

## THE IMPORTANCE OF RADIOPROTECTION CONTROLS IN NUCLEAR MEDICINE

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### ABSTRACT

In nuclear medicine the main objective of radioprotection controls is to protect three people groups from external and internal radiation. To obtain this goal, the dose limitation system has to be followed firmly and for that, basic procedures have to be introduced. These basic procedures are the result of several activities which have to be balanced, one against the other to be effective.

The aims of radioprotection are to ensure that people are not exposed to doses enough to cause acute radiation symptoms and to limit the doses of radiation. This is achieved by the use of shielding, containment, careful design and operating and administrative procedures.

This paper presents a small list of general radioprotection problems found in nuclear medicine and establishes some rules related to the job schedule and control measures to be followed in favor of safety. By considering the general radioprotection problems, a number of factors of substantial relevance in the control of external and internal doses can be deduced and emphasis properly placed. Work with radioactive material should be concentrated on a limited number of work rooms. Good radioactive materials inventory are essential because of the potentially large diversity of material and users. Storage of radioactive materials ensure that the public is not unnecessarily exposed. Appropriate monitoring equipment should be available within each working site.

Line management commitment to safety has led to a heightened awareness for those control measures which encourages individuals to review and improve their own work rules. Investment in training programs, plant modifications and written procedures provide the necessary resource to support the dose reduction initiatives.

### 1. INTRODUCTION

Unsealed radioactive sources are used in nuclear medicine.

Radioactive sources are used in diagnostics procedures "in vivo" and "in vitro", and in some laboratories they are used in therapeutic procedures. As a consequence of the radioactive sources usage in nuclear medicine laboratory there is the risk of the external radiation and the external and internal contamination by the personnel.

In this case, the people involved in nuclear medicine laboratory job need the skill to identify the risks associated to their job and need the knowledge of radioprotection regulation and procedures to be put into practice.

### 2. FACILITIES REQUIREMENTS

The nuclear medicine laboratory workplace layout should be designed according to the radiation source containment principle. The workplace where the radiation exposure can overpass the 3/10 of the worker annual limits<sup>(1)</sup> should be classified as controlled, otherwise will be classified as supervised, save it is lower than the public annual limits and in this case will be considered as free.

The controlled and supervised workplace need to be brought together and be separated from the free workplace. They need to be well identified by visible warnings and signals at the workplace entrance and inside it. The workplace entrance needs to be controlled. The workplace site needs to be ordered in such a manner that the environment of major risk will be situated inner and the other external surroundings, that is from radioactive source handling workplace to the radioactive source fraction to be administered to the patient.

### 2.1. General Guidance Related to the Workplace

These guidances are essentially related for the contamination risk, which is the most dangerous.

- The surfaces should be washable and resistant to the chemical corrosion and warming.
- The walls and the ceilings should be covered with a washable, hard and non-porous paint.
- Material applied in covering should be easily decontaminated.
- The floor with such materials as linoleum, rubber tile or polyvinyl chloride and the junction of floor and the walls should be sealed and rounded in order to facilitate cleaning.
- The sinks should be provided with taps designed for operation by foot, knee or elbow, rather than by hand.
- The spouts used for radioactive material disposal should be connected to a waste collection tank of liquid wastes.
- A shower should be installed for emergency cases.
- Appropriate rooms should be designed for radioactive sources and radioactive waste storage.

### 2.2. Additional Guidance for Workplace

- a) Sites where radioactive material aliquotes are separated will be labeled and identified and will be provided with:
  - Walls with at least 15cm of bricks thickness in order to limit the neighbor places irradiation.
  - Showers should be installed for emergency situations.
  - Spouts used for radioactive material disposal should be connected to a waste collection tank of liquid wastes.
  - Strongbox for radioactive material storage.
  - Solid-waste collection system.
- b) In hospital patients submitted to therapy:
  - Should be hospitalized in rooms with short dimensions.

- The rooms should be classified as controlled area.
- The room should have such walls thickness that dose rate in the exterior would be lower than  $25 \mu\text{Sv/h}$ .
- The urinal of those rooms should be connected to the dilution on decay<sup>(2)</sup> tank.

c) **Other places**

Depending on the activity handled and the physical and chemical properties of the radionuclides and the activities levels, these places need to be provided with a:

- Radioactive waste temporary storage place.
- Fume cupboard for radioactive material handling.
- Bench easy to be decontaminated.
- Active sinks connected to dilution tanks.

### 3. PROTECTION REQUIREMENTS

#### 3.1 External Radiation in Controlled Areas

The radioprotection general guidance regarding the three basic factors, i.e, time, distance and shielding materials continues valid for external radiation.

a) **Radioprotection for external radiation.**

- The best shielding is distance until 1 meter because the dose value for this type of source depends inversely on the square distance from it. If we go from 1 centimeter to 1 meter the dose will be reduced by a factor of  $10^4$ , but if we go from 1 meter to 4 meters the dose value decreases only a factor of 16. Work at distances over 1 meter became difficult and the dose value decreases a little. To work at a distance of 1 meter is easy because a remote-handling tong of 30cm long more 70 cm of arm perform 1 meter. This distance limitation impose very low activity sources handling and then conversely that we need to make use of the other two basic factors.
- The dose received by a person is proportional to the time of irradiation, and then will be reduced if the radioactive material handling will be done only at the time of administration to the patient and if the people incharged of the handling work in turns.
- Do not touch the flacon that contains radioactive material with the hands, because even small, distances will reduce a lot of the doses in hands.
- Use movable shielding, particularly if the activities are higher than 10 MBq. The shielding thickness depends on the activity, the types and the energy of the radiation.
- Do not use activities bigger than necessary.
- Maintain in the laboratory only the necessary number of people to avoid unnecessary irradiation.

- To prevent and to avoid the dispersion of contamination, keeping the normal condition of personal cleanliness maintaining as regular monitoring program for contamination, using protection clothes and absorbent material if necessary.
- To the controlled and supervised are look at the behavior guidance as: don't drink, don't eat, don't smoke.
- If possible, transport radioactive material in the same containment used at the reception.

### 3.2. Radioactive Contamination in Person

Radioactive surface contamination is unwanted radioactive material deposited in an uncontrolled manner in or on animate or inanimate objects, irrespective of their situations, in such concentrations that radiological hazard is caused. In the case of personal contamination we can distinguish the external contamination, i.e., the radioactive material is on the body surfaces, using an external irradiation and the internal contamination when the radioactive material enter the body using an internal irradiation.

The protection against radioactive contamination is assured by the availability of equipment's and by the adhesion of recommendations for radioactive products handling.

#### a) In the sources handling

- The sources handling needs the glove use.
- Mouth-operated equipment, e.g., pipettes, must not be used or even be present in any radioisotope laboratory.
- The source handling should be reduced at the minimum time.
- The distance operator-source should be maximized in such a manner to propiciate good operation conditions.
- The protection shielding thickness should be in accord to the radiation characteristics.
- The radioactive substances movement needs to be done in a containment involved in a removable absorbent paper.
- A fume cupboard is necessary for solution evaporation.
- Containment container should be removed to sinks appropriated for this purpose.

#### b) In source management

During the reception of radioactive products, their characteristics need to be appropriately recorded in a log-book and then put in the storage place.

- The activity decrease due to the administration to the patient or by other reasons needs to be recorded in an appropriate log-book.
- The flacon or container with radioactive material needs to be immediately identified and in a clear manner.

- The source that becomes out of use needs to be recorded immediately in its storage place.
- The radioactive substances cannot be delivered in the environment unless they attend the regulation enforced.

c) In radioactive waste management

- The radioactive waste collected must be segregated according to the peculiar characteristics of the facility<sup>(2,3,4)</sup>.
- The empty package for radioactive material cannot be thrown into the normal inactive waste without any verification that is not containment and without to have removed any indication, warn or signal accusing radioactive material.

#### 4. RADIOACTIVE WASTE

The radioactive wastes should be object of controlled elimination.

The sealed radioactive waste can be thrown into the normal inactive waste provided the regulation<sup>(3,4)</sup> permits, conversely it needs to be eliminated by an authorized service corporation.

The environment deliveries need to be according to the international recommendations.

The human excreta can be delivered in a sewage sanitary.

#### 5. CONCLUSION

In the uncontrolled and supervised area the worker needs to know the recommendations about radioactive materials handling, at least the IAEA recommendations published in the safety series<sup>(5,6)</sup> collections, needs to wash the hands and control the surface contamination.

The dosimeter should be used in an easily looking way during his job journey.

The dosimeter needs to be maintained in an appropriate place when the user is out of the workplace. The aim is to be sure that the dosimeter was not irradiated without the presence of the user.

The radioactive wastes must be disposed in an appropriate package, classified according to their characteristics and storage in a specified and appropriate place before the disposal as normal inactive waste or an authorized activity.

#### 6. REFERENCES

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