Chapter 20: Management of Therapy Patients


Objective: to familiarize with radiation protection aspects related to the management of nuclear medicine therapy patients

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CHAPTER 20  

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When the patient is kept in hospital following radionuclide therapy, the people at risk of exposure include hospital staff whose duties may or may not directly involve the use of radiation.

It is generally felt that it can be effectively managed with well trained staff and appropriate facilities.
Once the patient has been released, the groups at risk include members of the patient’s family, including children, and carers; they may also include neighbours, visitors to the household, co-workers, those encountered in public places, on public transport or at public events, and finally, the general public.

It is generally felt that these risks can be effectively mitigated by the radiation protection officer (RPO) with patient-specific radiation safety precaution instructions.
Protective clothing should be used in radionuclide therapy areas where there is a likelihood of contamination. The clothing serves both to protect the body of the wearer and to help to prevent the transfer of contamination to other areas. Protective clothing should be removed prior to going to other areas.

The protective clothing may include:

- laboratory gowns
- waterproof gloves
- Overshoes

When β-emitters are handled, the gloves should be thick enough to protect against external beta radiation.
• In radionuclide therapy nuclear medicine, most of the occupational exposures come from $^{131}$I, which emits 356 keV photons.

• The attenuation by a lead apron at this energy is minimal (less than a factor of two) and is unlikely to result in significant dose reductions and may not justify the additional weight and discomfort of wearing such protective equipment.

• Typically, thicker permanent or mobile lead shielding may be more effectively applied for those situations which warrant its use.
Individual monitoring needs to be considered during the management of radionuclide therapy patients. In addition to general advice on persons most likely to require individual monitoring in nuclear medicine, consideration needs to be given to nursing or other staff who spend time with therapy patients.
Protection of the patient in therapeutic nuclear medicine is afforded through the application of the principles of **justification** and **optimization** — the principle of dose limitation is not applied to patient exposures.

A patient that has undergone a therapeutic nuclear medicine procedure is a source of radiation that can lead to the exposure of other persons that come into the proximity of the patient.

External irradiation of the persons close to the patient is related to the radionuclide used, its emissions, half-life and biokinetics.

Excretion results in the possibility of **contamination** of the patient’s environment.
The system of radiation protection handles, in different ways, people that may be exposed by therapeutic nuclear medicine patients:

- If the person is in close proximity because their occupation requires it, then they are subject to the system of radiation protection for occupationally exposed persons.
- If the person is voluntarily providing care the patient, then their exposure is considered part of medical exposure, and they are subject to dose constraints.
- If the person is simply a member of the public, then their exposure is part of public exposure.
While precautions for the public are rarely required after diagnostic nuclear medicine procedures, some therapeutic nuclear medicine procedures, particularly those involving $^{131}$I, can result in significant exposure to other people, especially those involved in the care and support of patients. Hence, members of the public caring for such patients in hospital or at home require individual consideration.
The decision to **hospitalize or release** a patient after therapy should be made on **an individual basis** considering several factors including residual activity in the patient, patient’s wishes, family considerations (particularly the presence of children), environmental factors, and existing guidance and regulations.
For some patients, hospitalization during and following treatment may be necessary and appropriate. The medical practitioners can determine that such patients may need to remain hospitalized beyond the period of time dictated by other dose constraint or clinical criteria. For example, incontinent patients or ostomy patients may require extended hospitalization to ensure safe collection and disposal of radioactively contaminated body wastes.
The **nuclear medicine physician has the responsibility** to ensure that no patient who has undergone a therapeutic procedure with unsealed sources is **discharged from the nuclear medicine facility** until it has been established by either a medical physicist or by the facility’s RPO that the activity of radioactive substances in the body is such that the doses that may be received by members of the public and family members would meet national criteria and dose constraints.
20.3 RELEASE OF THE PATIENT

20.3.1 The decision to release the patient

Iodine-131 typically results in the largest dose to medical staff, the public, caregivers and relatives.

Other radionuclides used in therapy are usually simple $\beta$-emitters (e.g. $^{32}\text{P}$, $^{89}\text{Sr}$ and $^{90}\text{Y}$) that pose much less risk.
20.3 RELEASE OF THE PATIENT

20.3.1 The decision to release the patient

The modes of exposure to other people are:

- external exposure
- internal exposure due to contamination
- environmental pathways

The dose to adults from patients is mainly due to external exposure. Internal contamination of family members is most likely in the first seven days after treatment. The risks from internal contamination of others are less significant than those from external exposure.
20.3 RELEASE OF THE PATIENT
20.3.1 The decision to release the patient

In general, contamination of adults is less important than external exposure. However, contamination of infants and children with saliva from a patient could result in significant doses to the child’s thyroid. Therefore, it is important to avoid contamination (particularly from saliva) of infants, young children and pregnant women owing to the sensitivity of foetal and paediatric thyroids to cancer induction.

Written instructions to the patient concerning contact with other persons and relevant precautions for radiation protection must be provided as necessary.
The day to day management of hospitalization and release of patients should be the **responsibility of the licensee**. In applying dose constraints, registrants and licensees should have a system to measure or estimate the activity in patients prior to discharge and assess the dose likely to be received by members of the household and members of the public.
20.3 RELEASE OF THE PATIENT
20.3.1 The decision to release the patient

- A method to estimate the acceptable activity of radiopharmaceuticals for patients on discharge from hospitals is to calculate the time integral of the ambient dose equivalent rate and compare it with the constraints for patient comforters.
- For this calculation, either a simple conservative approach based on the physical half-life of the radionuclide or a more realistic one, based on patient-specific effective half-life, can be used.
- The assumptions made in these calculations with regard to time and distance should be consistent with the instructions given to patients and comforters at the time the patient is discharged from hospital.
20.3 RELEASE OF THE PATIENT

20.3.1 The decision to release the patient

In the calculation of the effective half-life, the behaviour of 131I can be modelled using two components for the biological half-life: the extra-thyroidal (i.e. existing outside the thyroid) iodine and thyroidal iodine following uptake by thyroid tissue.

The assumptions used often err on the side of caution; it is sometimes felt that they significantly overestimate the potential doses to carers and the public.
20.3 RELEASE OF THE PATIENT

20.3.1 The decision to release the patient

• When deciding on the appropriate discharge activity for a particular patient, the licensee should take into account the transport and the living conditions of the patient, such as the extent to which the patient can be isolated from other family members and the requirement to dispose safely of the patient’s contaminated excreta.

• Special consideration shall be given to the case of incontinent patients. In some cases, such as for the elderly or children, it may be necessary to discuss the precautions to be taken with other family members.
Current recommendations regarding release of patients after therapy with unsealed radionuclides vary widely around the world. However, the decision to release a patient is based on the assumption that the risk can be controlled when the patient returns to their home. This is generally achieved by combining an appropriate release criterion with well tailored instructions and information for the patient that will allow them to deal effectively with the potential risk.
When required, the patient shall be provided with written and verbal explanation of instructions with a view to the restriction of doses to persons in contact with the patient as far as reasonably achievable, and information on the risks of ionizing radiation.

It is important to develop effective communication methods.
The amount of time that each precaution should be implemented should be determined based upon an estimate of the activity in patients prior to discharge and an assessment of the dose likely to be received by carers or members of the public under various precaution formulations as compared to the appropriate dose constraints.
Registrants and licensees should ensure that **carers** and **comforters of patients** during the course of **treatment** with radionuclides receive sufficient **written instructions** on relevant radiation protection precautions (e.g. time and proximity to the patient).
Female patients should be advised that breast-feeding is contraindicated after therapeutic administration of radionuclides, and females as well as males should be advised concerning the avoidance of conception after therapeutic administrations.
The International Commission on Radiological Protection (ICRP) and International Atomic Energy Agency (IAEA) suggest that women should not become pregnant for some time after radionuclide therapy.

<table>
<thead>
<tr>
<th>Therapy</th>
<th>Times for female avoidance of conception</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{32}$P,</td>
<td>3 months</td>
</tr>
<tr>
<td>$^{131}$I</td>
<td>4-6 months</td>
</tr>
<tr>
<td>$^{89}$Sr</td>
<td>24 months</td>
</tr>
</tbody>
</table>
The administration of therapeutic doses of relatively long lived radionuclides in ionic chemical forms to males is also a possible source of concern because of the appearance of larger quantities of these radionuclides in ejaculate and in sperm.

It is widely recommended in practice, on the basis of prudence, that male patients take steps to avoid fathering children during the months immediately following therapy.
Patients travelling after radioiodine therapy rarely present a hazard to other passengers if travel times are limited to a few hours. Travel for 1–2 h immediately post-treatment in a private automobile large enough for the patient to maintain a distance of 1 m or greater from the other vehicle occupant is generally permissible. A case by case analysis is necessary to determine the actual travel restrictions for each patient, especially for longer trips and for travel by public transport.
Current international **security measures**, such as those in place at airports, can include extremely **sensitive radiation detectors** (designed to detect levels of radioactivity far below those of concern to human health). It is quite possible that patients treated with $\gamma$-emitting radionuclides could trigger these alarms following discharge up to several weeks after treatment. Triggering of an alarm does not mean that a patient is emitting dangerous levels of radiation.

The security authorities are well aware of this possibility, and if a patient is likely to travel soon after discharge, the **hospital should provide a written statement of the therapy and radionuclide used**, for the patient to carry.
The IAEA gives an example of a credit card-style card that might be given to a patient at the time of discharge.
20.4 PUBLIC EXPOSURE

• The registrant or licensee is responsible for controlling public exposure resulting from a nuclear medicine practice.

• The presence of members of the public in and near the nuclear medicine facility shall be considered when designing the shielding and flow of persons in the facility.

• Exposure to members of the general public from released patients also occurs, but this exposure is almost always very small.
20.4 PUBLIC EXPOSURE

- The unintentional exposure of members of the public in waiting rooms and on public transport is usually not high enough to require special restrictions on nuclear medicine patients, except for those being treated with radiiodine who should receive patient-specific instructions for limiting public exposure.

- Exposure of the general population can occur through environmental pathways including sewerage, discharges to water, incinerated sludge or cremation of bodies. From the point of view of the individual doses involved, this is of relatively minor significance.
20.4 PUBLIC EXPOSURE

20.4.1 Visitor to patients

• Arrangements should be made to control access of visitors (with special emphasis on controlling access of pregnant visitors or children) to patients undergoing radionuclide therapy and to provide adequate information and instruction to these persons before they enter the patient’s room, so as to ensure appropriate protection.

• Registrants and licensees should also take measures for restricting public exposure to contamination in areas accessible to the public.
Registrants are responsible for ensuring that the **optimization process** for measures to control the **discharge of radioactive substances** from a source to the environment is subject to dose constraints established or approved by the regulatory body.

- **diagnostic patients**: no need for collection of excreta and ordinary toilets can be used
- **therapy patients**: very different policies in different countries, but, in principle, the clearance criteria should follow a dilution and decay methodology
20.4 PUBLIC EXPOSURE
20.4.2 Radioactive waste

- Much of the activity initially administered is eventually discharged to sewers. Storing a patient’s urine after therapy appears to have minimal benefit as radionuclides released into modern sewage systems are likely to result in doses to sewer workers and the public that are well below public dose limits.
- Once a patient has been released from hospital, the excreted radioactivity levels are low enough to be discharged through the toilet in their home without exceeding public dose limits.
The following aims should be considered in the design of radionuclide therapy treatment rooms and wards:

- **optimizing** the exposure to external radiation and contamination
- maintaining **low radiation background** levels to avoid interference with imaging equipment
- **meeting pharmaceutical requirements**
- ensuring **safety and security** of sources (locking and control of access)
Rooms for high activity patients should have:

- **Separate toilet** and washing facilities
- **The design of safe and comfortable** accommodation for visitors
- **Floors and other surfaces** should be covered with smooth, continuous and non-absorbent surfaces that can be easily cleaned and decontaminated
- Secure areas should be provided with bins for the **temporary storage** of linen and waste contaminated with radioactive substances.
Radiation sources used in radiopharmaceutical therapy have the potential to contribute significant doses to medical personnel and others who may spend time within or adjacent to rooms that contain radiation sources. Meaningful dose reduction and contamination control can be achieved through the use of appropriate facility and room design.
Shielding should be designed using source related source constraints for staff and the public.

The shielding should be designed using:

- the principles of optimization of protection
- taking into consideration the classification of the areas within it
- the type of work to be done
- the radionuclides and their activity intended to be used
20.5 RADIONUCLIDE THERAPY TREATMENT ROOMS AND WARDS

20.5.1 Shielding for control of external dose

• It is convenient to shield the source, where possible, rather than the room or the person.

• Structural shielding is, in general, not necessary for most of the areas of a nuclear medicine department.

• The need for wall shielding should be assessed in the design of a therapy ward to protect other patients and staff, and in the design of rooms housing sensitive instruments (e.g. well counters and gamma cameras) to keep a low background.
Typical **shielding effectiveness** values for $^{131}I$.

<table>
<thead>
<tr>
<th>Material</th>
<th>Half Value Layer</th>
<th>Tenth Value Layer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lead</td>
<td>3.0 mm</td>
<td>11 mm</td>
</tr>
<tr>
<td>Concrete</td>
<td>5.5 cm</td>
<td>18 cm</td>
</tr>
</tbody>
</table>
For **permanent shielding evaluations**, the design effective dose rate $P$ (in mSv per year or mSv per week) in a given occupied area is derived by selecting a source related dose constraint, with the condition that the individual effective doses from all relevant sources will be well below the prescribed effective dose constraints for persons occupying the area to be shielded.
20.5 RADIONUCLIDE THERAPY TREATMENT ROOMS AND WARDS

20.5.1 Shielding for control of external dose

**Typical values** for design effective dose $P$ in occupied areas adjacent to a radionuclide therapy treatment room

<table>
<thead>
<tr>
<th></th>
<th>Annual effective dose (mSv/year)</th>
<th>Weekly effective dose (mSv/week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>occupational worker</td>
<td>10</td>
<td>0.2</td>
</tr>
<tr>
<td>member of the public</td>
<td>0.5</td>
<td>0.01</td>
</tr>
</tbody>
</table>

A **critical review** of conservative assumptions should be performed, to achieve a **balanced decision** and avoid accumulation of over-conservative measures that may go far beyond optimization.
It is preferable that patient treatment rooms be for *individual patients* and adjacent to each other.

When required, shielding should be provided for nurses and visitors of radionuclide therapy patients, for which *movable shields* may be used within patient rooms.

When required, prior to each treatment, *movable shields* should be placed close to the patient’s bed in such a way that exposure of the nurses caring for the patient is minimized.
Floors and other surfaces should be:

- covered with smooth, continuous and non-absorbent surfaces
- easily cleaned and decontaminated
- finished in an impermeable material which is washable and resistant to chemical change
- curved to the walls
- with all joints sealed
- glued to the floor
The walls should be finished in a smooth and washable surface, for example, painted with washable, non-porous paint.

Control of access is required to:

- source storage,
- preparation areas
- rooms for hospitalized patients undergoing radionuclide therapy
20.5 RADIONUCLIDE THERAPY TREATMENT ROOMS AND WARDS

20.5.2 Designing for control of contamination

- A **separate toilet** room for the exclusive use of therapy patients is recommended.
- A sign requesting patients to **flush the toilet well and wash their hands** should be displayed to ensure adequate dilution of excreted radioactive materials and to minimize contamination.
- Bathrooms designated for use by nuclear medicine patients should be finished in **materials that are easily decontaminated**.
- Hospital **staff should not use patient washing facilities**, as it is likely that the floors, toilet seats and sink tap handles will frequently be contaminated.
• Management of radionuclide therapy patients should be planned and performed in a way that minimizes the spread of contamination in air and on surfaces.

• Work with unsealed sources should be restricted to a minimum number of locations.
20.6 OPERATING PROCEDURE

20.6.1 Transport of therapy doses

• Radiopharmaceuticals need to be transported within the facility in shielded, spill-proof containers if warranted by the type of radionuclide and amount of activity.

• The shielding should be such that external doses are maintained as low as reasonably achievable (ALARA).

• The facility RPO should be consulted in designing or evaluating the appropriateness of shielding and transport methods.
20.6 OPERATING PROCEDURE

20.6.2 Administration of therapeutic radiopharmaceuticals

**Administration** is normally by:

- oral route
- intravenous injection (systemic)
- intracavitary (instillation into closed body cavities).

**Shielded syringes** should be utilized to ensure that extremity doses are maintained below occupational dose constraints:

- plastic shield for beta emitting radionuclides to minimize bremsstrahlung,
- high Z materials for photon-emitting radionuclides,
- with a transparent window to allow for visualization of the material in the syringe.
20.6 OPERATING PROCEDURE

20.6.2 Administration of therapeutic radiopharmaceuticals

- For administrations by *slower drip or infusions*, the activity container should be placed within a suitable shield. In addition, consideration should be given for shielding pumps and lines.

- For *oral administrations* of therapeutic radiopharmaceuticals, the radioactive material should be placed in a shielded, spill-proof container.
20.6 OPERATING PROCEDURE

20.6.2 Administration of therapeutic radiopharmaceuticals

- Procedures for administering a therapeutic radiopharmaceutical shall include considerations to ensure as complete a delivery as possible of the prescribed therapeutic activity.
- Any retention of material in syringes, tubing, filters or other equipment utilized for administration should be analysed.
- Where appropriate, equipment should be flushed or rinsed with isotonic saline (or another physiological buffer) or water for oral administrations.
20.6 OPERATING PROCEDURE

20.6.2 Administration of therapeutic radiopharmaceuticals

- **Absorbent materials** or pads should be placed underneath an injection or infusion site.

- The facility RPO should be consulted to determine the necessity of **other protective equipment** (e.g. shoe covers, step-of-pads, etc.) for particular radiopharmaceutical therapies.

- Appropriate **long-handled tools** should be utilized when handling unshielded radioactive materials.
20.6 OPERATING PROCEDURE

20.6.2 Administration of therapeutic radiopharmaceuticals

- All materials utilized in administrations shall be considered as medical and radioactive waste, and should be labelled with the radionuclide, a radiation precaution sticker, and stored and or disposed of in a manner consistent with local regulations.
Prior to administration, the following should be verified:

- The dose on the radiopharmaceutical label matches the prescription
- Identification of the patient by two independent means
- Identity of the radionuclide
- Identity of the radiopharmaceutical
- Total activity
- Date and time of administration
- Patients have been given information about their own safety
• **Pregnancy is a strong contraindication** to unsealed radionuclide therapy, unless the therapy is life-saving. Therefore, the patient should be advised to take **appropriate contraceptive measures** in the time prior to therapy.

• The feasibility and performance of medical exposures during pregnancy require **specific consideration** owing to the radiation sensitivity of the developing embryo/foetus.

• The **ICRP** has given detailed guidance in **Publications 84 and 105**. Radiation risks after prenatal radiation exposure are discussed in detail in **ICRP Publication 90**.
20.6 OPERATING PROCEDURE

20.6.4 Exposure rates and postings

- Values of ambient dose equivalent from the patient should be determined. This information will assist in deriving appropriate arrangements for entry by visitors and staff.
- Following the administration of the therapeutic radiopharmaceutical to the patient, anterior exposure rates at the surface of and 1 m from the patient should be measured at the level of the patient’s umbilicus, using a calibrated radiation monitor (e.g. a portable ionization chamber). These initial measurements are to be taken within 1 h of administration of the radiopharmaceutical therapy.
Rooms with radiotherapy patients should be **controlled areas**. A sign such as that recommended by the International Organization for Standardization (ISO) should be posted on doors to the patient’s room and radioactive material storage areas as an indicator of radiation.
A new symbol has been launched by the IAEA and the ISO to define dangerous sources capable of death or serious injury, including food irradiators, teletherapy machines for cancer treatment and industrial radiography units.

For radionuclide therapy applications, the new symbol will not be located on building access doors, transport packages or containers.
Facilities may also consider placing a ‘radioactive precautions’ wristband on the patient’s wrist if the patient is to remain in medical confinement.

For those patients remaining in medical confinement, the patient should be resurveyed each day at the point of maximal uptake of the radiopharmaceutical.

The exposure rate or dose rate measured can then be used in determining the activity remaining in the patient as well as developing appropriate release instructions for the patient.
20.6 OPERATING PROCEDURE

20.6.5 Patient care in the treating facility

• Medical practitioners should exercise their clinical duties consistent with patient safety and good quality medical care.

• Unless otherwise specified by the facility RPO, nurses, physicians and other health care personnel are to perform all routine duties, including those requiring direct patient contact, in a normal manner.

• Medical practitioners should avoid lingering near the patient unnecessarily and should spend as little time as necessary in close proximity to radioactive materials or patients treated with radiopharmaceuticals and remain at appropriate distances.
20.6 OPERATING PROCEDURE

20.6.5 Patient care in the treating facility

- Ward nurses should be informed when a patient may pose a radioactive hazard, and advice and training should be provided.
- The training should include radiation protection and specific local rules, in particular, for situations where there is a risk of significant contamination from, for example, urine, faeces or vomiting.
- Other nursing should be postponed for as long as possible after administration, to take full advantage of the reduction of activity by decay and excretion.
20.6 OPERATING PROCEDURE

20.6.6 Contamination control procedures

- Work procedures should be formulated so as to minimize exposure from external radiation and contamination, to prevent spillage from occurring and, in the event of spillage, to minimize the spread of contamination.

- All manipulation for dispensing radioactive materials should be carried out over a drip tray, in order to minimize the spread of contamination due to breakages or spills.
20.6 OPERATING PROCEDURE

20.6.6 Contamination control procedures

- Particular attention and measures to limit spread of contamination are required in the case of incontinent patients and, in cases of oral administration, if there are reasons for believing that the patient may vomit.
- Contaminated bedding and clothing should be changed promptly and retained for monitoring.
- Crockery may become contaminated.
- Local rules should specify washing up and segregation procedures, except for disposable crockery.
20.6 OPERATING PROCEDURE

20.6.6 Contamination control procedures

• The use of **disposable plastic-backed** absorbent pads or plastic sheeting taped in place in the areas most likely to be contaminated, such as the floor around the toilet and sink, may be appropriate for a facility.

• Removal of loose contaminated items from the patient’s room should be done on a **daily basis**.

• In the event of a **large volume spill** of blood, urine or vomitus, staff should **cover the spill with an absorbent material** and immediately contact the **facility radiation safety service** for appropriate cleanup assistance and specific instructions.
20.6 OPERATING PROCEDURE

20.6.6 Contamination control procedures

After a spillage, the following actions should be taken:

- The RPO should immediately be informed and directly supervise the cleanup.
- Absorbent pads should be thrown over the spill to prevent further spread of contamination.
- All people not involved in the spill should leave the area immediately.
- All people involved in the spill should be monitored for contamination when leaving the room.
20.6 OPERATING PROCEDURE

20.6.6 Contamination control procedures

After a spillage, the following actions should be taken:

- If **clothing is contaminated**, it should be **removed** and placed in a plastic bag labelled ‘radioactive’;
- If **contamination of skin** occurs, the area should be **washed** immediately;
- If **contamination of an eye** occurs, it should be **flushed** with large quantities of water.
After a spillage, the following actions should be taken:

- If **clothing is contaminated**, it should be **removed** and placed in a plastic bag labelled ‘radioactive’;
- If **contamination of skin** occurs, the area should be **washed** immediately;
- If **contamination of an eye** occurs, it should be **flushed** with large quantities of water.
20.6 OPERATING PROCEDURE

20.6.6 Contamination control procedures

- Upon discharge and release of the patient, all remaining waste and contaminated items should be removed and segregated into bags for disposable items and launderable items.
- All radioactively contaminated waste items should be labelled with the radionuclide and a radiation precaution sticker, and be stored and or disposed of in a manner consistent with local regulations.
- The patient’s room should be checked for removable contamination utilizing appropriate survey equipment (e.g. a Geiger–Müller counter or scintillation survey meter).
- Where necessary, wipe tests should be performed.
Contamination monitoring is required for:

- all working surfaces, tools, equipment, the floor and any items removed from this area.
- protective and personal clothing, and shoes
- clothing and bedding of therapy patients.
- during the maintenance of contained workstations, ventilation systems and drains
• If the medical condition of a patient deteriorates such that intensive nursing care becomes necessary, **urgent medical care is a priority and should not be delayed**

• The **advice of the RPO** should be sought immediately

• In some cases, the patient may need to be **transferred to intensive, special care or cardiac care units**
20.7 CHANGES IN MEDICAL STATUS

- It is possible that patients in these units are in close proximity to each other with little or no shielding available. As such, radionuclide therapy patients may present a radiation hazard to other patients or medical staff.

- The RPO shall determine whether portable shielding is necessary to reduce doses to other patients or medical staff, whether specific personnel monitoring is necessary, and whether specific radiation precautions are necessary to keep radiation exposures ALARA.
20.7 CHANGES IN MEDICAL STATUS

20.7.1 Emergency medical procedures

- **Life-saving efforts shall take precedence** over consideration of radiation exposures received by medical personnel.
- Medical personnel should **proceed with emergency care**, while taking precautions against the spread of contamination and minimizing external exposure.
- The staff should **avoid direct contact** with the patient’s mouth, and all members of the emergency team should wear protective gloves.
- **Medical staff should be informed** and trained on how to deal with radioactive patients.
In the event that **surgery on a patient** is required, radiation protection considerations should not prevent or delay life-saving operations.

The following **precautions** should be observed:

- The operating room staff should be **notified**
- Operating **procedures** should be **modified** under the supervision of the RPO to minimize exposure and the spread of contamination
- Protective equipment may be used
- Rotation of personnel may be necessary if the surgical procedure is lengthy;
- The RPO should **monitor** all individuals involved;
- Doses to members of staff should be measured as required.
If it is estimated that the circulating blood or the area of the body to be treated surgically contains a significant quantity of the radiopharmaceutical, the RPO and the surgeon should discuss the procedures to be performed to keep radiation exposure to surgical personnel ALARA.

Radioactive material can be kept off of surgeons through the use of gloves (the use of double gloves may be appropriate).
20.7 CHANGES IN MEDICAL STATUS

20.7.2 The radioactive patient in the operating theatre

- Any specimens sent for pathological examination should be monitored for contamination.

- Tools and other equipment from the surgery should be monitored for radioactive contamination, decontaminated as necessary, and stored for radioactive decay or treated as radioactive waste in accordance with local regulations.
20.7.3 Radioactive patients on dialysis

- The care of patients receiving radiopharmaceutical therapy and who are on dialysis may require additional consideration.

- In general, for systemic treatments, these patients will not biologically clear radioactive materials as quickly as typical patients since the clearance is highly dependent on the schedule of the dialysis session.

- It may be necessary to reduce or otherwise adjust the activity required for a therapy.
• The decision as to the activity required for such patients should be based upon either a trace trial administration of activity and the observed elimination rate, or a careful review of the available literature for similar patient administrations.

• Typically, the largest amount of radioactivity will be eliminated during the first dialysis session following radiopharmaceutical therapy.
The RPO should assess the **radiation exposures** likely to be received by medical practitioners during the sessions.

In such cases, **no significant contamination of dialysis machines** has been reported.

In most cases, however, **no special precautions will be required** and the dialysis and radiation safety staff will advise patients on how to deal with disposables.
If a patient who still contains a therapeutic amount of radioactive material is re-admitted to the treating institution, the RPO shall be notified as soon as possible after re-admission.

Patient medical charts should include information on dates of cessation of radiation precautions.
20.7 CHANGES IN MEDICAL STATUS

20.7.5 Transfer to another healthcare facility

Patients transferred to another healthcare facility should meet the criteria for unrestricted clearance (the possibility for the generation of low level radioactive waste should be examined by the RPO of the treating facility and any issues should be discussed with the facility accepting the patient transfer).

In the rare event that the patient does not meet the criteria for unrestricted clearance, the RPO shall ensure that the facility accepting the patient transfer has an appropriate licence that would allow acceptance of the patient with therapeutic amounts of radioactive materials on board.
If the patient die in the period immediately following therapy, special consideration may need to be given to the treatment of the corpse.

The authorities in many countries now place limits on the radioactivity that may be present in the corpse before autopsy, embalming, burial or cremation.

No special precautions are required for direct burial or cremation, without embalming, provided the activity involved is not in excess of national limits.
No special precautions are required for embalming if activities do not exceed the levels mentioned in table 14 of IAEA n. 63 for autopsy.

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Activity limit (MBq)</th>
<th>Autopsy/embalming</th>
<th>Burial</th>
<th>Cremation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phosphorus-32</td>
<td></td>
<td>100 (IPEM)</td>
<td>2000 (IPEM)</td>
<td>30 (IPEM)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>300 (Aus)</td>
<td></td>
<td>400 (Aus)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>400 (S)</td>
<td></td>
<td>400 (S)</td>
</tr>
<tr>
<td>Strontium-89</td>
<td></td>
<td>50 (IPEM)</td>
<td>2000 (IPEM)</td>
<td>20 (IPEM)</td>
</tr>
<tr>
<td>Yttrium-90</td>
<td></td>
<td>200 (IPEM)</td>
<td>2000 (IPEM)</td>
<td>70 (IPEM)</td>
</tr>
<tr>
<td></td>
<td>150 (colloidal, Aus)</td>
<td></td>
<td></td>
<td>1000 (Aus)</td>
</tr>
<tr>
<td></td>
<td>450 (sealed, Aus)</td>
<td></td>
<td></td>
<td>1200 (S)</td>
</tr>
<tr>
<td></td>
<td>200 (S)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iodine-131</td>
<td></td>
<td>10 (IPEM)</td>
<td>400 (IPEM)</td>
<td>400 (IPEM)</td>
</tr>
<tr>
<td></td>
<td>450 (Aus)</td>
<td></td>
<td></td>
<td>1000 (Aus)</td>
</tr>
<tr>
<td></td>
<td>600 (S)</td>
<td></td>
<td></td>
<td>1200 (S)</td>
</tr>
<tr>
<td>Gold-198</td>
<td>150 (Aus) colloidal</td>
<td></td>
<td></td>
<td>1000 (Aus)</td>
</tr>
<tr>
<td></td>
<td>450 (Aus) sealed</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All</td>
<td></td>
<td></td>
<td></td>
<td>74 (US)</td>
</tr>
</tbody>
</table>

If the activities are greater, then a corpse should not normally be embalmed, but if embalming is required an RPO should be consulted.

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* IPEM: The Institute of Physics and Engineering in Medicine.
* Aus: Australia.
* S: Sweden.
20.8 DEATH OF THE PATIENT

20.8.1 Death of the patient following radionuclide therapy

- In cases where the death occurs in a hospital, access to the room occupied by the deceased should be controlled until the room has been decontaminated and surveyed.
- The treating medical practitioner and the RPO shall be notified immediately.
- To minimize external radiation risk, the corpse may need to be retained in a controlled area.
- Depending on the number of days that have elapsed between radiopharmaceutical treatment and death, the radiation hazard may have been reduced considerably, and precautions minimized.
20.8.1 Death of the patient following radionuclide therapy

- In the rare event that large quantities of radiopharmaceuticals are still within the body, the RPO shall identify specific radiation precautions as necessary, depending on the type of radionuclide and measured exposure rates.
- Nursing staff should be provided with instructions informing them that the normal procedure of pressing down on the abdomen of a corpse must not be performed due to the radiation and/or contamination levels that may result.
20.8 DEATH OF THE PATIENT

20.8.1 Death of the patient following radionuclide therapy

- The RPO shall notify the morgue prior to the arrival of the body, and the RPO should discuss radiation safety precautions with morgue personnel, as required.
- In most cases, if the patient has already been released from the treating facility, no special precautions are generally necessary for handling the body.
20.8.2 Organ donation

- If organ donation is being considered, the RPO shall determine necessary precautions for operating theatre personnel who will harvest the organ(s).
- Unless the organ is directly involved in the treatment regime, it is unlikely that the donated organ will contain an amount of radioactive material to cause significant damage to the organ or deliver a radiation dose to the recipient sufficient to nullify the donation. However, the nuclear medicine physician and RPO should be prepared to estimate such quantities and doses.
20.8 DEATH OF THE PATIENT

20.8.3 Precautions during autopsy

- The **dose constraints** applying to **pathology staff** responsible for the conduct of **autopsy examinations** will be either those for the general public or those for radiation workers, depending on the classification of the staff concerned.

- These constraints and the **radiation safety procedures** to be applied in practice should be determined in close consultation with the **RPO**.

- Where the possibility that the corpse may be radioactive arises, a proposed autopsy should be suspended until the situation is clarified to the greatest extent possible and a risk assessment has been undertaken by the RPO.
20.8 DEATH OF THE PATIENT

20.8.3 Precautions during autopsy

- If **death occurs within 24–48 h** post-administration, a considerable amount of activity may be present in blood and urine. In these cases, the RPO should supervise the autopsy. Any residual activity in tissue samples should be evaluated prior to releasing the samples to the pathology laboratory.

- If **death occurred more than 48 h** post-administration, there will typically be little, if any, activity in the blood or urine. In these cases, activity may only be present in residual treated areas or metastatic disease sites.

- The staff dose may be reduced by **deferring** the autopsy.
20.8 DEATH OF THE PATIENT

20.8.3 Precautions during autopsy

• **Unsealed radioactive substances** may be present in a particular body cavity or organ, or they may have concentrated after systemic administration (e.g. $^{131}$I in the thyroid gland).

• **Drainage** of the cavity or excision of the organ will reduce exposure if undertaken at the start of the autopsy.

• **β-radiation sources** may provide significant dose to the hands because they will be in close contact with body tissues and fluids; double surgical gloves may be helpful in reducing skin exposures.
20.8 DEATH OF THE PATIENT

20.8.4 Preparation for burial and visitation

- Funeral directors will need to be advised of any necessary precautions, and notification of the relevant national competent authorities may be required.
- Where the body will be prepared for burial without autopsy or embalming, if the RPO believes that the potential dose likely to be received by the personnel preparing the body will not exceed the appropriate dose constraint, burial can proceed.
- Where dose constraints may be exceeded, the RPO should provide radiation precaution information.
20.8.4 Preparation for burial and visitation

- Where the **body will be prepared** for burial **by embalming**, the RPO should **notify the morgue** that the body contains therapeutic quantities of radioactive material and should provide them with precautions to minimize radiation exposure and radioactive contamination.

**In most cases, no precautions will be necessary during visitation**
20.8 DEATH OF THE PATIENT

20.8.5 Cremation

• A proportion of the activity retained will appear in cremated remains and may be sufficient, particularly in the case of long lived radionuclides, to require controls to be specified.
• The main concern is in respect to the scattering of ashes.
• The crematorium personnel should be informed by the treating facility that the body might contain radioactive material.
• Crematorium employees may receive external or internal exposure (from inhalation of radioactive particles while handling the ashes).

No precautions are necessary as long as there is minimal time required to handle the body at the crematorium.
• The most likely **hazard to the general population** in the vicinity of the crematorium is the **inhalation of radioactive material** emitted with the stack gases.

• The potential for effective doses from cremation of **bodies containing** $^{131}$I should be evaluated. If a crematorium were to handle bodies that contain $^{131}$I and do not exceed **100 GBq** in a single year, the **effective dose to individuals in the surrounding population** would not likely exceed **0.1 mSv**. No specific radiation hazard would exist even if a crematorium were to handle several bodies per year containing $^{131}$I.
20.12 IAEA Radiological Protection in Medicine, Publication 73, Pergamon Press, Oxford (1996)
REFERENCES


