be stopped by a paper or a few centimeters in air. Beta radiation may be stopped by a centimeter or two of Lucite. More penetrating x-ray or gamma radiation usually requires lead or tungsten shielding. Personnel protective equipment may be appropriate for some uses and these may take the form of lead aprons for diagnostic radiographic procedures or some therapeutic procedures, or movable lead shields in other clinical procedures.

B. OCCUPATIONAL RADIATION DOSE LIMITS

An occupational dose is the dose received by an employee whom the individual's assigned duties involve exposure to radiation and/or radioactive material. The occupational dose does not include dose received from background radiation or from medical procedures administered to the individual or dose received as a member of the general public. There are a variety of sources of exposure to ionizing radiation in the Medical Center setting. These sources include radiation producing machines in the Radiology, Cardiology, and Radiation Oncology Departments or radioactive materials used in Nuclear Medicine for diagnostic and therapeutic procedures and sealed sources of radioactive materials that are used in the treatment of cancer by the Radiation Oncology Department. There is an annual limit on the occupational dose that may be received which includes dose that may be received from external sources or internal sources. The annual occupational dose limits are set out in Table 1-1.

The use of ionizing radiation seldom requires that an occupationally exposed worker receives the maximum limit. In order to maintain doses to workers at a minimal level, there are levels of dose that trigger an investigation into the work practice that caused an elevated level of dose. Since the different types of work that are done in the medical center present different situations for exposure, investigational levels have been established that are appropriate for the work being performed (Table 1-1). The purpose of an investigation into an elevated dose is to determine the cause and whether there can be a dose saving by reviewing the work procedure and any relevant engineering or administrative controls. Table 1-1 lists the annual occupational dose limits and the investigational dose levels for Medical Center workers.

Occupational dose is required to be monitored when

- adult employees are likely to receive a dose greater than 10% of the values in Table 1-1 (Annual Occupational Dose Limits).
- minors or declared pregnant employees are likely to receive a dose greater than 1% of the annual occupational dose limit for an adult employee.
- workers enter a high or very high radiation area.

Occupational intake of radioactive material is required to be monitored (bioassays) when:

- adult employees are likely to receive in excess of 10% of the annual limits of intake (found in 10 CFR 20 Appendix B).
- minors or declared pregnant workers are likely to receive a committed effective dose equivalent in excess of 50 mrem in a year.

TABLE 1-1

Maximum Dose Limits[1]

Whole Body (total effective dose equivalent)	5 rems (50 mSv) / year
Skin of Whole Body, an Organ or Any Extremity	50 rems (500 mSv) / year
Lens of the Eye	15 rems (150 mSv) / year
Fetal Dose	0.5 rems (5 mSv) / gestation period
Maximum Dose Limit for the Public	0.1 rem (1 mSv) / year

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[1]California Radiation Control Regulations Title 17 (10 CFR 20.1201)

C. PREGNANT PERSONNEL POLICY

The dose to an embryo/fetus during the entire pregnancy shall not exceed 500 mrem from occupational dose of a declared pregnant woman. In the event of suspected or known pregnancy, it is the responsibility of the employee to notify her supervisor and the Radiation Safety Officer in writing so that an appraisal of her potential occupational exposure to ionizing radiation can be made. The Appendix to the Nuclear Regulatory Commission Guide 8.12 "Possible Health Risks to Children of Women Who are Exposed to Radiation During Pregnancy" is available upon request (476-1300). The Radiation Safety Officer is available for consultation and advice in evaluating the potential occupational exposure and methods to reduce exposure. The pregnant employee's workload and schedule may be revised to reduce or avoid procedures where the potential exists for radiation exposure. Pregnant staff may not be assigned to work in some areas. However, it is not the policy that pregnant employees be required to stop working in all duties where potential exists for exposure to ionizing radiation.

Pregnant employees (or those suspected to be) who continue to work in fluoroscopic and special procedures should wear wraparound lead aprons that protect all sides of the body. Pregnant employees continuing to work in duties where the potential for exposure to ionizing radiation exists should be issued a film badge which is used to monitor fetal exposure. This dosimeter can be requested from Environmental Health & Safety (476-

1300). The fetal dose monitoring allows for a monthly review of the dose level to ensure that the prescribed dose limit is not exceeded. Should the fetal dose approach 500 mrem, then it is mandatory that the worker no longer work in areas where occupational dose to ionizing radiation is present until termination of the pregnancy.

The pregnant employee should immediately inform her supervisor of any unexpected, unusual, or potentially high exposures.

D. RADIATION MEASURING DEVICES

1. Dosimetry

Dosimetry badges can measure the exposure to a level as low as 1 mrem per month. These badges are worn on the upper torso of the body in the same position in order to evaluate deep dose equivalent to the employee. The badges must be protected from non-occupational exposure including especially any medical or dental exposure the employee may undergo. Ring badges use thermoluminescent detectors to assess exposure to extremities. These detectors are accurate to levels as low as about 30 mrem per month. Both the dosimetry badge and ring badges are exchanged on a monthly frequency and the results of the monitoring are made available to each monitored employee. Some workers wear two dosimetry badges: one over the apron at the upper torso like above, and a 2nd badge under the apron at the waist.

Type of Radioactive Use	Type of Dosimeter Required
Fluoroscopy	Quarterly Collar/Waist
Interventional Radiology	Monthly Collar/Waist
Nuclear Medicine/ PET	Monthly Body and Ring
Portable X-Ray	Quarterly Collar
Radiation Oncology - Machines	Quarterly Body
Radiation Oncology - Materials	Quarterly Body and Ring
Research - Any amount of Low Energy Beta ***	None
Research - Greater than 5 mCi/Exp emitting High Energy Beta/Gamma**	Quarterly Ring
Research - Greater than 20 mCi/Exp emitting High Energy Beta/Gamma**	Quarterly Body and Ring
ERT	Quarterly Body and Ring

2. Investigations of Overexposures

The Radiation Safety Office will investigate all exposures exceeding the guidelines below. When indicated, a bioassay will be performed. The record of these investigations will be added to the radiation exposure file of the individual, and the individual and his Laboratory Supervisor will be informed of the results. The RSO is responsible for notification to the California Department of Public Health in cases of known or suspected exposures that exceed the permitted limits. Whenever these

exposure limits have been reached or exceeded, depending upon the extent of the overexposure, personnel may be required to avoid future work with radiation for a period of time.

a. UCSF Investigational/Action Limits
Due to UCSF's commitment to the of As Low As is Reasonably Achievable (ALARA) principle, the investigational/action limits have been set as follows:

Monthly ALARA Alerts	Quarterly ALARA Alerts
DDE Level 1 - 75 mrem	DDE Level 1- 125 mrem
LDE Level 1 - 250 mrem	LDE Level 1 - 375 mrem
SDE Level 1 - 1000 mrem	SDE Level 1 - 1250 mrem
DDE Level 2 - 200 mrem	DDE Level 2 - 375 mrem
LDE Level 2 - 500 mrem	LDE Level 2 - 1125 mrem
SDE Level 2 - 2000 mrem	SDE Level 2 - 3750 mrem
DDE Level 3 - 350 mrem	DDE Level 3 - 1000 mrem
LDE Level 3 - 1000 mrem	LDE Level 3 - 3000 mrem
SDE Level 3 - 3500 mrem	SDE Level 3 - 10000 mrem

3. Survey Meters

A useful instrument for measuring radiation levels is the survey meter (ionization, scintillation, or GM meters are generally used). Other instrumentation may be needed depending upon the type of radiation one is trying to monitor. Background radiation levels must be measured prior to measuring the area where one expects to find an elevated reading. Background radiation rates may be at a level of 20 microrem per hour. See Table 1-2 for background radiation sources.

TABLE 1-2

Typical Exposure Levels From Some Common Sources

Activity/Source	(mrem/year)
Natural Background:	
USA	300
Variation Across U.S. (NCRP Report 160)	70-2000
Living in brick or stone residence	up to 100 extra
Internal isotopes in body	25
Round-trip coast-to-coast flight (SF-NY)	5-6
Television	1
Natural gas heaters	22

PART II: DIAGNOSTIC RADIOLOGY (RADIATION PRODUCING EQUIPMENT)

A. POLICIES FOR RADIATION PRODUCING MACHINES AND SURROUNDING AREAS

Note: Only individuals who possess valid certificates or permits for a specific type of equipment and procedure may operate x-ray equipment to image patients.

1. All personnel operating x-ray equipment and personnel in the immediate area (x-ray room or 6 feet from a portable x-ray machine) shall wear a dosimetry badge.

2. The structural shielding requirements of any new or renovated installation shall be discussed with EH&S Radiation Safety (476-1300) to insure compliance with State and Federal regulations.

3. An annual scheduled survey of all diagnostic and fluoroscopic equipment for patients shall be made by EH&S Radiation Safety (476-1300). In addition, radiation surveys will be made of all new installations and after every change that might increase the radiation hazard (i.e., replacement of x-ray tube, changes in filtration of beam, etc.).

4. Within any room where fluoroscopic equipment is in use, protective aprons shall be worn by the physician, nurse, technician, and all other persons. The protective aprons should be long enough to cover the thigh and have at least 0.25 mm lead equivalency. If there is a need to turn one's back to the beam, then wrap-around aprons should be worn.

5. In the operation of mobile and dental units:

    a. The operator should stand as far as possible from the tube and patient during exposure, and shall wear a protective apron, or step behind an adequate shield.

    b. An operator, standing at least 6 feet from the tube and patient, should not operate machines to produce more than 5,000 milliampere-seconds of exposure during any one week. Rotation of operators or the use of portable shields is recommended for greater workloads.

6. The unprotected hand of the fluoroscopist shall never be placed in the X-ray beam. When the hand is adjacent to the beam, a protective glove of at least 0.25 mm lead equivalent should be worn when possible.

7. In an emergency, a person who needs to hold a patient shall wear protective gloves and a protective apron. No part of this person's body should be in the useful beam. No persons shall be regularly employed to hold patients during exposure, nor shall anyone from the Diagnostic Radiology Department ever be permitted to perform such service.

8. Shutter mechanisms and interlocking devices shall not be tampered with and shall be inspected by EH&S Radiation Safety at regular intervals to insure proper operations.

9. All X-ray protective apparel that may become defective due to use or abuse, such as protective lead aprons or gloves, should be inspected for radiation leakage at least annually, or whenever the integrity of the equipment is suspect.

10. For fluoroscopy machines, a manually reset, cumulative timing device (5 minutes) shall be used which will either sound an alarm, or turn off the apparatus when the total exposure reaches a certain previously determined limit.

11. In cineradiography (recording of images with a cine-camera, e.g. for cardiac catheterization), tube currents and potentials are higher than those used in fluoroscopy. Thus, special care should be taken to decrease patient exposure. The exposure rates on these cineradiography units shall be determined during the annual survey by EH&S Radiation Safety (476-1300).

12. Pregnant staff may work with fluoroscopy equipment only if they use appropriate protective shielding. A special dosimetry badge is available for the pregnant worker.

B. OPERATOR'S RESPONSIBILITY

The operator of any radiation producing equipment is responsible for

1. Notifying EH&S Radiation Safety (476-1300) when there is any change in the setup, i.e., new equipment installed, changes in shielding, change in output of radiation, or change in usage of the unit.

2. Requesting and wearing appropriate monitoring devices if required by EH&S Radiation Safety. Always wear the assigned monitoring device (e.g., dosimetry badge) when working with the unit. Whenever protective lead aprons are worn, the body dosimeter should be worn on the outside of the apron at the collar. If a second whole body badge is required, it should be worn underneath the apron at waist level. In addition, ring badges are to be worn if the unprotected hands and forearms come in close proximity to the beam.

3. Keeping exposure as low as possible. The operator shall never expose himself/herself to the direct beam, and must not stand within one meter of the tube or irradiated target while the unit is in operation unless adequately shielded. Make full use of X-ray protective lead apparel: barriers, lead aprons, gloves, and goggles.

4. Clearing the area of all nonessential personnel. The operator shall ensure that all essential personnel are adequately shielded.

5. Observing any restrictions on the use of the unit recommended by EH&S Radiation Safety (476-1300).

6. Using minimum exposure factors. Fluoroscopic work shall be performed in the minimum time possible using the lowest dose rate and smallest aperture consistent with clinical requirements.

7. Ensuring that the C-arm of mobile fluoroscopic C-arm equipment is positioned with the x-ray tube underneath the patient or, when operating in the lateral or other planes, with the x-ray tube on the side of the patient opposite the operator(s).

8. Visually monitoring tube current and potential of fluoroscopic equipment with image intensifiers at frequent intervals, because, under automatic brightness control, these variables can rise to high values. A weekly QC test is required for automatic exposure control of the image intensifier with all fluoroscopy units.

9. Notifying the supervisor and calling UC Police (9-911) immediately to report accidental exposures to radiation. UC Police will triage with EH&S Radiation Safety.

C. RADIOGRAPHY CABINETS

1. All radiography cabinets must be registered with Environment, Health & Safety, 476-1300.

2. All equipment users must be trained by either a representative of the machine manufacturer or the department supervisor who is experienced in the operation of the equipment. A record of authorized operators with their training date(s) should be kept on file in the department. Training shall meet title 17 section 30337.

3. The interlock system in the radiography cabinets must not be bypassed. The interlock system should be checked periodically.

4. The audible or visible warning signals on the control panel must be automatically activated while X-rays are being generated.

5. The operation of the cabinet must be under the control of a timer which automatically terminates the exposure survey with the equipment.

6. When not in use the electrical power switch should be turned “off”.

7. EH&S is responsible for performing an annual equipment exposure survey.

8. Some radiography cabinets are equipped with a viewing window on the front door. This is made of lead glass and if broken must be replaced with one with similar lead equivalency.

9. EH&S should be informed of any maintenance which involves the removal of a shielded panel. The unit must not be used after such repairs until a survey of the unit has been completed by EH&S.

D. ELECTRON MICROSCOPES

1. All electron microscopes must be registered with Environment, Health & Safety, 476-1300.

2. All equipment operators must be trained by either a representative of the equipment manufacturer or the department supervisor who is experienced in the operation of the equipment. A record of authorized users with their training date(s) should be kept on file in the department.

3. Production of X-rays in electron microscopes is the result of high energy electron production and in general does not pose a radiation safety hazard.

4. All electron microscopes must be surveyed annually by EH&S, and after any repair which may have impaired the shielding of the “electron gun”.

5. A potential source of X-ray exposure is the viewing port. If cracked or broken it should be replaced with a similar glass to ensure continued protection.

E. LEAD APRONS

1. Lead aprons are required to be inspected for damage & wear on an annual basis. The inspection should be made by a qualified individual, documented, and the inspection date written on the apron with a special silver-tipped marker.

2. For those department aprons being inspected by EH&S, arrangements must be made in advance to have staff bring all of the aprons to a designated location where EH&S has enough space to complete the inspection. Please provide current apron inventory information to EH&S at that time.

3. Between annual inspections, if new aprons are purchased please contact EH&S at 476-1300 to update the inventory and arrange inspection of the newly purchased aprons, including thyroid shields.

PART III: NUCLEAR MEDICINE (DIAGNOSTIC USES OF RADIONUCLIDES)

A. GENERAL INFORMATION

Nuclear Medicine combines Chemistry, Physics, Mathematics, Computer Technology, and Medicine in using radioactivity to diagnose and treat disease. Though there are many diagnostic techniques currently available, Nuclear Medicine uniquely provides information about both the structure and function of virtually every major organ system within the body. It is this ability to characterize and quantify physiologic function which separates Nuclear Medicine from other imaging modalities such as x-ray. Nuclear Medicine procedures are quite safe, they involve little or no patient discomfort and they do not require the use of anesthesia (except for some young pediatric patients). Diagnostic procedures may be divided roughly into two groups: sample counting and patient measurement.

1. Sample counting. In these procedures (at a stated time after administration of the radionuclides), specimens such as blood, urine, feces, expired air, etc. are taken for measurement. They are transported from the patient's room to the Nuclear Medicine Department for further processing. In most cases, the amount of radioactivity in the specimen is very low. While there is negligible radiation hazard, care must be taken in handling such materials to prevent loss, spillage or spread of contamination or bloodborn pathogens. The tests usually require knowledge of the total sample volume, so partial loss of the contents could lead to erroneous results.

2. Patient Measurement. Many diagnostic procedures in Nuclear Medicine involve direct measurement of the amount or distribution of a radionuclide tracer within the patient. In such cases, measurements are usually made directly on the patient in the Nuclear Medicine Department. Such tests may be called uptakes, scans, imaging procedures, or dynamic function study.

B. NURSING CARE

Nuclear Medicine shall inform Nursing Units of patients having received radionuclides for diagnostic procedures by completing the nursing advisory form. The urine of patients who have received millicurie doses of technetium for diagnostic procedures will probably contain a significant amount of radioactive technetium for short periods. Therefore, urine tests of parameters other than radioactivity level should be postponed at least one day. In the event a patient were to be incontinent within the first 24 hours after receiving a radionuclide for a diagnostic procedure:

1. Put on gloves;

2. Use Chux pads to absorb liquid;

3. Wash contamination from skin of the patient and personnel;

3. Restrict access to control the possible spread of contamination;

4. Notify UC Police (9-911) immediately. UC Police will triage with EH&S Radiation Safety. Then call the Nuclear Medicine physician at 353-1521.

C. SPECIMEN TRANSPORT

Nursing care of patients who have received tracer or diagnostic doses generally presents no radiation hazards. If urine, fecal, or emesis material is to be saved for the laboratory, disposable gloves shall be worn in the collection or placement of the material into containers.

D. GUIDELINES FOR THE USE OF RADIONUCLIDES IN THE OPERATING ROOM AND CARDIAC CATH LAB

Radionuclides are used as tracers in many Nuclear Medicine procedures to examine the function of an organ system. In the operating room such techniques are useful in various applications, from identifying certain lesions that must be removed to monitoring the concentration of a material in systemic circulation. Specialized equipment may be needed in order to detect the radiation from the tracers in the patient, such as a gamma camera or probe devices. Generally, the amount of radioactivity given to a patient in these situations is not great enough to require the use of lead aprons by the operating room staff. Information regarding the amounts of material used in a procedure may be obtained from the Nuclear Medicine physician. Assessment of need for personnel protective equipment or monitoring may be obtained from Environmental Health and Safety. Please contact the Radiation Safety section of Environmental Health and Safety at 476-1300. Anyone who may receive an exposure of 500 mrem in a year from procedures done in the operating room should be monitored with assigned personnel dosimetry.

1. The Nuclear Medicine physician supervising the procedure will advise whether personnel protective equipment is needed. Contact Environmental Health and Safety for assistance, if necessary.

2. Water-tight gloves should be worn whenever liquid radioactivity is utilized in a procedure. These gloves should be removed prior to leaving the room to minimize the spread of contamination. Hand-washing is also advised after the gloves have been removed.

3. The radioactive material that is to be administered to the patient must be identified as the proper radionuclide, the intended chemical form and the amount of radioactivity assayed in a dose calibrator that is subject to routine quality control procedures.

4. Administration of the material to the patient shall be performed in such a manner that any spilled radioactivity can be readily absorbed and removed. The potential for contaminating equipment must be considered and adequate monitoring for contamination provided.

5. Monitoring for contamination must be conducted by an individual familiar with performing routine surveys and instrumentation. The Nuclear Medicine personnel assisting with the procedure is the responsible person to perform the survey. EH&S may also become involved in room clearance surveys.

6. Prior to performing any contamination survey

    a. select an appropriate survey instrument;

    b. check the battery or that the device is powered up;

c. perform constancy test with the designated radioactive source to ensure the meter is responding appropriately to radiation;

d. examine the instrument for damage.

7. Establish a background reference reading.

    a. With the meter set to its most sensitive response scale, make a measurement of the background radiation in an area of the room where no contamination or radiation is expected to be found. Use this value for determining the presence of contamination.

    b. A rule of thumb is that a reading of greater than two times the background indicates contamination.

8. Monitor all materials that have come into contact with the patient.

    a. Survey the operating table, linen, coverings, instruments and floor.

    b. Survey the surgical team's extremities and the soles of their shoes in case some liquid escaped to the floor.

    c. Survey any fluids and tissues collected from the patient.

9. Place all contaminated items in a container and identify the container with a sign stating the radionuclide, the exposure reading at either the surface or at one meter and the date. The Nuclear Medicine technologist should remove the material for storage until a radioactive waste pick-up can be arranged with Environmental Health and Safety. Seal all containers of liquids so that fellow workers do not become accidentally contaminated by removing or handling the waste generated by the Operating Room staff or Nuclear Medicine personnel. Remember that all sharps containers should be erect, properly labeled and not overfilled.

PART IV. NUCLEAR MEDICINE
(THERAPEUTIC AND PALLIATIVE USES OF RADIONUCLIDES)

A. THYROID THERAPY WITH 1-131

This type of therapy is given to patients in order to treat thyroid cancer. The majority of these patients will be treated as out-patients, but some patients must be hospitalized, as a result of their medical condition or domestic situation at home. The 1-131 is given orally, usually in capsule form. The material becomes absorbed into the bloodstream and so all bodily fluids may be contaminated. The radiation exposure to workers is reduced by utilizing the ALARA concepts of time, distance & shielding and by contamination control. Nearly 50% of the dose given to a patient may be excreted in the first twelve hours and this usually occurs via the urinary system.

Prior to the release of the patient from the hospital, the patient may receive instructions regarding how to reduce exposure to family members. These instructions will be provided by the Nuclear Medicine physician and/or the EH&S radiation safety specialist.

1. Contamination Control

   For in-patient I-131 thyroid therapy, the patient room needs to be prepared ahead of time by EH&S personnel in order to minimize the spread of contamination. The floor of the room is covered with a plastic material that is taped down securely. All items that the patient handles regularly are covered with plastic or absorbent paper. Designated containers for linen and paper products are also placed in the room. A movable lead shield is placed beside the bed to protect staff from gamma radiation exposure. Disposable gloves and shoe covers should be worn when working with the patient or with items the patient has handled. All materials should remain in the room until a contamination survey can be conducted and the room is cleared by EH&S. For further information, page the radiation safety specialist assigned to the patient, or call EH&S at 476-1771.

2. Dishes

   Only disposable dishes, utensils and trays should be used. The dishes, together with other waste, should be placed in the appropriate containers in the room. The materials will be surveyed by EH&S personnel and, if found to be radioactive, removed for storage.

3. Linen

   Linens should be held in the room and placed in the designated container until the room is monitored by EH&S personnel. Once cleared, the linen can be sent to the laundry.

4. Toilet Instructions

   The patient must only use the toilet facilities in the room assigned. The toilet should be flushed three times to clear the waste from the lines and dilute the

material. The patient should be counseled to avoid splashing urine (sitting is recommended) when voiding and to wipe the toilet seat after use. In some cases, the patient's urine will be pumped via catheter within plastic tubing that is released into a constant flow toilet or dedicated drain. For collection of urine, Nuclear Medicine should give instructions for the collection and storage of the specimen. Gloves should be used if personnel are involved with the collection of specimens or in assisting the patient with a bedpan or urinal. The gloves should be washed and then discarded and then the hands should be washed after removing the gloves. Patients should always sit when using the toilet.

5. Telephone

   The telephones and other frequently handled items should be covered with a water-tight barrier to prevent contamination. The items will be surveyed for contamination and either decontaminated if necessary or stored if decontamination efforts are not sufficient.

6. Shower or Bath

   Unless ordered by a physician, a bath should be postponed for 48 hours. If possible, patients should bathe themselves and should rinse the shower or tub thoroughly afterwards.

7. Environmental Services

   Environmental Services shall not be performed until a radiation clearance survey has been made at the conclusion of the use of the room. EH&S will monitor the room and remove the radioactive materials. When the room has been cleared by EH&S, then the room may be cleaned by Environmental Services.

8. Dosimetry Badges

   Dosimetry badges shall be worn by staff regularly attending an I-131 in-patient. An electronic dosimeter is available at some therapy rooms to report radiation exposure in real time.

9. Restriction of Visiting Time

   Nurses and visitors to patients receiving radioactive I-131 should be limited to the stay times posted on the door of the room by EH&S personnel. The times are calculated based upon monitoring the exposure from the patient. Visitors shall avoid all direct contact with the patient and shall maintain a minimum six foot distance from the patient. Children and pregnant women should not visit a patient receiving radioactive I-131 therapy.

10. Transporting Patients

    Occasionally, patients who have received 1-131 therapy may need to be transported to various clinical services at the Medical Center. Since such patients may contaminate items or irradiate other patients, notify Nuclear Medicine at 353-1693 when such patients are to be transported so that proper precautions can be taken.

11. Spills

If there is a spill of radioactive fluid or if a patient who has received radionuclide vomits or is incontinent during the first forty-eight hours, page the EH&S radiation safety specialist posted on the door, or page the Radiation Safety Specialist on-call at 443-6888. Then call the Nuclear Medicine physician listed on the Doctor's Orders Form. Do not attempt to clean up the spill. In such situations, interim steps to help stop the spread of the spill can be taken, as follows:

a. Restrict the area. Do not allow people to enter, except for urgent patient treatment.

b. Keep people two meters away from the spill.

c. People who may have been contaminated should remain in room until cleared by Nuclear Medicine or EH&S Radiation Safety.

d. Remove contaminated clothing while still in the area. Place contaminated items in a plastic bag and identify the items as radioactive.

e. Cleanse contaminated skin using facilities in the room. Take care not to damage the integrity of the skin while removing contamination from-it.

f. If there is appreciable liquid spilled, cover the area with absorbent material.

g. Retain all contaminated or suspected materials in the area until cleared by Nuclear Medicine or EH&S Radiation Safety.

12. Emergencies

a. Non-Radiation

For seizures, cardiac arrest, trauma, etc., follow normal emergency procedures. Call physician listed on Doctor's Orders Form. The physician will determine the need to triage with UC Police (9-911). Nuclear Medicine or EH&S Radiation Safety shall survey potentially contaminated items and personnel. If high radiation levels are present, rotate hospital staff, when possible, to minimize individual exposures.

b. Surgical Procedures

If surgery is required within twelve days of 1-131 therapy, notify the physician listed on the physician's orders and Nuclear Medicine, if possible before the surgery. (If the surgery involves thyroid tissue, extend the notification period to 45 days.) Monitor tissue specimens prior to Pathology Lab studies. Either Nuclear Medicine or EH&S radiation safety personnel can perform this function.

13. Radiation Patient Death

d. Notify UC Police (9-911) that the patient has died and still contains radioactive material. UC Police will triage with EH&S Radiation Safety. Then notify Nuclear

Medicine and the attending physician on the Doctor's Orders Form. The physician who pronounces the patient dead is responsible for placing a radioactivity precautions tag on the body. The body is not to be released to a funeral director without the approval of the Radiation Safety Officer (RSO) or his designee. Any handling of the body, autopsy, embalming procedure or treatment of the body must be performed under guidance from Environmental Health and Safety (476-1300). This restriction is for the radiation protection of those who need to handle the remains of the patient.

b. If permission has been granted to perform an autopsy, this should be carried out only after consultation with, and under the direction of the Radiation Safety Officer. If the patient dies within the first 24 hours of oral administration of 1-131, the body fluids removed during an autopsy should be placed in closed systems and later flushed into the sewer with adequate water for dilution of the material. When no autopsy is to be performed, the body may be released to the funeral director with the approval of the Radiation Safety Officer.

   Make sure that the morgue pack form for RADIATION PATIENT DEATH is completely filled out by either Nuclear Medicine or EH&S Radiation Safety. Keep one copy of the form in the chart. Send one copy of the form with the body to the morgue. Retain the third copy in the morgue pack. Place a Radioactive Label on the body bag.

c. Transport of the body: Make sure that all hallways are cleared and elevators are free of other passengers when transporting the body to the morgue. If recommended by either Nuclear Medicine or EH&S Radiation Safety, wear a lead apron when transporting the body.

d. In the morgue, move the body into the cold storage area. Make sure that the Radioactive Label on the bag is clearly visible. Then, flip the sign outside the door of the cold storage unit to indicate a radioactive source is inside. Place the form indicating the level of radioactivity in the holder just below the sign outside the door of the cold storage unit.

14. Nursing Care

   Nursing care is to be restricted for the term of treatment to those activities essential to the well-being of the patient. Disposable gloves & shoe covers shall be worn to perform routine patient care. If special nursing care is required, EH&S Radiation Safety (476-1300) or Nuclear Medicine (353-1693) and the Administrative Nursing Manager of the nursing unit will collaborate to identify the specific care requirements. Radiation dosimetry discussed in Part I applies.

B. THERAPY WITH Sm-153

Samarium-153 is used in the treatment of painful metastatic disease in bone tissue. The material is administered intravenously. Sm-153 is typically administered in doses of 50-70 mCi. A patient with metastatic disease may

have a 50% uptake of Sm-153 and the remainder will be excreted through the urinary system and, to a lesser extent, through the GI tract. Other routes of excretion are insignificant for these radionuclides.

Contamination control involves employing universal body fluid precautions when-working with the patient. Personnel dosimetry is not needed when working with a therapy patient containing Sm-153 as the beta radiation is absorbed within the patient. Some x-rays may be emitted by the patient but the levels of exposure are too low to require the use of lead aprons or shields.

Prior to the release of the patient from the hospital, the patient may receive instructions regarding how to prevent contamination in the household, particularly the bathroom. These instructions will be provided by the Nuclear Medicine physician and/or an EH&S radiation safety specialist.

1. Contamination Control

   For in-patient Sm-153 therapy the patient room needs to be prepared ahead of time by EH&S personnel in order to minimize the spread of contamination. The floor of the room is covered with a plastic material that is taped down securely. All items that the patient handles regularly are covered with plastic-backed paper. Designated containers for linen and paper products are also placed in the room. Disposable gloves & shoe covers should be worn when working with the patient or with items the patient has handled. All materials should remain in the room until a contamination survey can be conducted and the room is cleared by EH&S. For further information page the radiation safety specialist assigned to the patient, or call EH&S at 476-1771.

2. Dishes-No special precautions are necessary.

3. Linens-Bag contaminated linen separately.

4. Toilet Instructions

   The patient should use the toilet facilities in the room assigned. The toilet should be flushed three times to clear the waste from the lines and dilute the material. The patient should be counseled to avoid splashing urine when voiding and to wipe the toilet seat after use. For collection of urine, Nuclear Medicine should give instruction for the collection and storage of the specimen. Gloves should be used if personnel are involved with the collection of specimens or in assisting the patient with a bedpan or urinal. The gloves should be washed and then discarded and then the hands should be washed after removing the gloves. Male patients should always sit when using the toilet.

5. Telephone-No special precautions are necessary.

6. Baths- are permitted unless prohibited for any other reason by the physician.

7. Environmental Services shall not be performed until a radiation clearance survey has been made at the conclusion of the use of the room. EH&S will monitor the room and remove the radioactive materials. When the room has been cleared by EH&S, then it may be cleaned by Environmental Services.

8. Dosimetry Badges- It is not necessary for the nursing staff to wear dosimetry badges when working with Sm-153 patients.

9. Restriction of Visiting Time- There is no need to restrict visitors or routine nursing functions due to the low exposure potential from these patients.

10. Transporting Patients-No special precautions are necessary.

11. Spills

Should there be a spill of radioactive fluid, or should the patient who has received Sm-153 be incontinent during the first 48 hours, call 9-911 and page the EH&S radiation safety specialist on-call at 443-6888. Then call the Nuclear Medicine physician listed on the Doctor's Orders Form. Do not attempt to clean up the spill. In such situations, interim steps to help stop the spread of the spill can be taken as follows:

a. Restrict the area-allow no one to enter except for urgent patient treatment.

b. Keep people at least 2 meters from the spill.

d. People who may have been contaminated should remain until surveyed.

e. Remove contaminated clothing while still in the area. Place contaminated items in a plastic bag and identify the items as radioactive.

e. Cleanse contaminated skin using facilities in the room. Take care not to damage the integrity of the skin while removing contamination from it.

f. If there is appreciable liquid spilled, cover the area with a chux or similar absorbent material.

g. Retain all contaminated or suspected materials in the area until cleared by Nuclear Medicine or EH&S Radiation Safety.

12. Emergencies

a. Non-Radiation

For seizures, cardiac arrest, trauma, etc., follow normal emergency procedures. Call physician listed on Doctor's Orders Form. The physician will determine the need to triage with UC Police (9-911). Nuclear Medicine or EH&S Radiation Safety shall survey potentially contaminated items and personnel. If high radiation levels are present, rotate hospital staff, when possible, to minimize individual exposures.

13. Radiation Patient Death

    a. Notify UC Police (9-911) that the patient has died and still contains radioactive material. UC Police will triage with EH&S Radiation Safety. Then notify Nuclear Medicine and the attending physician on the Doctor's Orders Form. Any handling of the body, autopsy, embalming procedure or treatment of the body must be performed under guidance from Environmental Health and Safety 476-1300). This restriction is for the radiation protection of those who need to handle the remains of the patient.

    b. Make sure that the morgue pack form for RADIATION PATIENT DEATH is completely filled out by either Nuclear Medicine or EH&S Radiation Safety. Keep one copy of the form in the chart. Send one copy of the form with the body to the morgue. Retain the third copy in the morgue pack. Place a Radioactive Label on the body bag.

    c. Transport of the body: make sure that all hallways are cleared and elevators are free of other passengers when transporting the body to the morgue. If recommended by either Nuclear Medicine or EH&S Radiation Safety, wear a lead apron when transporting the body.

    d. In the morgue, move the body into the cold storage area. Place the Radioactive Label on the bag so that it Is clearly visible. Then, flip the sign outside the door of the cold storage unit to indicate a radioactive source is inside. Place the form indicating the level of radioactivity in the holder just below the sign outside the door of the cold storage unit.

14. Nursing Care

    There are no restrictions for routine nursing-care of these patients. If special nursing care is required, EH&S Radiation Safety, Nuclear Medicine and Administrative Nurse Manager of the nursing unit will collaborate to identify the specific care requirements.

CARE INSTRUCTIONS FOR I-131 THERAPY PATIENTS

Observe all instructions which have been checked below:

Room #_____ I-131 Activity _____mCi, Date:_____Time:_____

_____ Patient must remain in room.

_____ Use disposable dishes and utensils only.

_____ Patient may not have any visitors (other than parents) while on radiation isolation.

_____ No visitors under 18 years of age.

_____ No pregnant visitors.

_____ Hold all linen and disposable waste in room until cleared by Radiation Safety Office.

_____ Wear film badges while in the room.

_____ Work behind the lead shield.

_____ Wear disposable gloves and shoe covers while in the room.

_____ Notify Radiation Safety Office prior to room release.

_____ STAY TIME LIMIT BEHIND THE LEAD SHIELD AS NEEDED.

Stay Time	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Nurse						
Visitor						

IN EMERGENCY CALL:

NAME	DAY	NIGHT/WEEKEND

NURSE'S CHECK LIST (I-131)

The nurse is responsible for assuring that all precautions and care guidelines for patients receiving radioactive therapy are followed. Nuclear Medicine personnel are responsible for completing and posting the "Radioactive Precautions" sign and care instructions on the door of the patient's room. If there are problems, contact Nuclear Medicine.

1. Does the chart cover have "Radioactive" warning label?

2. Is the room door posted with proper "Radioactive Caution" signs and Care Instructions for I-131 patients?

3. Review Doctor's Orders Form for patients who have received I-131 therapy.

    a. Room assignment and private room.

    b. Patient restriction to room.

    c. Nursing and visiting time restrictions.

    d. Prohibitions against visiting by persons under 18 years and pregnant women (including staff).

    e. Expiration date for precautions.

    f. Film badges, if required.

    g. Note special contamination control procedures required, e.g., disposable dishes, saving linens, special toilet cleaning, etc.

    h. Room must be monitored prior to reassignment.

    i. Forms shall contain the responsible physician's name and 24-hour telephone number.

    j. Review physician instructions and restrictions with patient.

External Dose Record for 1-131 Therapy Patients

Patient Name:

Infusion Date:

Time Begin: **End:**

	Date/Time	Reading @ 1m (mR/hr)
	0-1 hour post infusion	
date		
time		
	Day 1	
date		
time		
	Day 2	
date		
time		
	Day 3	
date		
time		
	Day 4	
date		
time		
	Day 5	
date		
time		
	Day 6	
date		
time		
	Day 7	
date		
time		

PART V: RADIATION ONCOLOGY (BRACHYTHERAPY & TELETHERAPY)

A. BRACHYTHERAPY

The prefix “brachy” means “short-range” so brachytherapy refers to therapy with radioactive sources placed on or in a patient’s body. Applicators may be positioned surgically. The applicators will then be “afterloaded” with radioactive sources. The radioactive sources may be permanent or temporary implants. They are shaped like seeds or capsules. In all cases, the radioactive material is completely sealed and does not disperse within the patient’s body.

1. Operating Room and Post-Operative Care

   Many sources are placed in the patient via “afterloading” procedures. This means that the source holding devices are implanted in the Department of Radiation Oncology or in the O.R., but the sources are not installed until later. If sources are inserted into the patient in the operating room, precautions shall be followed such as using film badges, placing the patient in a remote corner of the Post Anesthesia Care Unit, and keeping away other patients and pregnant staff. For prostate implant patients, a lead apron can be placed over the pelvis to reduce exposure to staff. For brain implants, a lead-shielded “cap” must be worn by the patient to reduce exposure to staff and family. POST-ANESTHESIA CARE PERSONNEL SHALL ALWAYS BE INFORMED PRIOR TO ARRIVAL OF A RADIOACTIVE PATIENT.

2. Permanent Interstitial Implants

   This treatment consists of permanently implanting sealed sources in the form of 3-5mm long seeds into a patient as treatment for cancer.. Radionuclides used for this form of therapy include I-125 and Pd-103 and Cs-131. The activity of the radioactive sources is greatest immediately after implantation and then decays exponentially over a period of weeks or days, depending on which nuclide is used. Apart from the direct radiation, hazards could occur if a seed is dropped, misplaced, or lost.

   The patient shall not be discharged until the radiation emanating from him/her has decreased to permissible levels. This will be determined by the radiation measurements near the patient and also by the ages of persons living in the patient’s household. The attending physician, fellow or resident shall be responsible for indicating the expected time of discharge on the “Doctors Orders Form” and for discussion with the patient and his/her family in advance of the procedure, including completion of the form “Instructions for Family of Patient with Permanent Implants”.(Appendix 2)

3. HDR Remote Afterloader

   The High Dose Rate (HDR) machine is a remote afterloader that employs a single high activity Ir-192 source. The source can be programmed for multiple dwell positions within multiple channels (corresponding to multiple discrete sources within multiple catheters or applicators for conventional interstitial brachytherapy). The HDR machine can be used with needles, flexible catheters, bronchial or esophageal tubes, or gynecological applicators. One HDR is housed in the Mt Zion Department of

Radiation Oncology, and the other at Mission Bay hospital gateway medical building. Radiation treatments with the HDR last 10-15 minutes.

Because the HDR machine is located in the Department of Radiation Oncology and does not involve radiation exposure to other hospital personnel, HDR Emergency Instructions are located by the HDR control suite and not included in this manual.

4. NeoVista Sr-90 Ophthalmic System-Epiretinal Radiotherapy

   The NeoVista Sr-90 Ophthalmic System is an intraocular ophthalmic device intended for the treatment of neovascularized ocular tissue by means of focal delivery of radiation to target tissues. Because the radiation source is primarily beta particles, with a very short range in water and body tissue, very little radiation reaches the non-target tissues. Using standard vitroretinal surgical techniques, the sealed source is temporarily placed over the center of the lesion by means of a proprietary intraocular probe. The treatment device is stored in the Radiation Oncology source room at Long Hospital, until needed for the procedure at ACC Ophthalmalogy. The device is transported to and from the source room by Radiation Oncology staff. The tiny Sr-90 source is completely contained within the apparatus tip and even though the device tip itself enters the patient's eye, the source cannot escape from outside of the device. There is no exposure to hospital staff other than those directly handling the application device. At the completion of the procedure, Radiation Oncology staff will supervise the sterilization of the device.

5. Leksell Gamma Knife

   The Leksell Gamma Knife is located in Radiation Oncology Long Hospital and utilizes high energy gamma-emitting Co-60 sealed sources contained securely inside the equipment. Patients are brought within close proximity of the equipment to receive their treatment while staff remains outside the room watching the procedure by video monitor. Only authorized, trained staff should enter the Gamma Knife room even when no patient is present and the sources are in the maximum shielded position. Unescorted access to the Gamma Knife suite is restricted to those staff who have passed UCSF security clearance.

6. Nursing Responsibilites in Radiation Oncology

   a. Dosimeter badges are required when working in the HDR & Gamma Knife suites, as well as participating in any procedure involving the implantation of seeds in the operating room particularly when accompanied by use of fluoroscopic X-ray. Brain implant patients are required to wear a lead-lined "cap" which will effectively reduce exposure in the room. Exposure from prostate implant patients is significantly reduced by the thickness of body anatomy surrounding the pelvis, and can be reduced further by the practice of placing a lead apron over the pelvic area in the O.R recovery area.

   b. Whenever practical, without harm or discomfort to the patient, encourage the patient to provide for themselves. In all cases, avoid excessive hurrying or assuming an awkward position that might hinder efficiency in performing a task or cause undue alarm to the patient.

c. For all radioactive implant patients, apply ALARA principals such as maintaining maximum distance possible from the patient, except when performing tasks necessary for patient care.

d. When appropriate, ensure that the "Radioactive" warning signs, survey form, labels, and wrist bands remain in place as long as the patient is radioactive.

e. When working in the Gamma Knife suite, avoid spending any more time than necessary in close proximity to the steel roller opening of the unit, where the exposure dose rate is increased

7. Physician's Responsibility in Radiation Oncology

a. Insure that the nursing staff on the appropriate floor is notified 24 hours or more in advance of a brachytherapy procedure, so that proper radiation safety procedures can be instituted (including the acquisition of portable shields, as required). IF A PATIENT HAS SPECIAL NURSING NEEDS, THE HEAD NURSE FOR THE APPROPRIATE FLOOR MUST BE NOTIFIED AT LEAST THREE (3) WORKING DAYS PRIOR TO THE BRACHYTHERAPY PROCEDURE.

b. Fill out and sign the "Doctor's Orders Form" as soon as the patient is implanted. The form should include names and phone numbers of those to be contacted in case of an emergency. For non-remote after-loading patients, the physician should also ensure that a yellow radioactive-alert wrist ID band is filled out and placed on the patient. Warning signs for the patient's chart and door shall be posted. Attending nurse(s) shall be notified.

c. Ensure that radioactive patients are not left unattended in public thoroughfares. The general public shall be excluded from elevators transporting radioactive patients.

d. Verify that no sources remain in the patient or the room after the implant is over. Verification shall be by survey instrument, and may be performed by a brachytherapy technologist or other qualified person. Verification shall be documented in the patient's chart.

e. Notify UC Police (9-911) of any missing sources. UC Police will contact EH&S. Then call Radiation Oncology (353-8900, 353-7175) to report the incident. The site of a radiation accident should never be left unobserved or without warning markers. OEH&S and Radiation Oncology will coordinate the search for the missing sources.

f. DEATH OF A PATIENT- Contact EH&S (476-1300) immediately.

8. Brachytherapy Technologist Responsibility

a. Perform or assist with patient surveys and room surveys when requested.

b. Affix all warning signs, labels, etc., and recover the appropriate ones after

therapy is completed.

c. Place an empty shielded container, source handling tools, and a survey meter in the patient's room for non-remote afterloader, temporary implant patients. Also, the technologist shall remove the container, tools, and survey meter when the implant is over.

d. Check all materials in a non-remote afterloader, temporary implant patient's room for radioactivity before anything is removed from the room (residents may share the duty for these tasks).

e. Assist with loading and unloading the radioactive sources.

9. Possible Excessive Exposure or Displacement of Source

a. Notify UC Police (9-911) if there is believed to be loss or breach of a source or excessive exposure to any personnel. UC Police will contact EH&S. Then notify the Radiation Oncology at 353-8900 or 353-7175.

b. A lead shielded container, long-handled forceps, and a survey instrument shall be available during all radioactive implant procedures. In the event that sources have to be removed for emergency reasons, or if the sources become displaced, they shall be placed in this container.

CAUTION: NEVER HANDLE SOURCES WITH YOUR HANDS, EVEN IF WEARING GLOVES, SINCE THE DOSE RATE AT THE SURFACE OF THE SOURCES IS EXTREMELY HIGH AND WILL NEEDLESSLY EXPOSE YOUR HANDS.

c. If, through an unforeseen accident, a source is damaged and possible leaking (i.e., if there is physical or presumptive evidence of the source being broken, bent, or cracked) immediately notify UC Police (9-911). UC Police will contact EH&S. Then notify Radiation Oncology (353-8900, 353-7175). Place the source in the shielded container if this can be done without further damage to the source. Gently slide a source onto a piece of paper or grasp source with long forceps or tongs (10"-12" long) and place the source in the shielded container in the room. Place the container in a remote portion of the room. Perform a field wipe survey for contamination.

d. A nursing supervisor shall be notified in cases where an unusually long period has been spent with a patient who has received a therapeutic dose of radioactive material. This could possibly occur during periods of short staffing or when more than one patient with radioactive material is being attended.

10. Death of Patient Who Has a Radioisotope in Place

Note: only take these precautions if the body still contains an active radioactive source.

In the event of the death of the patient, physicians shall:

a. Remove the radioactive sources, if possible; otherwise, survey the body prior

to removal to the morgue. Notify UC Police (9-911) that the patient has died and still contains radioactive material. UC Police will contact EH&S.

b. Make sure that the morgue pack form for "Radiation Patient Death" is completely filled out by the appropriate radiation oncology attending physician or EH&S radiation safety. Keep one copy of the form in the chart. Send one copy of the form with the body to the morgue. Return the third copy in the morgue pack. Place a "radioactive" label on the body bag.

c. If the radioactive source has not been removed, arrange for transport of the patient by appropriate personnel. Make sure that all hallways are cleared and elevators are free of other passengers when transporting the body to the Morgue if the radiation dose rate is greater than 0.2 mR/hr.

d. In the Morgue, move the body into the cold storage area. MAKE SURE THAT THE "RADIOACTIVE" LABEL ON THE BODY BAG IS CLEARLY VISIBLE. Then, flip the, sign located outside the door of the cold storage unit to indicate a radioactive source is inside. Place the form indicating the level of radioactivity in the holder just below the sign outside the door of the cold storage unit.

B. TELETHERAPY

Although the typical radiation exposure rates in teletherapy are several hundred times higher than in brachytherapy, actual exposures to involved personnel are less because the personnel are absent from the treatment rooms during radiotherapy and thick shielding attenuates radiation to low levels outside the treatment room.

Teletherapy treatment machines are either X-ray generators, such as linear *accelerators (4 MV and above) and superficial X-ray units (up to 100 kV), or* radionuclide (Cobalt-60) units, such as the Gamma Knife System. The Gamma Knife System is a radiation therapy unit containing 192 sealed sources of Cobalt-60 located in a hemispherical shield with collimator ports directed to a single three-dimensional focus inside the unit. It is used for radiosurgery of intracranial abnormalities.

Several precautions must be observed to prevent accidental exposures. Hospital staff must never be in a treatment room with the door closed, since interlocks prevent exposures when doors are open. If the door is closed, one should check with the control station before entering the room. A flashing red light above the door indicates that radiation is being produced. A warning alarm sounds when the door is closed and treatment is initiated. Anyone accidentally in a treatment room when an exposure begins would immediately push an emergency-off button; it is very important that all those who work in the treatment rooms know the location of these buttons. Personal film badges must not be left in a treatment room, since in official records an exposure to a badge is considered an exposure to the owner.

For most treatment machines, no radiation hazard exists when the machine is off. Two exceptions to thisare for the cobalt machine, which produce low-level radiation even when off, and high-energy accelerators (e.g., Clinac 20), which in some cases can induce low-level radioactivity in parts struck by the beam, such as the collimators, monitor chamber, etc. Radiation hazards from these sources are minimal under normal operating conditions.

Radiosurgery, total body irradiation (TBI), and intraoperative radiotherapy (IORT) are all specialized types of teletherapy, described below. Common radiotherapy procedures are also described in Appendix 11 (Radiation Oncology Procedures).

1. Radiosurgery

   Radiosurgery refers to the use of a Cyberknife treatment unit or Gamma Knife System to deliver a high dose of radiation to a small region within the brain or other body part, usually given in a single treatment. For the Gamma Knife a stereotaxic frame is fixed to the patient's skull on the day of the procedure and an MR or CT scan (and an angiogram in the case of arteriovenous malformations) is performed with the frame in place to localize the lesion to be treated. Linear Accelerators also have the capability to be utilized in a highly focused radiosurgery mode to small, targeted areas of the body.

   The patient is transported to the Radiation Oncology department and moved to the treatment couch with the stereotaxic frame still in place. A high dose of radiation is focused at the brain lesion. After radiation treatment has been delivered, the stereotaxic frame is removed. Personnel involved in Gamma Knife radiosurgery must all undergo special training in safety and emergency procedures for the system before participating in a patient treatment. Emergency instructions for the Gamma Knife unit are located in the control area just outside the Gamma Knife room in the Department of Radiation Oncology.

2. Total Body Irradiation (TBI)

   Total body radiation therapy is used predominantly as a preparation for bone marrow transplantation and may be given as a single treatment, three daily treatments, or twice daily treatments for three to five days. Immediate side effects usually include nausea, vomiting, diarrhea, and "sunburn" effects on the skin.

3. Intraoperative Radiotherapy (IORT)

   Intraoperative radiotherapy (IORT) is another specialized type of teletherapy. For certain tumors, there is an advantage to giving a radiation treatment during the surgical procedure (for example: normal bowel in front of the tumor bed could be moved out of the way of the radiation beam). After as much of the tumor as possible has been removed, the anesthetized patient is treated with electron radiation in the operating room using the Mobetron machine.

   All operating rooms used for IORT (as well as neighboring rooms in all directions) have undergone an initial radiation survey to determine usage limitations for the Mobetron machine. These limitations on the number and type of IORT treatments ensure that no hospital personnel will receive more radiation exposure than is allowed for the general public. During the 1-3 minutes that the radiation beam is on, "Radioactive" warning signs are posted on the operating room door and operating room personnel leave the operating room.

NURSE'S CHECKLIST

BRACHYTHERAPY SEED IMPLANT PATIENT CARE

1. Check for appropriate private room assignment.

2. Review ALARA concepts of time, distance & shielding.

3. Review the "Doctor's Orders Form" in the chart. Follow the nursing/visiting time and distance restrictions specified on this form.

4. Check for the "Radioactive" warning label on the cover of the patient's chart.

5. Check that the patient is wearing a radioactive-alert wristband.

6. Check for the "Radioactive" warning sign and survey form on the patient's room door.

7. If the survey form on the patient's door indicates that the dose rate at 1 meter is <0.2 mR/hr without shielding, no lead shielding is needed. Otherwise, shielding may be required. See the "Doctor's Orders Form" in the chart and the survey form on the patient's room door.

   Iodine-125 (1-125) and palladium-103 (Pd-103) can be easily shielded with a thin layer of lead, such as a lead eye patch for eye plaque patients, a lead-lined hat for brain implant patients, or lead aprons to cover the pelvis of prostate implant patients while in the post-recovery area.

8. Visitation by pregnant women and persons under 18 is discouraged. If visitation occurs, appropriate shielding must be in place, and visitors should follow time and distance restrictions.

9. Review instructions and restrictions (from the "Doctor's Orders Form" in the chart and the survey form on the patient's room door) with the patient.

10. For patients discharged from the hospital with radioactive implants in place, verify that the patient is provided with discharge instructions (Appendix 2 "Instructions for Patients").

EMERGENCY PHONE NUMBERS:

Daytime:	353-8900, 353-7175
Evenings and Weekends:	
Resident On-Call:	digital beeper 443-6248 answering service 476-4811 (24 hrs)
Attending On-Call:	443-9472 or answering service 476-4815 (24 hrs)
Brachytherapist:	digital-beeper443-4004
Physicist:	353-7190
Nucletron Emergency Service:	(800) 336-2249

PART VI: DEATH PROCEDURES WHEN RADIONUCLIDES ARE PRESENT

A. PROCEDURE AFTER DEATH OF PATIENT

1. If a patient has received brachytherapy, the radioactive source shall be removed from the body by Radiation Oncology personnel before the patient leaves the hospital room if possible. If implant material cannot be removed from the patient, notify UC Police, 9-911. UC Police will triage with EH&S Radiation Safety. Then notify Radiation Oncology (353-8900, 353-7175). (See Section V.A.10).

2. If a patient containing unsealed radioactive material dies in the Medical Center, precautions should be taken to avoid contamination. (See Sections IV.A.13, and IV.B.13).

B. CONDUCT OF AUTOPSY

1. Brachytherapy Implants (Radiation Oncology)

a. When a cadaver known to contain any radioactive material is to be autopsied, Pathology shall be notified. Permanent implants may need to be removed prior to autopsy depending on the level of residual activity. Call the Radiation Safety Officer (476-1300) or Radiation Oncology (353-8900, 353-7175) for assessment, survey, and possible source removal.

b. Once the sources have been removed, no special precautions are necessary.

2. Unsealed Sources (Nuclear Medicine)

a. The amount of activity remaining in the body should be estimated by reference to the time elapsed since the administration of the isotope and its biological fate (see "Death of Radiation Patient" form).

b. If the remaining amount is less than 5 mCi (which will be noted on the form), no special precautions are necessary other than the usual wearing of gloves.

c. In cases of I-131, where the thyroid contains most of the activity, a thyroid shield should be used. Such cases should be handled using appropriate precautions.

d. Where the residual activity exceeds 5 mCi, the following procedures shall be followed:

1) Survey the body before it is opened to establish maximum working time. Film badges shall be required. Ring badges may be required.

2) Drain carefully all body fluids and save for medical analysis, if necessary. In cases of I-131 therapy, the blood and particularly the urine will be radioactive. Dispose of fluids by flushing down the appropriate drain at least three times.

3) After the body is opened, a second survey shall be made by Nuclear Medicine (353-1693) or by EH&S Radiation Safety (476-1300), to estimate the level of beta dose for P-32 or other beta-emitting radionuclides.

4) In cases of I-131, the thyroid gland will produce a gamma dose of about 0.5 R/min near its surface for each 10 mCi in it and, consequently, should not be touched by hand directly. Its removal should be accomplished using a long instrument (12" forceps).

5) Highly radioactive fluids should be stored behind a shield. Contact Nuclear Medicine (353-1693) for further information or contact EH&S Radiation Safety (476-1300) for fluid disposal.

6) All instruments and clothing involved in the autopsy shall be monitored by EH&S Radiation Safety, 476-1300, after the procedure and they shall be stored or decontaminated before being returned to general use or dispatched to a laundry. The autopsy room should also be surveyed and decontaminated.

7) EH&S Radiation Safety (476-1300) must be consulted before releasing any corpse directly to the mortuary for embalming.

APPENDIX 1

PROCEDURES FOR DOSIMETRY AND/OR RING BADGE USERS AND COORDINATOR

A. Dosimetry Issuance Criteria

Personnel dosimeters (dosimetry badges or finger rings) are issued in order to monitor the dose to workers who in the course of their duties are likely to receive a dose in excess of 10% of the annual occupational dose limit. Please refer to Table 1-1 in Section I: Principles of Radiation Protection for the annual occupational dose limits. Workers who handle 5 mCi or more of beta or gamma emitting radioactive materials with an average energy greater than 100 keV are issued finger rings, while workers who handle 20 mCi or more of beta or gamma emitting radioactive materials with an average energy greater than 100 keV are issued dosimetry badges to monitor whole body dose. Workers who use radiation producing machines (e.g., radiographic equipment) are issued dosimetry badges to monitor their exposure. Those who are occupationally exposed to x-ray radiation from radiographic procedures or gamma or x-ray radiation from radioactive materials that have been implanted or administered to patients and who may receive a dose in excess of 10% of the annual limit of occupational dose shall be issued dosimetry. A determination of the potential for exposure that may cause a dose to a worker to reach this level is made by the Radiation Safety Program of Environment, Health & Safety. Contact the Radiation Safety Officer at 476-1300 for questions or an evaluation of the exposure potential to ionizing radiation.

B. Coordinator's Responsibility

A dosimetry coordinator is appointed by the department or laboratory to oversee the dosimetry program elements in the department or laboratory. The program elements include:

1. The maintenance of the current list of participants in the dosimetry program for the unit. It is necessary to add and delete participants to the program on the packing list that accompanies the dosimeters. A request for dosimetry can be made using the Dosimetry Request Form that can be obtained from EH&S.

2. The collection of dosimeters from the participants and exchange of dosimeters monthly;

3. The return of all dosimeters, whether used or not, to EH&S staff in a timely manner.

4. Posting or making available for participants' review the exposure reports which are issued on a monthly or quarterly basis depending on department. EH&S is the official office of record for the UCSF Dosimetry Program.

C. Participant’s Responsibility

1. Each participant in the dosimetry program is to wear the dosimeter in the proper manner when working in a radiation area and only at the work site.

2. Dosimeters are not to be worn when the worker is undergoing a radiographic, therapeutic, or Nuclear Medicine procedure. The purpose of the dosimetry program is to measure occupational dose from ionizing radiation.

3. The proper care of the dosimeter includes protecting the film badge from water damage or exposure to high heat.

4. The dosimeter should be worn at a location that will measure the dose that one may receive and so it should be worn outside any lead apron (unless a special dosimeter has been issued for under apron measurements or fetal monitoring) and at either waist or neck level. Wear the dosimeter in a consistent manner.

5. Promptly exchange the dosimeter on the designated monthly /quarterly basis.

6. Complete a Lost Badge Report should a dosimeter be misplaced.

7. Cooperate in an investigation of a high exposure in order to determine cause and work practices that may be responsible.

8. Store the dosimeter at the work site.

APPENDIX 2

RADIATION PATIENT DEATH RADIOACTIVITY REPORT

NURSING INSTRUCTIONS: (See also Radiation Protection Handbook, Sections IV, V and VI.)

Notify Nuclear Medicine (353-1693, 476-1000 off-hours) or Radiation Oncology (353-8900, 353-7175), as appropriate. If these services cannot be reached, contact EH&S Radiation Safety at 476-1300.

Give this form to the reviewing individual when he/she arrives on the unit.

___REVIEWER INSTRUCTIONS:

Please check appropriate lines and complete any necessary information.

_____This body does not contain significant amounts of radioactive material (i.e. it contains less than 5 mCi). No special precautions are required.

OR

_____This body contains a significant amount of radioactive material. The following precautions should be observed:

_____Use special precautions in transporting the body until_____

_____Do not perform autopsy until_____

_____Shielding required for_____

_____Radioactivity is concentrated in_____ therefore, use special precautions when removing the organ.

_____Flush unwanted body fluids down the special drain and flush three times.

_____Hold all other contaminated waste for EH&S clearance prior to disposal.

_____Do/____Do Not release remains to mortician prior to consulting with EH&S Radiation Safety (476-1300).

_____If the removed organs are to be dissected immediately, each one should be monitored and treated in accordance with the exposure rates.

REPORT OF RADIOACTIVITY TO MORTICIAN

The remains have been examined with the following result:

Radioactive Isotope:_____ Estimated Activity:_____

Maximum Dose Measured on Body Surface:_____ mR/hr.

_____ This body measures less than 30 mR/hr at body surface. No further precautions are required.

_____ This body measures more than 30 mR/hr at the body surface and further precautions should be observed as listed below:

_____

_____

_____

Precaution:
1. Wear vinyl gloves
2. Wear vinyl or plastic apron
3. Do not splash body fluid
4. Wash all instruments after using

Signature:_____ Date:_____

Print Name:_____

Title:_____ Department:_____

APPENDIX 3

RADIATION SIGNS, NOTICES, AND FORMS

Examples of frequently used signs, notices, and forms
for patients undergoing radioactive diagnostic or therapeutic procedures
(Not all inclusive)

See EH&S website at http://www.ehs.ucsf.edu/radiation-safety-postings

APPENDIX 5

PHYSICAL PRINCIPLES OF RADIATION AND RADIOACTIVITY

A. GENERAL INFORMATION

All substances are made of invisibly small particles called atoms. Atoms can be grouped with over 100 different varieties, each variety being called an element. Some familiar elements include oxygen, sulfur, iron, and gold. Each element itself exists in several varieties called isotopes of the element. Some of these isotopes are made up of stable atoms, while others consist of unstable or radioactive atoms. An isotope is identified by the name of the element plus a number, such as cobalt-59 (stable) or cobalt-60 (radioactive). Radioactive atoms sooner or later spontaneously change their internal composition and emit radiation. Isotopes of such atoms are called radioisotopes or radionuclides.

Appendix 10 lists the radioisotopes most commonly used by Nuclear Medicine for diagnosis and therapy. Table A-1 below lists the radioisotopes most commonly used by Radiation Oncology.

Table A-1

Radionuclide	Half-life	Photon Energies (MeV)
Cesium-137	30.0 years	0.662
Cobalt-60	5.26 years	1.17-1.33
Iodine-125	60 days	0.0285 (average)
Iridium-192	74.2 days	0.37 (average)
Palladium-103	17.0 days	0.0209 (average)
Cesium 131	9.7 days	0.26 (average)

B. TYPES OF RADIATION

Technically, visible light, microwaves and radio waves, all are different types of radiation. However, in this handbook, the word "radiation" will only mean "ionizing radiation"; that is, radiation with energy greater than 10 keV.* Several different kinds of radiation may be produced.

1. Alpha particles (actually helium nuclei) are emitted only by radioisotopes of radium, uranium, and other heavy elements. They are seldom encountered in the usual medical application of radiation. Alphas are easily shielded and do not constitute an external exposure hazard to nurses or other staff members. (However, alpha-emitting radioisotopes taken internally may be quite hazardous.) The range of alphas is about 2 inches in air and about 0.05 mm in tissue.

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* The electron-volt (eV) is a unit of energy commonly used for radiation: 1,000 eV equals 1 keV; 1,000,000 ev equals 1 MeV.

2. Beta radiation (actually high-speed electrons) is emitted by most radioisotopes. It is stopped by about one-half inch of wood, plastic, water, tissue, etc. Therefore, patients who have received radioactive material that gives off only beta radiation do not become an external radiation hazard to nurses or others.

Problems may arise, however, due to contamination of bedding, dressings, etc. Radioisotopes that emit only betas include radioactive phosphorus (P-32) and tritium (H-3).

3. Gamma radiation is a type of energy similar to light, but much more penetrating. It can penetrate through many inches of iron, wood, concrete, water, etc. Patients who have received large doses of radioactive material that emit gamma rays (for example, in undergoing some therapy procedures) may be a source of exposure to nurses and others. The gamma-emitting radioisotopes used therapeutically in medicine as sealed sources include iodine (I-125), cobalt (Co-60), iridium (Ir-192), palladium (Pd-103), and cesium (Cs-137 and Cs 131), and unsealed sources consisting of P-32, Sr-90, Ra 223, and I-131.

4. X-rays are similar in nature to gamma rays, but are emitted by x-ray machines and some radioisotopes (I-125 for example). Two kinds of x-ray machines are found in hospitals: diagnostic units and therapy units. The penetrating power of x-rays from isotopes and diagnostic units is generally modest in tissue, and quite low in lead. Therapy machine x-rays, depending on energy setting, may be extremely penetrating, depending on the type of machine. The useful beam of diagnostic and therapeutic x-ray machines is restricted by a cone or an adjustable collimator. All permanent installations of diagnostic and therapy x-ray machines are in shielded rooms. Portable x-ray machines and fluoroscopic equipment may be routinely used on certain nursing units and in surgery.

5. Neutron radiation combines the penetrating power of gamma rays with the potential hazard of alpha rays. However, neutrons are rarely encountered in a hospital environment, although high energy therapy machines may emit some neutrons. Unlike other types of radiation, neutrons may make other substances radioactive. The equipment capable of producing neutrons is found in the Radiation Oncology Department. The walls of the treatment rooms shield these neutrons so they are not a health hazard for personnel.

C. RADIOACTIVE DECAY

Half the atoms in a pure sample of a radioisotope decay in a characteristic time, therefore a radioisotope is said to have a half-life. After two half-lives, one-quarter of the original amount will remain; after three half-lives, one-eighth will remain, and so on. The half-life is a constant for any given radioisotope, and cannot be changed by temperature, chemical reaction, or anything else. Half-lives of several isotopes are given in Table A-I. An important measure of the size of a radioactive sample is the number of disintegrations (decays) per unit time in the sample. This is called the activity of the sample. Activity is proportional to the number of atoms and to the inverse of the half-life. A common unit of activity is the curie (Ci), which equals 37 billion disintegrations (decays) per second. More familiar are the millicurie (mCi - 37 million disintegrations (decays)/sec) and the microcurie (µCi - 37 thousand disintegrations (decays)/sec). Sometimes activity in Radiation Oncology is expressed as milligram radium equivalent (mg Ra eq). This is the amount of an isotope that would produce the same amount of radiation as that mass of radium. (One gram of Ra has about 1 Ci activity.) Finally, a modern unit of activity is the becquerel (Bq), defined to be one decay per second.

D. INTERACTION OF RADIATION WITH MATTER

When radiation penetrates and interacts with matter, it loses some of its energy and ionizes a portion of the atoms it encounters. The amount of energy deposited per unit mass is called the absorbed dose. A common unit of dose is the rad, which equals 100 ergs per gram of material. A more modern unit of dose is the gray (Gy); one gray equals 100 rads. Doses of therapeutic radiation are specified in rads or grays. Because radiation interacts on the molecular level, the energy it deposits is very efficient biologically. For example, a whole-body dose of 1000 rads (10 Gy) delivered in a short time will kill a human being, but will only raise the temperature of the tissues 0.004 degrees F.

Another measure of the amount of radiation is called the exposure. ("Exposure" is also used loosely to mean any irradiation.) Exposure is expressed in units of roentgens (R), milliroentgens (mR), etc., and is defined only for gamma rays and X-rays. Although exposure and dose are conceptually different, an exposure of one R will deposit a dose of about one rad in tissue for x or gamma radiation.

APPENDIX 6

EMERGENCY ADMISSION OF A PATIENT INVOLVED IN A RADIATION ACCIDENT

Protocol: Emergency Department (ED) management of patients with suspected external radiation contamination

Purpose: To provide appropriate guidelines for treatment of patients with radiation contamination and protection of staff from radioactive contamination

Equipment: See attached list

Procedure/Assessment:

I. Initial Personnel Mobilization

A. Upon notification of a radiation exposure/disaster, the Medical Center Administrator-On-Call (353-1797) is notified by the person(s) receiving the initial call. A call-back number should be obtained for verification of the exposure. If the accident is on the premises, the party is instructed to remain at their location until met by the MD/RN team. The AOC will:

1. Obtain appropriate information as to the nature of the exposure, agent of exposure, number of exposed individuals, expected time of arrival.

2. Notify UC Police (9-911). UC Police will triage with EH&S Radiation Safety.

3. EH&S Radiation Safety (476-1300) will notify the California Department of Public Health via the State Warning Center at (800) 852-7550, (24/7) if necessary.

4. Notify ED attending physician on duty or resident-in-charge and ED Nursing staff (353-1238) who will evaluate personnel available in department and secure additional nurses and physicians.

5. Notify UC Police (9-911) to secure the ED parking lot area. This area will be designated to set up a triage station and an adjacent hot zone area centered around the permanent outdoor shower stalls.

6. If the Disaster Control Center is operational, and if radiation is part of a disaster, then notify Disaster Control Center (DCC).

B. The DCC (if part of a disaster) or the AOC will:

1. Consult with OEH&S Radiation Safety regarding protective attire and floor coverings required for the MD/RN Evaluation team.

2. Ensure MD/RN team is available to evaluate and decontaminate patients and prepare PT pool room for evaluation.

3. Assign personnel to obtain supplies and equipment as needed by the MD/RN team. Supplies will be kept in the ED. (See Decontamination Supply List.)

II. MD/RN Evaluation

A. Preparation—Upon notification the team will:

1. Assemble supplies and equipment for use in decontamination areas, as needed.

2. Assess decontamination area for accessibility and remove obstacles. Work with OEH&S Emergency Response Team. The ERT will provide radiation safety service.

3. Radiation survey meters should be brought from the ED to the outdoor decontamination area, and the battery checked. Personal dosimetry cards should also be brought to the area and prepared to distribute to those responders that will need them.

4. Request campus police to secure area from traffic to permit evacuation of decontaminated patients to ED.

5. Dress in full surgical clothing.

6. Re-check equipment and area prior to arrival of patients.

B. Patient Arrival—MD/RN team will meet patients at loading area. (For accident victims on campus the MD/RN team will meet the patient at the location of the accident.)

1. Instruct ambulance or other vehicle to remain at loading area until cleared to leave by EH&S Radiation Safety.

2. Perform brief medical evaluation and first aid. EH&S Radiation Safety to perform survey for location and level of radioactivity.

3. Transfer patients to shower contamination area wrapped in clean sheet or on sheet covered stretcher.

4. If resuscitation is required, the initial evaluation and survey will be eliminated and the patient will be resuscitated and then transported.

C. Patient Treatment

1. Ambulatory Patients:

a. Identify patient and isolate all personal belongings.

b. Instruct patient to remove all clothing and place in yellow isolation bags for subsequent survey for radioactivity.

c. Save all samples of clothes, blood, urine, emesis, stool—label with name, date, and time of collection.

d. Survey with Geiger counter for areas of body with direct contamination. (Note: frequently, clothing will protect skin from contamination.)

e. Instruct patient to shower applying soap/detergent and water to all areas of body, especially those known contaminated; re-survey.

f. Patient should re-wash areas until additional washings do not result in a decrease in radioactive material contamination.

g. If still contaminated, MD/RN team will consult with EH&S Radiation Safety.

h. Once decontaminated, re-survey at edge of shower area, dress in clean gown, etc., and escort to ED for disposition.

2. Non-Ambulatory Patients in Decontamination Room

a. Cut off and remove all clothing; save in yellow plastic bags for subsequent survey.

b. Evaluate injuries.

c. Save all samples of clothing, blood, urine, stool, emesis, and label with name, date, and time of collection.

d. Survey patient with Geiger counter for areas of direct contamination.

e. Care of contaminated open wounds:

1) Wash wound and immediate surrounding areas separately and cover wound before remaining areas of body are decontaminated.

2) Wound may require irrigation and preliminary debridement. Further debridement and definitive therapy should wait until sophisticated measures may be performed and a consultant has been contacted.

3) Save any tissue removed; label with name, date, and time of collection.

f. Wash patient with soap/detergent and water, and re-survey until decontaminated.

g. Once decontaminated, place on clean sheet of stretcher and re-survey; transport to ED for disposition.

D. Clean Up

1. MD/RN team secures and labels all articles of clothing, linen, and equipment used on patients for decontamination.

2. MD/RN team removes outer surgical clothing and place in red isolation bags at door of decontamination room; then will be surveyed for radioactivity prior to leaving room.

3. EH&S Radiation Safety coordinates complete monitoring and removal of bags of contaminated articles.

Decontamination Supply List

1. Surgical clothing for personnel: masks, gloves, cover-all surgical gowns, shoe covers, caps
2. Linen: sheets, towels, patient slipper/box, patient gowns/gloves (a box), blankets
3. Paper roll to cover flooring
4. Code cart with oxygen and suction
5. Dressing supplies: scissors, razors, dressings, tape, suture sets, scalpels, wound irrigation kits
6. Specimen containers
7. Small plastic isolation bags
8. Plastic isolation bags
9. Labels, marking pens/clipboards/papers
10. Stretchers
11. Wheelchairs
12. Soap
13. Geiger counters (from EH&S Radiation Safety, 476-1300) and extra batteries, "Radiation Area" signs
14. Record/forms (ED records, ID bands, survey form)
15. Electronic or spare dosimeters (from EH&S Radiation Safety, 476-1300)

APPENDIX 7

RADIATION SAFETY FOR MIBG THERAPY PROGRAM

The MIBG Therapy Program is to be conducted primarily at the Mission Bay PCRC, although adult patients are typically treated at Parnassus. The care of these patients will require special precautions due to high dose I-131 administration. The following is an outline of the procedures to be followed:

ROOM SHIELDING

The maximum permissible radiation exposure in uncontrolled areas is 2.0 mR in any hour. Therefore, additional shielding must be provided to reduce the exposure outside the patient room(s) to 2.0 mR/hr or less. In the shielded rooms, the walls are lead shielded as are the ceiling and floor. A portable lead shield is placed at the patients bedside to shield staff and family members when entering the room.

ROOM PREPARATION

The patient room will be prepared by EH&S in a manner similar to that of an "Inpatient Therapy Room." This requires EH&S technicians to:

- Cover the entire floor with thick, plastic wrap The covering should extend up the baseboard.
- Cover the mattress and pillows with plastic wrap.
- Cover the telephone, TV control, panic button, bathroom seat, sink fixtures, light switches, bed railings, medicine table, bathroom door knob and fixtures with cellophane wrap.

Plastic lined waste containers and linen hampers are to be placed in the room.

POSTING

The door is to be posted with:

- "Caution Radioactive Material" warning sign
- Completed "Nursing Instructions Form." This will also have instructions regarding visiting times.
- Special instructions, if necessary.

FOOD SERVICE

Disposable dishes and utensils must be used. The leftover food should be placed into the designated radioactive waste container in the room, and will be removed by EH&S technicians daily. Any dishes or plastic trays that enter the room by mistake must remain in the room until surveyed and removed by EH&S.

DO NOT MIX FOOD WASTE WITH OTHER CONTAMINATED WASTE.

LINEN

Linen, towels and all other launderable items must be put into the designated linen hamper for removal by EH&S.

TOILET INSTRUCTIONS

a. The foley catheter should remain in for at least 72 hours post infusion. During this period the urine is pumped through plastic tubing into the continuous flow toilet. The pump should remain on at all times when hooked up to the foley catheter. If patients have a bowel movement while the foley catheter is in, they need to use either a bedpan or bedside commode. Only bowel excrement of small volume is allowed to be disposed in the continuous flow toilet. Larger volume excrement should be placed into a red biohazard bag and left in the bathroom for EH&S to remove.

   No items such as sanitary wipes or paper towels are discarded into the continuous flush toilet. These items will plug the toilet. It is very important that the toilet does not get plugged and overflow.

b. Once the foley catheter has been removed, the patient must flush the toilet three times upon use. Males must sit while urinating. Care should be taken to **not** contaminate the bathroom.

c. If the patient is using diapers, double-bag the diaper and place in the bathroom for pickup and disposal by EH&S. Upon discharge from PCRC, the family may be requested to continue collecting diapers at the UCSF Family House and return them to PCRC for collection by EH&S.

HOUSEKEEPING

Housekeeping must be postponed until a survey has been made at the conclusion of the room use. EH&S Radiation Safety will survey and release the room to housekeeping.

DOSIMETRY BADGES

All personnel (physicians, nurses, etc.) MUST wear a film badge or electronic dosimeter while in the patient room. Additionally, family members who enter the room are required to wear the electronic dosimeter to monitor their dose. A "Dosimetry Record Form" (see attached) will be posted for use by staff & family.

VISITING RESTRICTIONS

Visitation of MIBG patients is limited to the following:

- No visitors except parents or designated caretakers while on radiation isolation.
- No pregnant persons are allowed in the patient room or the anteroom.
- No visitors under 18 years of age are allowed in the patient room or anteroom.
- Family members are to wear disposable shoe covers, gloves and gowns when entering the patient room.
- All visitors should stop at the nurses' desk for instructions.
- Family members are instructed on how to use the radiation detection equipment just outside the room to monitor their gloves & shoe covers before exiting the room.

NURSING CARE

Nursing care is to be restricted for the term of the treatment to those activities which are essential to the well-being of the patient. The following guidelines are intended to minimize radiation exposure to the nursing staff:

- No pregnant staff shall be assigned to care for MIBG patients.
- Shoe covers, gowns and gloves are to be worn **prior to** entering room
- All blood tests should be drawn before MIBG therapy has begun.
- All nursing staff should use the radiation detection equipment located just outside the room to monitor their gloves & shoe covers before exiting the room.
- Nursing staff must also wear their permanently assigned dosimetry badges when entering the room.
- As much as possible, stay behind the bedside lead shield.
- As a general rule, blood draws should not be performed and sent to Clinical Labs within the first 72 hours post-infusion. In the event of a critical need requested by Pediatric Oncology, blood samples can be sent to Clinical Labs within the 72-hour timeframe if the tubes, plastic bag & each page of the requisition is

labeled with a “radioactive” sticker. Urine samples, however, should not be sent to Clinical Labs until 96-hours post infusion.

- If patient vomits or is incontinent on clothing, put on gloves and remove contaminated clothing, cleanse contaminated skin and cover spill with paper towels. Place all waste material in the radioactive waste bin.

- Place all gloves, shoe covers, etc. into designated radioactive waste container in the room.

- Place all material which has come into contact with the patient into the radioactive waste container in the room.

EMERGENCIES

In case of medical emergencies, such as cardiac or respiratory arrest, seizures or trauma, follow normal protocols for the treatment of the patient. The primary goal is to provide appropriate emergency medical and nursing attention to the patient, while at the same time controlling radiation exposure to staff in the PCRC or ICU. If time allows prior to entering the room:

- Wear disposable gloves, shoe covers and gowns.

- Obtain radiation dosimeters.

- Reduce skin contact to a minimum possible.

- Page the EH&S Radiation Safety Specialist on-call at 443-6888, for immediate telephone guidance on exposure issues until EH&S staff arrive.

- All personnel not involved in physical resuscitation of the patient must stay behind the bedside lead shield.

Certain emergency medical procedures can be performed in the treatment rooms by ICU staff. In that situation, the ICU staff follow the same safety precautions as the MIBG nursing staff. If the MIBG patient needs to be transferred to PICU or adult ICU then the following precautions should be followed:

- Page the EH&S Radiation Safety Specialist on-call. They will provide telephone guidance on exposure and contamination issues until EH&S staff arrive to provide an accessment.

- EH&S staff will provide onsite site- specific training.

- Before moving the MIBG patient from bed to transport guerney, cut urine catheter tube that leads to lead bucket and connect a foley bag to the end. Use absorbent material such as “chux” under the area being cut to absorb any potential drips of urine. Patient urine is radioactive so to prevent room contamination the urine needs to be securely collected in a foley bag before moving patient.

- Transportation/ICU staff should place electronic self-reading dosimeter(s) from MIBG room around their neck and take note of the existing exposure reading. ICU staff working in closest distance with patient should always wear electronic dosimeter(s).

  Once transferred to the PICU or ICU, the MIBG patient should be kept in a separate room away from other patients. Movable lead shields can be brought up by EH&S staff to provide shielding, as well as an shielded lead container for the foley bag.

  ICU staff should take turns limiting their bedside time with the patient and be aware that the radiation exposure increases dramatically the closer distance they are to the patient. Staff should also stand behind the lead shield whenever possible.

ROOM RELEASE

At the conclusion of the treatment and upon release of the patient, EH&S must be contacted to perform a survey of the room prior to authorizing release for general use. If the room is found to be contaminated, it will be decontaminated prior to release. **Do not allow "Environmental Services" or Housekeeping into the room prior to this authorization.**

WASTE DISPOSAL

EH&S has instituted a comprehensive waste monitoring program. The program includes a survey of all items, identification of contaminated waste material and its segregation from those which are not contaminated. EH&S staff will service the MIBG room daily, and has storage space designated for radioactive waste.

TRAINING REQUIREMENTS

Family members who are assisting in the MIBG patient's care will receive radiation safety training by an EH&S Radiation Safety Specialist prior to the treatment. This training will include basic concepts of radiation such as ALARA, how to reduce exposure by utilizing the lead shield, and limiting the time spent close to the patient. The family members will also be trained how to wear gloves, gown & shoe covers, monitor themselves with radiation detection equipment, and learn what to do in the event that contamination is discovered.

Nursing staff must attend annual MIBG radiation safety training conducted by EH&S, as well as periodical training sessions for new staff.

CARE INSTRUCTIONS FOR MIBG THERAPY PATIENTS

Observe all instructions which have been checked below:

Room #_____ ^{131} I Activity:_____mCi, Date:_____Time:_____

_____Patient must remain in room.

_____Use disposable dishes and utensils only.

_____Patient may not have any visitors (other than parents) while on radiation isolation.

_____No visitors under 18 years of age in patient room or anteroom.

_____No pregnant visitors in patient room or anteroom.

_____Hold all linen and disposable waste in room until cleared by Radiation Safety Office.

_____Staff must wear film badges while in patient room.

_____Work behind the bedside lead shield.

_____Wear disposable gloves and shoe covers while in the room.

_____Notify Radiation Safety Office prior to room release.

Time after Dose Admin	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6
Nurse						
Parent						

IN EMERGENCY CALL:

NAME	DAY	POSITION
		OEH&S Radiation Safety Specialist

GUIDELINES FOR HOME CARE AFTER TREATMENT WITH 131-I MIBG
(Applies To All Patients)

Duration to be established by OEH&S Radiation Safety Specialist upon discharge:

1. Patients should continue to sleep in a bed by themselves for up to 2 weeks.

2. Continue to flush toilet twice after each use.

3. Avoid extended time periods of close contact (closer than 1 meter distance) with children or pregnant women.

4. If disposable diapers are needed, collect soiled diapers in a plastic bag and store for at least 1 week before disposing in regular trash.

5. Wash hands carefully with soap and water after changing diapers or handling urine, vomitus or stool.

6. Wear plastic wristband for 1 month from date of discharge.

ELECTRONIC DOSIMETER USAGE LOG

PROCEDURE:

1. Dosimeter always remains **"ON."**
2. Record dosimeter value on this sheet before entering room.
3. Wear dosimeter at collar.
4. After use, record dosimeter value on this sheet.
5. Do not turn unit **OFF**. If turned off, turn back **on.**

Name	Date	Reading before	Reading After	EHS Use

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MIBG FACT SHEET

MIBG uses radioactive iodine (I-131) for treatment of neuroblastoma and pheochromocytoma. The radioiodine is bound to the MIBG compound which is infused into the patient.

It is important to note the following:

- The iodine is not volatile; therefore, it will not pose an inhalation hazard to those present in the room.
- A fraction of the MIBG is absorbed by the tumor, the remainder is excreted in the urine.
- During the first eight hours, there is an approximate 20% - 25% reduction in the external radiation level emitted from the patient. Within twenty-four hours, this radiation level falls to typically 50-60% of the original level measured at the completion of the I-131 MIBG administration.
- The radiation emitted from the I-131 in the patient decreases with distance by the "Inverse Square Law." This means doubling the distance will reduce the exposure to a quarter of the original value.
- Radiation Safety Office will be monitoring the radiation exposure in the room during the treatment for verification of the shielding adequacy.

EMERGENCIES

In case of medical emergencies, such as cardiac or respiratory arrest, seizures or trauma follow normal protocols for treatment of the patient. If time or conditions allow, prior to entering the room:

- Wear disposable gloves.
- Obtain pocket dosimeter
- Stay behind lead shields as much as possible.
- When leaving the area, using a Geiger counter, monitor personnel and equipment.

For immediate telephone guidance, contact the EH&S Radiation Safety Specialist by calling their pager number which is posted on the safety instruction form attached to the patient room door.

MIBG FACT SHEET
(Page 2)

EXPOSURE

The personnel exposure during contact with the patient will depend on the activity administered to the patient, distance from the patient, shielding provided and the contact time. The values listed below are calculated with the following assumption:

The contact is during the first eight hours (i.e., at the time of maximum retention).

No shielding between patient and staff. I-131 activity administered is 350 mCi.

Contact Time (min)	Calculated Exposure (mR)
15	250
30	500
45	750
60	1000

NOTE:

1. These exposures are for the skin-to-skin contact.
2. The maximum exposure is at the xyphoid or umbilicus.
3. Additional, specific information regarding the patient care will be posted for each patient.
4. Nursing staff should attempt to limit their exposure to 15 mrem per shift.

EXPOSURE LIMITS

Currently, the legal exposure limits are as follows:

- Occupationally exposed person = 5,000 mR per year whole body
- Adult member of patient family (caregiver) = 500 mR per year

A patient is considered acceptable for free release when the exposure level from the patient at one meter is 2 mR/hr or less.

APPENDIX 8

RADIATION SAFETY FOR THERAPY WITH Y-90 MICROSPHERES

Yttrium-90 Microspheres (SirSpheres or TheraSpheres) are used in the treatment of hepatic malignancies. Since hepatic malignancies are supplied principally by the hepatic artery, transarterial administration of the Y-90 via the femoral artery is ideal for treatment of these cancers. This procedure is performed in an Interventional Radiology suite using fluoroscopic guidance. Y-90 microsphere treatment involves coordination between interventional radiology, nuclear medicine and radiation safety.

The Y-90 microspheres must be regarded as being a radiation hazard to the hands of the staff preparing the specific patient dose and the staff involved in the implant procedure. This includes the staff responsible for room clearance after the procedure, typically the radiation safety specialist, but possibly also nuclear medicine technologists. Furthermore, the operations of preparing a specific patient's dose, implanting the Y-90 microspheres and clearing the delivery apparatus after the procedure, must be regarded as having the potential to be a contamination hazard.

Once the Y-90 microspheres have been implanted, the patient becomes the radiation source. The hazard posed to others by the patient is significantly less than that of the Y-90 vial alone due to tissue absorption of the emissions. There are three general radiation safety principles, which are:

- operations should be performed as quickly and efficiently as possible;
- staff should maintain as great a distance as possible from the isotope and
- appropriate shielding should be used wherever possible.

As the emission from yttrium-90 is high-energy beta, shielding is best provided with a low atomic number material such as acrylic. This reduces the amount of Bremsstrahlung radiation produced. In addition, acrylic is optically clear and permits the physician to continually observe the product and procedure. The individual patient dose vial is in its own acrylic holder designed to be seated in an accompanying acrylic box. Yttrium-90 has two features that provide inherent safety for staff and patients. These are:

- the mean penetration depth of emissions through tissue (2.5 mm) and air (3.7 m) and
- the relatively short half-life (64.1 hours)

Shielding and PPE

Shielding of staff from radiation requires:

- distance between staff and the radiation source;
- use of remote handling equipment;
- deliberate barriers when working with isotopes;
- appropriate protective clothing and
- working areas that will contain or restrict any contamination.

Radiation protection for other hospital occupants and the general public is achieved through restriction of access to procedure rooms and through strict controls on disposal of radioactive waste.

Distance between staff and the radiation source is achieved in most areas by physical distance between working areas and storage areas. Only staff involved in a procedure should be in attendance. Furthermore, staff should stand well clear at stages not directly involving them. The general rule is doubling the distance from any radiation source reduces the radiation exposure to 25%. Distance therefore provides significant shielding, particularly with the short penetration radiation produced by yttrium-90. Beta emissions from yttrium-90 are absorbed well by the air, hence the double distance rule overstates the radiation received at any given distance. These principles should be applied in the area preparing the specific patient dose, the implant suite and the recovery area.

The shipping vial, the vials containing the patient radiation dose, all instruments and disposable items used for preparing the dose and implanting the device should be handled with forceps to reduce finger doses.

Deliberate barriers to provide shielding are a mandatory requirement. Preparation of the Y-90 microspheres should be performed behind an acrylic shield. This may be of any configuration, but an acrylic shield with a cover angled open away from the operator works well. The shield should allow easy access, generally from the side of the operator's hands. Acrylic provides good shielding for beta emitters and being optically clear, provides an unobstructed field of vision. As an added precaution, the work area for dose preparation must be on a tray with a disposable absorbent lining to contain any contamination from accidental spillage.

All staff must wear appropriate protective clothing. This includes at least a protective coat or gown, preferably with full-length sleeves, but must also include a lead apron during the implant procedure involving fluoroscopy. Disposable booties and gloves (double or triple glove for staff handling the isotope) are necessary during the procedure. The microspheres form a slurry so there is always a potential risk of contamination as doses are drawn and delivered between vials, and when connecting and disconnecting tubes during the implant procedure.

Monitoring for Radiation

Monitoring of radiation exposure should occur at two levels. The first should include routine monitoring of environmental radiation contamination from beta sources (GM meter with pancake probe) and to measure bremsstrahlung radiation dose rate from the patient (ion chamber). In addition, individual personal monitoring is required for all staff handling Y-90 microspheres. (See attached radiation safety survey sheet)

All staff participating in Y-90 microsphere procedures will wear personal dosimetery. Badges should be worn to provide representative doses. In the case of Y-90 microspheres, where finger doses are potentially high, monitoring rings for personnel handling the Y-90 are used.

Y-90 Patient Nursing Care

The patient may be moved to the recovery room following the implantation procedure. Patients should receive general nursing care and hospital accommodation in line with local regulations pertaining to patients with therapeutic radioactive implants. The patient can receive normal

nutrition and fluids as tolerated immediately after the procedure. If any further patient care is required in the immediate post-procedural period; it can be safely conducted in the recovery room. The radiation hazard presented by the patient to staff is minor, as the penetration ability of the implanted radiation confines it largely within the patient. The following precautions should be observed while the patient is in the recovery room:

- pregnant staff should not attend the patient;
- staff do not require personal monitoring or dosimetry;
- visitors may be allowed for 30-40 minutes. Visitors under 15 years of age and pregnant visitors should be cautioned about close proximity to the patient;
- there is no need to collect bed linen, rubbish or items of clothing;
- should the patient need catheter bags, drainage bags etc. and these require changing, then staff should wear gloves and discharge the bags into the sluice and flush twice and
- for any questions or concerns, contact radiation safety at 476-1300 and
- if further intervention is required, the radiation safety specialist must be informed.

In the case of a patient requiring an abdominal drain, the radiation safety specialist should monitor the fluid. If the fluid is radioactive the doctor should be informed as high activity may indicate the need for medical intervention.

Patient Discharge

The discharge of patients following treatment by radioactive substances is permitted. Radiation exposure from the patient to members of the public is anticipated to be below regulatory limits. We recommend the following radiation safety precautions when the patient is discharged;

- the patient must proceed directly home. If the patient must travel by public transport, the traveling time must not exceed 2 hours;
- the patient should have a wristband placed by radiation safety which identifies the radioactive material as Y-90, notifies the patient to keep the wristband on for 30 days, and includes the contact number for UCSF Nuclear Medicine (415-535-1693);
- For the next 3 days, the patient should:
  - Sleep alone;
  - Have no pregnant visitors;
  - Not all children to sit on their lap and
  - Maintain a distance of 3 feet or more from others;
- In the next 30 days, in the event of a medical emergency or death, a family member or guardian must notify the attending medical staff or funeral director of the date and type of radioactive material. (this would also be accomplished if wristband is still present)

Emergency or Radiation Patient Death

For seizures, cardiac arrest, trauma, etc., follow normal emergency procedures. Call physician listed on Doctor's Orders Form. The physician will determine the need to triage with UC Police (9-911). Nuclear Medicine or EH&S Radiation Safety shall survey potentially contaminated items and personnel.

If the patient has died, notify UC Police (9-911) the deceased still contains radioactive material. UC Police will triage with EH&S Radiation Safety. Then notify Nuclear Medicine and the

attending physician on the Doctor's Orders Form. Any handling of the body, autopsy, embalming procedure or treatment of the body must be performed under guidance of a radiation safety specialist (476-1300).

Make sure that the morgue form for RADIATION PATIENT DEATH is completely filled out by either Nuclear Medicine or EH&S Radiation Safety. Keep one copy of the form in the chart. Send one copy of the form with the body to the morgue. Retain a copy in the morgue documentation. Place a Radioactive Label on the body bag.

In the morgue, move the body into the cold storage area. Place the Radioactive Label on the bag so that it is clearly visible. Then, flip the sign outside the door of the cold storage unit to indicate a radioactive source is inside. Place the form indicating the level of radioactivity in the holder just below the sign outside the door of the cold storage unit.

Discussion needs to take place between Radiation Safety, the morgue, the funeral home and the family regarding the following:

- Preparations of the body in the morgue and funeral home;
- Transportation of the decedent to the funeral home and funeral services;
- Burial versus cremation, including potential environmental release, and
- Viewing or funeral services.

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50 Medical Center Way
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IR SUITE L-313 ROOM SURVEY FOR Y-90 MICROSPHERES PATIENTS

Patient _____

MRN# _____

Date _____

Activity Y-90 infused _____

Post -Therapy Patient Dose Rate:

RIGHT SIDE at surface of chest _____ mR/hr, At 12" _____mR/hr At 1.0 meter_____mR/hr

LEFT SIDE at surface of chest _____ mR/hr, At 12" _____mR/hr At 1.0 meter _____mR/hr

Bicron RSO-5 ion chamber serial # _____

Post-Therapy Room Contamination Survey:

- **all IR staff gloves, gowns & shoe covers**
- **potentially contaminated waste items**
- **absorbent material used, including pad on floor next to patient**
- **floor beside table after absorbent pad is removed**

Survey results :_____

Pancake GM serial # _____ **background** _____

Survey performed by _____ **comments** _____

Start Time: _____

End Time: _____

APPENDIX 9

RADIATION SAFETY FOR THERAPY WITH Y-90 ZEVALIN

Yttrium-90 Zevalin radioimmunoconjugate is a treatment for follicular non-Hodgkin's lymphoma (NHL) that combines targeting by monoclonal antibodies with the cytotoxicity of localized radiation. Since Y-90 is a pure beta emitter, the Zevalin regimen is routinely administered as an outpatient procedure and is administered by using plastic shielding.

Until the dose has been administered, the Y-90 must be considered a radiation hazard to the hands of the staff preparing and administering the patient dose, as well as a contamination hazard.

Once the Y-90 Zevalin has been administered, the patient becomes the radiation source. The hazard posed by the patient is significantly less than that of the Y-90 vial alone due to tissue absorption of the emissions. There are three general radiation safety principles, which are:

- operations should be performed as quickly and efficiently as possible;
- staff should maintain as great a distance as possible from the isotope and
- appropriate shielding should be used wherever possible.

As the emission from yttrium-90 is high-energy beta, shielding is best provided with a low atomic number material such as acrylic. This reduces the amount of Bremsstrahlung radiation produced. Yttrium-90 has two features that provide inherent safety for staff and patients. These are:

- the mean penetration depth of emissions through tissue (2.5 mm) and air (3.7 m) and
- the relatively short half-life (64.1 hours)

Shielding

Shielding of staff from radiation requires:

- distance between staff and the radiation source;
- use of shielded or remote handling equipment;
- deliberate barriers when working with isotopes;
- appropriate protective clothing and
- working areas that will contain or restrict any contamination.

Radiation protection for other hospital occupants and the general public is achieved through restriction of access to procedure rooms, and through strict controls on disposal of radioactive waste.

Distance between staff and the radiation source is achieved in most areas by physical distance between working areas and storage areas. Distance therefore provides significant shielding, particularly with the short penetration radiation produced by yttrium-90. Beta emissions from yttrium-90 are absorbed well by the air.

Preparation of the Y-90 Zevalin should be performed behind an acrylic shield. Lead or tungsten syringe shields are not appropriate shielding for Y-90. The bremsstrahlung generated by

interaction of the high-energy beta may increase the doses of radiation rather than reduce them. Acrylic provides good shielding for beta emitters and being optically clear, provides an unobstructed field of vision. As an added precaution, the work area for dose preparation must be on a tray with a disposable absorbent lining to contain any contamination from accidental spillage. All staff must wear appropriate protective clothing, including proper PPE.

Monitoring for Radiation Contamination or Spills

Since Y-90 Zevalin is performed as an outpatient procedure, and external exposure rates in adjacent areas are minimal, a nuclear medicine injection room or examination room can be used for administration of the procedure. A Geiger-Muller survey meter should be in the room and within easy reach of the medical personnel. Thorough surveys must be performed after the procedure and following processing of any waste. Supplies for spill control, decontamination, and waste collection should be present and easily accessible before the infusion is started.

Nursing Care

It is anticipated the Y-90 Zevalin procedure will be performed outpatient. However, if nursing care is required immediately after the procedure, the radiation hazard presented by the patient to the staff would be minor, as the penetration ability of the implanted radiation confines it largely within the patient. The following precautions should be followed:

- pregnant staff should not attend the patient;
- staff do not require personal monitoring or dosimetry;
- visitors may be allowed for 30-40 minutes. Visitors under 15 years of age and pregnant visitors should be cautioned about close proximity to the patient;
- there is no need to collect bed linen, rubbish or items of clothing;
- use universal precautions and appropriate PPE
- for any questions or concerns, contact radiation safety at 476-1300.
- if further intervention is required, the radiation safety specialist must be informed.

Patient Discharge Instructions

It is anticipated the Y-90 Zevalin procedure will be performed as outpatient. Discharge of patients following treatment by radioactive substances is permitted. Radiation exposure from the patient to members of the public is anticipated to be below regulatory limits. We recommend the following radiation safety precautions when the patient is discharged;

- the patient must proceed directly home. If the patient must travel by public transport, the traveling time must not exceed 2 hours;
- For the next 3 days, the patient should:
  - Sleep alone;
  - Have no pregnant visitors;
  - Not all children to sit on their lap; and
  - Maintain a distance of 3 feet or more from others;

- In the next 30 days, in the event of a medical emergency or death, a family member or guardian must notify the attending medical staff or funeral director of the date and type of radioactive material.
- For the next year, avoid pregnancy and mothers should discontinue breastfeeding, using formula instead of breast milk.

Emergency or Radiation Patient Death

For seizures, cardiac arrest, trauma, etc., follow normal emergency procedures. Call physician listed on Doctor's Orders Form. The physician will determine the need to triage with UC Police (9-911). Nuclear Medicine or EH&S Radiation Safety shall survey potentially contaminated items and personnel.

If the patient has died, notify UC Police (9-911) the deceased still contains radioactive material. UC Police will triage with EH&S Radiation Safety. Then notify Nuclear Medicine and the attending physician on the Doctor's Orders Form. Any handling of the body, autopsy, embalming procedure or treatment of the body must be performed under guidance of a radiation safety specialist (476-1300).

Make sure that the morgue form for RADIATION PATIENT DEATH is completely filled out by either Nuclear Medicine or EH&S Radiation Safety. Keep one copy of the form in the chart. Send one copy of the form with the body to the morgue. Retain a copy in the morgue documentation. Place a Radioactive Label on the body bag.

In the morgue, move the body into the cold storage area. Place the Radioactive Label on the bag so that it is clearly visible. Then, flip the sign outside the door of the cold storage unit to indicate a radioactive source is inside. Place the form indicating the level of radioactivity in the holder just below the sign outside the door of the cold storage unit.

Discussion needs to take place between Radiation Safety, the morgue, the funeral home and the family regarding the following:

- Preparations of the body in the morgue and funeral home;
- Transportation of the decedent to the funeral home and funeral services;
- Burial versus cremation, including potential environmental release, and

Viewing or funeral services.

APPENDIX 10

(Pages A66-69)

RADPHARM - LST

MOST FREQUENTLY USED NUCLEAR MEDICINE RADIOPHARMACEUTICALS

- Dose, Biodistribution and Safety Precautions, Body Substance Isolation (BSI)

RADIOPHARM	ACTV	PHYS. T-1/2	BIO. T-1/2	STUDY DESCRIPTION	BIOLOGICAL DISTRIBUTION	PRECAUTIONS FOR HANDLING BLOOD/ EXCRETA	HOW LONG?
GALLIUM-67 Citrate	6mCi	3.25 days	2.5 days	Abscess, Infection Lung (Amiodarone)	Blood (iron binding proteins 20% in blood @ 4 hr;<3% in blood @ 24 hr. Excretion: Urine 10-30% first 24 hr. Feces 10%, 1-3 days.	Blood-use BSI Urine - use BSI Feces - use BSI	24 hours 24 hours 3 days
INDIUM-111 WBCs	0.5mCi	3 days	3 days	Abscess, Infection	Indium-111 Leukocytes: Blood 35% @ 4hr (0.06 mCi/ml); 10% @ 24 hr (0.02 Ci/ml); Marginating Pool (liver-spleen); Urine: None Feces: None	Blood WBC - use BSI first 24 hrs; BSI None	

INDIUM-111 Chloride MAA	0.5mCi			Coronary Arteries	Indium-111 MAA: Myocardium>90% Biol T-1/2 6hr. RES>90% -Transferrin 10% -Erythropoietic Marrow		
INDIUM-111 DTPA	0.5mCi	3 days	19 hours	CSF-Hydrocephalus	In-111 DTPA: CSF->Urine 65% @ 24 hrs; 85% @ 3 days; body activity retention 35 uCi after 3 days.	Urine - Use BSI	72 hours
KRYPTON-81 (gas)	1-10mCi mins.	13 secs.		Lung ventilation	Krypton-None		
IODINE-123 MIBG Adult - Pheo	10mCi max	13.2 hr	Multi-exp	Tumor diagnosis	1)Blood<10% of injection activity @ 24hr (0.05uCi/ml)	Blood - use BSI	24 hours
IODINE-123 MIBG Ped-neuroblastomas	<5mCi	13.2 hr	Multi-exp	Tumor staging	Same as Adult-Pheo	Same as Adult	24 hours
IODINE-131 Hippuran	300uCi Max	8 days	mono-exp	Kidney function	Normal kidneys: total body clearance T-1/2 = 24 min. Abnormal kidneys: Total body clearance T-1/2 = 4 hours.	Urine - use BSI	24 hours
IODINE-123 NaI	100 - 400uCi	13.2 hr	0.25 uptake thyroid imaging uptake		TB-40% of dose has a T-1/2 of 8 hours; 60% of dose has a T-1/2 of 7.6 days	Blood - use BSI Urine - use BSI	36 hours post 36 hours post

IODINE-131 NaI	0.1mCi	8 days	Multi-exp	Thyroid Uptake	TB-40% of dose has a T-1/2 of 8 hours; 60% of dose has a T-1/2 of 7.6 days.	Blood - use BSI Urine - use BSI	36 hours post 1 week post
IODINE-131 NaI	5mCi	8 days	Multi-exp	Thyroid therapy imaging mets-residual thyroid	TB - 40% of dose has a T-1/2 of 8 hours; 60% of dose has a T-1/2 of 7.6 days.	Blood - use BSI Urine - use BSI	36 hours 23 days
TECHNETIUM - 99M ECD	30mCi	6 hr	Multi-exp	Brain perfusion defects	1) 1 hour post injection approx 12% of dose in blood. 2)Urine approx 40% of injected activity @ 2 hours. 3) Feces approx 12% of injected activity.		
TECHNETIUM-99m EHIDA	1-5mCi	6 hr	T-1/2 max liver: 6 min normal pt	Hepatobiliary imaging/function	1) T-1/2 hepatic uptake = 6 min to infinity 2) Urine activity = 15 - 100% with a T-1/2 of approx 30 mins.	Blood - use BSI Urine - use BSI Stool - use BSI	1 hour 6 hours 48 hours
TECHNETIUM-99m DTPA	12mCi	6 hr	45 mins	Renal blood flow	Tc-99m DTPA: kidney clearance (GFR)	Urine - use BSI	First 12 hours
TECHNETIUM-99m HMPAO	30mCi	6 hr	Multi-exp	Brain perfusion defects	(1) 1 hr post injection approx 12% inj dose in blood; (2) Urine approx 40% of inj act @ 48 hr. (3) Feces approx 30% of inj act @ 48 hr.	Blood - use BSI Urine - use BSI Stool - use BSI	6 hours 24 hours 24 hours

TECHNETIUM-99m IDP	20mCi	6 hr	3 hours	Infarct sizing	TC-99m IDP (MDP bone): Bone 50-60% 3 hr post injection (Biol T-1/2>>Phys T-1/2 Urine 40-50% 6 hour post injection	Blood - use BSI Urine - use BSI	4 hours 24 hours
TECHNETIUM-99m MAA	2 x 2mCi	6 hr	6 hours	Coronary artery	Tc-99m MAA: Myocardium >90% T-1/2 6 hr >RES (>90% Biol T-1/2>>Phys T-1/2 Urine 1-5% (minor)	None	
TECHNETIUM-99m MDP	20mCi	6 hr	3 hours	Bone imaging	Urine: 40-50% of activity @ 3 hr.	Blood - use BSI Urine - use BSI	6 hours 24 hours
TECHNETIUM-99m Pertechnetate	0.1mCi	6 hr	I. 1.6d-77% II. 3.7d - 19% III. 22d - 4%	CSF Shunt flow quantitation	TC-99m Pertechnetate: Urine 5uCi @ 24 hr..	None	
TECHNETIUM-99m PYD RBCs	24mCi	6 hr	6 hours	Cardiac wall motion	Tc-99mRBC: RBC>80% - 10% spleen. 6uCi/ml blood @ 25mCi/70kg @ time of injection. Urine 10% of activity. Thyroid + Extrathyroidal tissue + bone 10% of activity.	Blood - use BSI Urine - use BSI	24 hours 24 hours
TECHNETIUM-99m HSA (human serum albumin)	2mCi	6 hr	15 days	Cerebrospinal fluid study for shunt patency or CSF leak	Tc-99m HSA: Biol T-1/2>Phys T-1/2	None	

THALLIUM-201	3.0 mCi	3 d	3 days	Cardiac-myocardial perfusion with Exercise/Redistribution	T1-201 Blood clearance T-1/2 2.9 min; Myocard extraction efficiency 88%; Myocard uptake plateau 5 - 15 min; Myocard uptake 4-5% of dose; Myocard clearance T-1/2 4.4 hr.	None	
TECHNETIUM-99m MAG-3	1-3 mCi	6 hr		Kidney function	Same as I-131 Hipparan	Urine - use BSI	24 hours
TECHNETIUM-99m MIBI	20mCi	6 hr		Myocardial perfusion	Clearance primarily hepatobiliary to feces, 5 - 20% urinary. Corrected for decay <1 mCi.	Urine - use BSI	24 hours
STRONTIUM-89	4mCi	50.5d	>30d	Palliation of bone pain from metastatic disease	~75% excreted within 1 1/2 weeks with approx 4:1 urine to feces ratio	Blood/Urine/Feces - use BSI	72 hours

APPENDIX 11

RADIATION ONCOLOGY PROCEDURES

Examples of most frequent special procedures
(Not all inclusive)

Refer to Section V for more detailed descriptions of
radiation protection procedures

PERMANENT PROSTATE IMPLANT

SOURCE: Multiple Cesium-131, Iodine-125, cesium 131 or Palladium-103 "seeds"

PURPOSE: To deliver radiation conformally and continuously over months to a prostate tumor

LOCATION: Operating Room- Mt Zion, Mission Bay

METHOD: Multiple radioactive seeds are permanently implanted within the prostate tumor in the operating room by Radiation Oncology personnel in conjunction with the Urologist.

SPECIAL INFORMATION/PRECAUTIONS:

During the implant procedure, a "Radioactive" warning sign is posted on the operating room door. Operating room personnel in close proximity to the patient wear lead aprons while the radiation seeds are being implanted, however most of the exposure potential for staff in this procedure comes from the use of fluoroscopic X-rays. The patient is surveyed immediately after conclusion of the surgery. In most cases, the pelvis shields the radiation sufficiently so that no radiation precautions are required, however as a good ALARA practice, a lead apron is usually placed over the patient's pelvis in the O.R. recovery area. Refer to the "Doctor's Orders" in the patient's chart and the "Radiation Survey Form" on the door of the patient's room for specific instructions. Before discharge from the hospital, the patient is given written radiation precaution instructions, a lead container, and a strainer (in the event of expulsion of a radioactive seed in the urinary stream).

PERMANENT BRAIN IMPLANT

SOURCE: Multiple Iodine-125, cesium 131 or Palladium-103 "seeds"

PURPOSE: To deliver radiation conformally and continuously over months to a brain tumor bed or brain tumor

LOCATION: Operating Room

METHOD: After tumor removal, the surgeon (with the assistance of Radiation Oncology personnel) glues radioactive seeds in place lining the resection cavity or the resection margin considered to be at high risk for tumor recurrence. The seeds are left in place permanently.

SPECIAL INFORMATION/PRECAUTIONS:

During the implant procedure, a "Radioactive" warning sign is posted on the operating room door. Operating room personnel in close proximity to the patient wear lead aprons. The patient is surveyed immediately after conclusion of the surgery. In many cases, the skull shields the radiation sufficiently so that no special radiation precautions are required, however it is standard practice at UCSF for a leaded cap to be made in O.R. before the patient arrives at Post-Operative Care. Refer to the "Doctor's Orders" in the patient's chart and the "Radiation Survey Form" on the door of the patient's room for specific instructions. The patient is given written radiation precaution instructions before discharge from the hospital.

HDR REMOTE AFTERLOADER BRACHYTHERAPY

SOURCE: A single Iridium-192 source within the HDR Remote Afterloader

PURPOSE: To deliver radiation focally and continuously to a tumor over about 10-15 minutes

LOCATION: Radiation Oncology Department

METHOD: A wide variety of tumors may be treated in this way with a wide variety of applicators, including needles, flexible catheters, gynecologic applicators, or bronchial, nasopharyngeal, or esophageal tubes. First, the applicators are placed in the patient within or adjacent to the tumor, often using conscious sedation. X-rays are taken of the area to be treated and the treatment is planned using special computer software. Then the patient is brought to the HDR room in the Radiation Oncology Department and the programmed HDR remote afterloader machine is connected to the applicator(s). The treatment is delivered over about 10-15 minutes.

SPECIAL INFORMATION/PRECAUTIONS:

The patient is not radioactive. The procedure is performed in the heavily shielded HDR room with Radiation Oncology personnel monitoring the patient from outside the room during treatment. No other radiation precautions are necessary.

INTRAOPERATIVE RADIOTHERAPY (IORT)

SOURCE: Mobetron (portable electron producing machine)

PURPOSE: To deliver radiation to a limited depth to a tumor bed during open surgery

LOCATION: Operating Room-Parnassus, Mission Bay, Mount Zion

METHOD: After as much of the tumor as possible has been removed by the surgeon, Radiation Oncology personnel position a special cone over the tumor bed and attach it to the Mobetron machine. The anesthetized patient is treated with electron radiation in the operating room using the Mobetron machine, before the surgical incision is closed. This way, skin and bowel or other important structures may be easily excluded from the radiation beam.

SPECIAL INFORMATION/PRECAUTIONS:

All operating rooms used for IORT (as well as neighboring rooms in all directions) have undergone an initial radiation survey to determine usage limitations for the Mobetron machine. These limitations on the number and type of IORT treatments ensure that no hospital personnel will receive more radiation exposure than is allowed for the general public. During the 1-3 minutes that the radiation beam is on, "Radioactive" warning signs are posted on the operating room door and operating room personnel leave the operating room. IORT procedures are typically done in OR rooms #8 or #11.

GAMMA KNIFE RADIOSURGERY

SOURCE: 192 Cobalt-60 sources housed within the Gamma Knife Unit

PURPOSE: To deliver highly focused radiation therapy to one or more intracranial targets (or occasionally targets in the nasopharynx, orbit, or just below the skull base). The most common lesions treated include malignant tumors, benign tumors, and arteriovenous malformations.

LOCATION: Radiation Oncology Department, Parnassus

METHOD: A stereotactic frame is applied to the patient's head on the morning of the procedure and an MRI scan is obtained (and, in the case of arteriovenous malformations, also an angiogram). Radiation Oncology personnel plan the treatment, which consists of one or usually multiple spots of highly focused radiation. After the plan is ready and has been approved by the Neurosurgeon and Radiation Oncologist, the patient comes to the Radiation Oncology Department for Gamma Knife treatment. Treatment duration may range from as little as 10 minutes to several hours, depending on the complexity of the treatment. The stereotactic frame is removed immediately after the treatment. CT can also be used to plan the gamma knife treatment.

SPECIAL INFORMATION/PRECAUTIONS:

The patient is not radioactive. The procedure is performed in the heavily shielded Gamma Knife room with treating personnel monitoring the patient from outside the room during treatments. Staff who enters the treatment room on a regular basis must be provided relevant safety training by either Radiation Oncology or EH&S and are required to wear dosimetry badges. No other radiation precautions are necessary.

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