

# **INPATIENT IODINE-131 RADIATION THERAPY: PATIENT CARE AND SAFETY PRECAUTIONS**

## **LEARNING GUIDE FOR REGISTERED NURSES AND REGISTERED PRACTICAL NURSES**

**Prepared by:** Nursing Education and Radiation  
Safety Committee  
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**NOTE** This learning guide contains information current at the time of publication. Policies and procedures and information are reviewed (at minimum) every 3 years. Please refer to related policies and procedures in the Nursing Policy and Procedure Manuals and in manuals related to practice in your clinical area for ongoing current information.

## 1.0 INTRODUCTION

The use of radiation in the treatment of cancer is based on the ability of radiation to interact with the molecules of the rapidly multiplying tumor cells to produce effects that are harmful to these cells.

This learning guide has been prepared to assist the learner in the development of the knowledge and skills required to provide nursing care for patients receiving treatment with radioactive Iodine (I-131) therapy.

### 1.1 AUTHORIZATION

To become authorized for the care of the patient undergoing radiation therapy, the nurse will review and/or complete:

- the Radiation Therapy: Patient Care and Safety Precautions learning guide;
- associated KGH radiation safety policies (please refer to Table 1 in section 4.3)
- the written authorization tests with a passing grade of at least 80% (located at the end of the guide).

### 1.2 EXPECTED COMPETENCIES

The nursing role is important in all phases of the therapy and includes:

- pre-treatment teaching and assessment;
- treatment-phase support;
- monitoring of patient condition;
- post-treatment education and follow-up.

## 2.0 IONIZING RADIATION AND RADIATION SAFETY

Ionizing radiation is any form of radiation that can ionize atoms and molecules. This means that the radiation can remove electrons from atoms or molecules through a variety of interactions. Such events generally lead to chemical reactions that leave the atoms or molecules in an altered form. For example, chemical bonds may be broken or new chemical bonds may be formed. All of the biological effects of ionizing radiation follow from such reactions.

Types of ionizing radiation include X-rays generated in X-ray equipment and various kinds of radiation emitted by radioactive material.

### 2.1 EFFECTS OF IONIZING RADIATION

#### 2.1.1 BIOLOGICAL

It is well known that ionizing radiation has detrimental effects on living things. At the cellular level the effect can be either:

- to 'kill' the cell which means to remove its capacity to divide and reproduce itself; or
- to cause a mutation or alteration in the cell's genetic material that could lead to a malignancy or, if the change is in a germ cell, to a hereditary defect.

It is worth keeping in mind that life has evolved in an environment that is full of background radiation and so our cells are very good at repairing damage to DNA molecules. In fact, many millions of strand breaks and other sorts of damage to DNA occur and are repaired in our cells every day.

#### 2.1.2 DETERMINISTIC

Deterministic effects are generally due to the killing of cells by radiation. Such effects are seen only at very high doses, for example, in patients receiving radiation therapy for a tumour. It is extremely unlikely that deterministic effects would be seen in personnel working in a hospital environment because the doses received are very low.

Sunburn, although caused by ultraviolet light, is clearly a deterministic effect. It only occurs above a threshold 'dose' and gets worse as the 'dose' increases.

#### 2.1.3 STOCHASTIC

Stochastic effects are due to radiation-induced changes to the DNA that can cause cells to become malignant. Such effects can occur at low doses where cell killing is negligible. The probability of a stochastic effect happening increases with dose, but the severity of the effect is independent of dose.

The rationale for virtually all radiation safety procedures in a hospital environment is to minimize the risk of stochastic effects.

## 2.2 RADIATION EXPOSURE TO HUMAN POPULATIONS

### NATURAL BACKGROUND RADIATION

Everyone is exposed to radiation throughout life by so-called natural background radiation. The sources are briefly described as follows:

#### Naturally Occurring Radioactive Substances

Rocks and soil contain varying quantities of naturally occurring radioactive materials (NORM). These substances include isotopes of uranium, thorium and potassium-40. All of these substances have half-lives of billions of years which implies that they have been present in the earth since its formation.

NORM is present in the earth, rocks, water and building materials. Small quantities are also found in all living things including humans. For example, about 1 potassium atom in 10,000 is the radioactive isotope, potassium-40. We all get small but measurable doses from the naturally occurring radioactive isotopes found in our bodies.

The concentration of NORM varies greatly around the world: there are locales in Brazil, India and Iran where the dose from NORM is many times higher than in North America.

Radon gas is one of the many radioactive decay products of uranium-238. It tends to collect in well-sealed basements and people breathe it and its decay products, which can then lodge in the lungs. The breathing of radon gas results in the largest source of radiation exposure from natural sources.

#### Cosmic Rays

Cosmic rays arise from the sun and other sources. Although most of them are stopped by the atmosphere, there is a measurable dose at sea level. The dose at higher elevations is higher. The cosmic ray background is much higher in airplanes flying at 35,000 feet or so; this is mainly a concern for flight crews.

#### Total Dose from Natural Background

In North America, the average dose from natural sources is approximately 3 mSv/year. This is known technically as an 'effective dose'.

### MAN-MADE SOURCES OF RADIATION

The largest dose to the population from man-made radiation sources results from medical procedures. This amounts to approximately 0.6mSv/year averaged over the population. This is about 20% of the dose received from natural sources.

Other sources include industrial sources, occupational sources, nuclear power, fallout from weapons tests, and consumer products. The dose from these sources is very small in comparison to that from medical procedures.

## 2.3 RISKS FROM EXPOSURE TO IONIZING RADIATION

### Source of Data

At the dose levels to which occupational workers are exposed, the main risks are considered to be stochastic (i.e., cancer). A number of groups of people exposed to radiation have been studied to estimate quantitative risk factors. Groups studied include the atom bomb survivors in Japan and some groups who were exposed to radiation for medical purposes.

Unfortunately, from a statistical point of view, all of these people were exposed to **high** doses of radiation, often in a **single** exposure. Estimating the risk to occupationally exposed workers involves a number of assumptions, since this group usually receives a **low** dose over a **long** period of time.

**Risk Comparison:** The following table lists some doses and compares the risk to two other well-known risky activities: smoking and highway driving.

Effective Dose (mSv)	Equivalent No. of Cigarettes	Equivalent No. of Highway km
1	300	1160
3	900	3480

At Kingston General Hospital, the workers who receive the highest doses are the Nuclear Medicine Technologists who work with radioactive materials every day. They typically receive doses of about 1 mSv/y and so their risk would fall close to the first row of the above table. This is the equivalent to smoking 300 cigarettes or driving 1160 kilometers (i.e., roughly from Kingston to Windsor and back). The bottom row shows the risk that arises from natural background radiation that we all receive.

Other personnel who work with radiation receive much lower doses and so their risks would be much lower.

## 2.4 EFFECTIVE DOSE LIMITS

Occupational dose limits (previously called maximum permissible doses) have been in existence for more than 50 years. In Canada, dose limits for people working with radioactive material are set by the Canadian Nuclear Safety Commission.

The current occupational dose limits are designed to ensure that the risk of stochastic effect (i.e., cancer induction) from radiation exposure received as a result of one's occupation is extremely low. These limits are given below.

Category	Limit (mSv/year)
Nuclear energy worker (NEW)	100 mSv over 5 years (for an average of 20 per year; maximum of 50 mSv in any given year)
Other workers and members of the public	1

Note that there is an additional dose limit for pregnant NEWs of 4 mSv once a pregnancy is declared (declaration is required by law at point of discovery of pregnancy). Other workers are expected to receive less than 1 mSv/year which is less than the limit for a pregnant NEW.

## 2.5 RADIATION PROTECTION AGENCIES/LEGISLATION

A number of agencies are involved in radiation protection in Canada. Only the first one listed below is concerned with protection from radioactive materials.

### Canadian Nuclear Safety Commission (CNSC)

The *Nuclear Safety and Control Act (NSCA)* was passed in Canada in 1997 to regulate nuclear energy and the use of radioactive materials. However, it did not come into effect until June 2000. The Canadian Nuclear Safety Commission (CNSC) writes and enforces regulations created under the Act.

### Radiation Protection Bureau (RPB)

The RPB is the branch of Health Canada that sets X-ray safety standards for all federal public service and for workers under the Canada Labour Code. They are empowered under the *Radiation Emitting Devices Act (RED Act)*. The RPB publishes Safety Code 35, which sets national standards for medical X-ray safety.

### Healing Arts Radiation Protection Act (HARP Act)

The HARP Act in Ontario was designed to regulate medical use of X-rays.

## 3.0 PROPERTIES OF RADIOACTIVE IODINE

Iodine-131 is a radioactive form of iodine that is used in the radiation therapy of various forms of thyroid disease. Iodine-131 emits two kinds of radiation: gamma rays and beta rays. The gamma rays are very penetrating and most of them will pass out of the patient and irradiate persons close to the patient. Beta rays only travel a few millimeters in tissue and irradiate only the tissues containing the Iodine-131, mainly the thyroid gland. Therefore, most of the radiation dose to the patient's thyroid gland comes from the beta radiation.

Iodine-131 behaves just as ordinary, non-radioactive iodine in the body. When it is administered, a portion is taken up by the thyroid gland, but the majority of it is excreted very rapidly.

Iodine-131 has a half-life of 8 days. This means that, after 8 days, one-half of the iodine-131 atoms in a sample of radioactive iodine decay to a non-radioactive product. After 16 days (2 half-lives), 75% will have decayed. After 80 days (10 half-lives), 99.9% of the radioactive atoms will have decayed.



## 4.0 RADIATION SAFETY IN NURSING CARE OF IODINE-131 PATIENTS

### 4.1 PRINCIPLES

Radiation protection can be summed up in four commonsense principles: time, distance, shielding and avoidance of contamination.

#### Time

Minimize your time near sources of radiation. Here, the patient is the source of radiation. So keep your time spent close to the patient as brief as possible. However, seeing to the patient's needs remains very important, so minimizing time must not compromise patient care.

#### Distance

The dose from a radiation source falls off rapidly as distance is increased. So if you merely have to talk with the patient, do so from a greater rather than a smaller distance. For example, stand 2 meters away rather than 1 meter away.

#### Shielding

The walls and doors of the two rooms used for iodine treatments (Connell 1069 and 1070) contain substantial quantities of lead to shield surrounding areas from excess radiation. The lead aprons worn in fluoroscopy suites are designed to stop diagnostic X-rays only, and will stop only a very small fraction of the gamma rays emitted by Iodine-131. Therefore these lead aprons are not recommended for use when caring for patients undergoing treatment with Iodine-131.

#### Avoidance of Contamination

Radioactive iodine is excreted in virtually all body fluids, so any portion of the room occupied by the patient can become contaminated. It is most important to take sensible precautions to avoid contamination of yourself. Standard precautions against infection are adequate to achieve this. If you do manage to ingest Iodine-131 it will concentrate in your thyroid and deliver a radiation dose to it.

### 4.2 THE ALARA PRINCIPLE

In paragraph 4a of the *Radiation Protection Regulations*, the principle of ALARA is described as:

“...(a) *keep the amount of exposure to radon progeny and the effective dose and equivalent dose received by and committed to persons as low as is reasonably achievable, social and economic factors being taken into account, through the implementation of*

- (i) management control over work practices,*
- (ii) personnel qualification and training,*
- (iii) control of occupational and public exposure to radiation, and*
- (iv) planning for unusual situations; and ...”*

The ALARA principle regulates that all aspects of radiation safety should be implemented such that(those exposed to radiation) receive the least dose possible in the given social and economic climate(s). The principle of ALARA is well established in the radiation safety community; from the design of radiation therapy bunkers to the development of nuclear medicine policies and procedures, the ALARA principle guides many of KGH (radiation therapy and safety based) policies and procedures.

### 4.3 IRRADIATING THE THYROID

Iodine-131 is often indicated for the treatment of thyroid cancer and hyperthyroidism. Because I-131 is radioactive, special precautions must be taken by the patient, the family and health care professionals.

Iodine-131 is often administered on an outpatient basis, with hospitalization required only if the dose exceeds 30 millicuries (1110 MBq).

**NOTE** MBq stands for megabecquerel. Historically, radioactive quantities were measured in curies and millicuries. When the S.I. system of units was introduced, the unit of radio-activity became the Becquerel (Bq).  $1 \text{ mCi} \equiv 37 \text{ MBq}$  (Mega-Becquerel), so  $30 \text{ mCi} \equiv 1110 \text{ MBq}$ .

As mentioned in section 4.1 above, distance, time, and shielding are important concepts in the care of the patient receiving any kind of radiation source; with unsealed radioactive sources (such as I-131), it is also important to prevent radioactive contamination of the environment. To help implement these precautions during the patients treatment, please refer to the patient education booklet '*What you need to know about your In-patient Iodine-131 treatment*' for further information.

Furthermore, there are several policies regarding Inpatient I-131 treatments; the policies (presented in Table 1 on the following page) have been setup in a step-by-step fashion to guide the readers along the process. In summary, the policies outline

- expectations on the patient and their visitors,
- expectations on the health care providers,
- work flow for treatment (i.e. who sets up the room, places signs, etc..) and
- what to do in the case of emergencies.

**TABLE 1** Outline and summary of policies regarding Inpatient I-131 treatments. Table of Contents can be found here: <http://krcc-2/DotNetNuke/DesktopDefault.aspx?tabid=841>

Step	Policy #	Policy # 08. POLICY NAME - Description <sup>1</sup> :	Location (click hyperlink below):
a)	100	<b>INPATIENT I-131 THERAPY (ACTIVITY &gt; 1.1 GBq) OVERVIEW</b> Summary of the I-131 In-patient pertinent policies.	<a href="#">Policy</a>
b)	101	<b>INPATIENT I-131 THERAPY (ACTIVITY &gt; 1.1 GBq) PATIENT EDUCATION</b> Describes the requirements for educating the patient regarding their treatment, and outlines the hospital's expectations of patients and visitors during their stay.	<a href="#">Policy</a> <a href="#">Booklet</a>
c)	102	<b>INPATIENT I-131 THERAPY (ACTIVITY &gt; 1.1 GBq) ROOM PREPARATION, SIGNAGE AND DECOMMISSIONING</b> Defines the requirements for room preparation and room decommissioning, prior to and after treatment.	<a href="#">Policy</a> <a href="#">Appendix A</a> <a href="#">Appendix B</a>
d)	103	<b>INPATIENT I-131 THERAPY (ACTIVITY &gt; 1.1 GBq) HEALTH CARE PROVIDERS</b> Describes the procedures and restrictions for staff members involved in the treatment (in nursing, nuclear medicine and environmental services).  <i>Health Care providers (i.e.; nursing, nuclear medicine and environment staff) MUST be familiar with radiation safety policy 02.102 Personal Dosimetry and Action Levels.</i>	<a href="#">Policy</a>
e)	104	<b>INPATIENT I-131 THERAPY (ACTIVITY &gt; 1.1 GBq) TREATMENT COURSE</b> Describes the procedures for administering the treatment, outlines safe practice while the patient is in the room, and describes required documentation	<a href="#">Policy</a> <a href="#">Appendix A</a>
f)	105	<b>INPATIENT I-131 THERAPY (ACTIVITY &gt; 1.1 GBq) EMERGENCIES</b> States protocols to follow in the event of an emergency such as spillage, surgery, death, etc.	<a href="#">Policy</a>

**NOTE**

<sup>1</sup> The precautions to be taken by nurses while caring for patients being treated with Iodine-131 are based on:

- compliance with the Nuclear Safety and Control Act;
- minimization of contamination of the patient's room;
- minimization of the dose to personnel and visitors arising from gamma rays emitted by the patient;
- minimization of the possibility of contamination and/or ingestion of Iodine-131 by personnel caring for the patient;
- safe handling of possible spills of radioactive materials.

## 5.0 Advanced Comp. TEST: Radiation Therapy

On the following answer sheet, circle the letter indicating the correct phrase that completes each of the following.

1. Ionizing radiation is distinguished from other forms of radiation in that it
  - a. does not penetrate solid matter
  - b. causes sunburns
  - c. ionizes atoms and molecules
  - d. feels warm
  
2. The effective dose limit for a Nuclear Energy Worker (NEW) is
  - a. 100 mSv / 5 years
  - b. 20 mSv/year
  - c. 4 mSv/year
  - d. 1 mSv/year
  
3. The effective dose limit for a pregnant Nuclear Energy Worker is
  - a. 50 mSv / remainder of pregnancy
  - b. 20 mSv / remainder of pregnancy
  - c. 4 mSv / remainder of pregnancy
  - d. 1 mSv/year
  
4. The effective dose limit for a nurse who is not designated as a Nuclear Energy Worker is
  - a. 50 mSv/year
  - b. 20 mSv/year
  - c. 4 mSv/year
  - d. 1 mSv/year
  
5. The Nuclear Safety and Control Act is enforced by the
  - a. Canadian Parliament
  - b. Radiation Protection Bureau of Health Canada
  - c. HARP Act in Ontario
  - d. Canadian Nuclear Safety Commission
  
6. The half-life of Iodine-131 is
  - a. 8 years
  - b. 8 weeks
  - c. 8 days
  - d. 131 days

7. Dosimeters provide a means of measuring
  - a. the amount of activity remaining in the patient
  - b. the amount of radiation exposure to the user
  - c. the amount of radioactivity ingested by the user
  - d. all of the above
8. The following must be posted before the therapy is administered:
  - a. the radiation warning sign
  - b. the radioisotope license and emergency contact procedures
  - c. the "Report to the Nurses Station Before Entering" sign
  - d. a&c
9. The items and surfaces the patient may come in contact with after the I-131 does has been administered must be covered to
  - a. absorb any spills that might occur
  - b. decrease the amount of spread contamination
  - c. prevent the item/surface from becoming contaminated with Iodine-131
  - d. all of the above
10. Most of the Iodine-131 administered to patients is
  - a. excreted within the first few days
  - b. retained in the thyroid
  - c. converted to other elements
  - d. retained in organs other than the thyroid
11. Radioactive iodine is excreted
  - a. only in the urine
  - b. only in feces
  - c. in all bodily fluids
  - d. only in saliva and sweat
12. The strategy that will give you the lowest dose from external sources of radiation is
  - a. minimizing your time and distance from the source
  - b. minimizing your time and maximizing your distance from the source
  - c. maximizing your distance and increasing your time near the source
  - d. maximizing your distance from the source and the time does not matter

13. In dealing with patients treated with Iodine-131, it is important to avoid contaminating yourself with radioactive iodine because
  - a. most of the dose you receive is from gamma rays emitted by the patient
  - b. any ingested Iodine-131 will go to the thyroid and irradiate it
  - c. you may acquire an infection from the patient
  - d. any ingested Iodine-131 will go to the bone marrow
14. The Radiation Safety Officer (RSO) or the Nuclear Medicine Technologist on call must be contacted if
  - a. a spill occurs
  - b. the patient vomits somewhere other than the toilet
  - c. when the patient is discharged
  - d. all of the above
15. The strategy that will promote excretion and reduce the patient's radioactivity level most quickly is
  - a. encouraging the patient to suck on sour candies
  - b. encouraging the patient to shower daily
  - c. encouraging the patient to drink plenty of fluids
  - d. instructing the patient to wear gloves when using objects in the room
16. Visitors are permitted to visit the patient after the first 24 hours as follows
  - a. the visitors are not pregnant or are not children
  - b. they may only visit for 30 minutes per day
  - c. they remain 2 meters from the patient
  - d. all of the above

**Answer Sheet for Take Home Test for Radiation Therapy**

Name \_\_\_\_\_ Date \_\_\_\_\_

1. a b c d

2. a b c d

3. a b c d

4. a b c d

5. a b c d

6. a b c d

7. a b c d

8. a b c d

9. a b c d

10. a b c d

11. a b c d

12. a b c d

13. a b c d

14. a b c d

15. a b c d

16. a b c d

## 8.0 REFERENCES

Please refer to Table 1.

Please refer to CNSC regulations including:

Nuclear Safety and Control Act

<http://laws-lois.justice.gc.ca/eng/acts/N-28.3/index.html>

General Nuclear Safety and Control Regulations

<http://laws-lois.justice.gc.ca/eng/regulations/sor-2000-202/page-1.html>

Radiation Protection Regulations

<http://laws-lois.justice.gc.ca/eng/regulations/sor-2000-203/page-1.html>



## 10.0 EVALUATION OF LEARNING GUIDE

Your feedback and comments are most appreciated. Thank you for your time in responding to this questionnaire. It will help us in planning/revising learning materials.

Circle appropriate response                      Strongly agree                      Strongly disagree

1. The content was clear and easy to understand.                      1                      2                      3                      4                      5

Comments:

2. The content was relevant.                      1                      2                      3                      4                      5

Comments:

3. My learning needs were met.                      1                      2                      3                      4                      5

Comments:

4. This guide (and referenced policies) will help me to meet the knowledge/skill requirements necessary to care for patients receiving I-131 treatment.                      1                      2                      3                      4                      5

Comments:

Additional comments/suggestions:

Please return completed evaluation to your Clinical Learning Specialist.

Thank you.