

Assessment of Personnel Dosimetry in Radiotherapy at Cancer Institute Guyana

Basmattie Sawh¹, Deivis Errada² and Petal Surujpaul^{3*}

¹Medical Imaging, Faculty of Health Sciences, University of Guyana, Guyana

²Medical Physicist, Cancer Institute of Guyana, Guyana

³Medical Physicist, Georgetown Public Hospital Corporation, Guyana

*Corresponding author: Surujpaul PP, Department of Radiology, Medical Physicist, Georgetown Public Hospital Corporation, University of Guyana, East & Thomas Streets, North Cummingsburg, Georgetown, Demerara 00000, Guyana, Tel: +1592-650-076; E-mail: psurujpaul@gmail.com

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Abstract

The only radiotherapy facility in Guyana, located at Cancer Institute Guyana (CIG) has a linear accelerator (LINAC), potential to produce photons of 6 Megavolts and 6 electrons energies of 5,7,8,10,12 and 14 MeV. This research aims to evaluate the levels of ionizing radiation retrospectively received by the OEP in the radiotherapy facility at CIG for 5 consecutive years from 2010 to 2014 inclusively and to relate the findings to the national and international dose limits of 20 mSv/year, for both safety and regulatory purposes to avoid and/or reduce biological effects. The Occupationally Exposed Personnel (OEP) are routinely monitored by the quarterly genesis Ultra TD dosimeter authorized by Sierra Radiation Dosimeter Service. Even though the results were well below the National and International dose limit, the results produced a variation of more than 2.1 mSv with a minimum mean annual dose of 0.264 mSv and a maximum mean annual dose of 2.353 mSv. Each OEP dose readings throughout the years was significantly below 5 mSv/year. These results allows the researcher to conclude even though the dose is well below 20 mSv, the need for optimization still applies. Background radiation, cannot be removed completely, but continuous monitoring should be done to help keep allows for radiation dose As Low As Reasonable Achievable (ALARA).

Keywords: Radiotherapy; Low dose rate; Thermoluminescent dosimeter; Occupationally exposed personnel

Abbreviations: ALARA: As Low As Reasonable Achievable; OEP: Occupationally Exposed Personnel; CIG: Cancer Institute Guyana; ICRP: International Commission on Radiological Protection; PD: Personnel Dosimetry; TD: Thermoluminescent Dosimeter; SRDS: Serria Radiation Dosimetry Service; LDR: Low Dose Rate

Introduction

Radiotherapy is used to treat cancers by destroying the harmful tumours using radiation sources in the form of X-rays, gamma rays and particles. In the radiotherapy department occupationally exposed personnel are exposed to continuous radiation. In Guyana the only radiotherapy facility is located at cancer institute and is in existence since June 2006 [1].

The therapy is given externally in the form of teletherapy, the linear accelerator at cancer institute produces energy for therapeutic purposes of 6 megavolts and electrons of 5,7,8,10,12 and 14 MeV for therapeutic purposes. One of the harm likelihood to happen is the biological effects (stochastic and deterministic effects). One of the three principles of radiation protection is optimization [2-4].

The ICRP strive to promote awareness radiological protections, guidance and recommendations to reduce unnecessary radiation to avoid inequitable exposure of OEP and the member of the public e.g. the ALARA program. The International Commission on Radiological Protection (ICRP) set dose limits for OEP is 20 mSv/year [5-8].

The ICRP dose limits are intended to serve as a boundary condition to limit the risk of stochastic effects such as cancer, genetic effects and to prevent deterministic effects such as cataracts, erythema etc. Although Guyana's national dose limit legalization is pending, it follows the International Commission Radiological Protection (ICRP) dose limit of 20 mSv/year.

Personnel dosimetry is a monitoring tool that is used to measure the amount of radiation dose Occupationally Exposed Personnel (OEP) receives, this does not protect the OEP against ionizing radiation, and hence it's important to assess personnel dosimetry to avoid biological effects to the OEP [9-14]. Dosimeters are used to measure and evaluate, the exposure of ionizing radiation instantly or over a period of time, these devices are able to easily differentiate between the different energies ranges e.g. X-ray, gamma rays. The assessment can be made instantaneously, in one month or several months this would depends to the device used to monitor the radiation dose. The dosimeters can accurately measure the radiation dose. There are three wear period of dosimeter, the monthly, quarterly and yearly dosimeter [15].

CIG uses the quarterly Thermoluminescent Dosimeter (TD) to monitor the OEP from Serria Radiation Dosimetry Service. TD dosimeters contains storage phosphors, in which a small amount of the electrons raised to the excited states by ionizing radiation becomes trapped in excited states and heat is being produced. The advantages of TD dosimeter are TD has a high sensitivity, physically small in size which makes it easy for OEP to wear and its equivalence to body tissues. The minimum reported dose of the TD is 1 mrem (0.01 mSv). These dosimeter responses accurately to X-ray, Beta, Gamma and

neutron radiation. TD badge material is lithium fluoride (LiF: Mg, Cu, P) [16-20]. This research analyzes radiation dose received by the OEP of CIG radiotherapy facility within the years 2010-2014 inclusively (5 years period) and compares the readings to the National and International Dose limit (20 mSv/year).

Some of the limitations related to the research are, the researcher is assuming the reports at Cancer Institute are accurate, the dosimeters are correctly worn by Occupationally Exposed Personnel, the dosimeter readings are in file for the years 2010-2014, dosimeters are irradiated when not being used worn by the Occupationally Exposed Personnel, Occupationally Exposed Personnel not wearing the dosimeters when exposed to ionizing radiation and dosimeters are not worn correctly e.g. the chest dosimeter should be placed at the level of the chest.

Hypothesis

The radiation dose occupationally exposed personnel received for five consecutive years will be well below the national and international dose limit (20 mSv/year).

Aim

The aim of this project is to identify and monitor the amount of radiation dose occupationally exposed personnel of cancer institute radiotherapy facility received within the years 2010-2014 by deducing instantaneous reading from extrapolation of dosimeter reading.

Objectives

The objectives of this project are:

- To collect dosimetry reading of the occupationally exposed personnel within the period of year 2010-2014.
- To evaluate trends in the radiation dose received by occupationally exposed personnel of cancer institute radiotherapy facility for the 5 year period.
- To compare and consolidate dosimetry reading for OEP in radiotherapy facility at cancer institute to the national and international standard.
- To eliminate any option that would lead to an annual individual dose greater than the set ICRP dose limit (20 mSv/year) [4] using IAEA radiological protection measures needed to meet the optimization principle [1].

Significance of research

Radiotherapy services uses a higher level of radiation than diagnostic imaging, energy range of 6 MeV-18 MeV and approximately 10-150 kV respectively, it would be important to estimate the amount of radiation dose received by occupationally exposed personnel to reduce unnecessary exposure to occupationally exposed personnel and practice dose optimization to eliminate options that would lead to higher dose than the set dose limit to avoid biological effect, since the current prudent assumption is that any dose, might cause some degree of harm. The threshold dose (2 Gy) is a lot higher than the set ICRP dose limit (20 mSv/year). The current dose limits are set to assure that short-term effects of radiation are avoided, and the risk of long term effects (induction of cancer, genetic effects, and effects on the fetus) are held to an acceptable level [21]. The researcher is evaluating trends in

the OEP dose levels to check how close the dose is to the dose limit and the possibility of stochastic effects the OEP have.

Materials and Method

Materials

The materials needed to conduct this research are: The dosimetry report: The dosimetry report for OEP at Cancer Institute for the years 2010-2014 will be used to find amount of radiation dose the occupationally exposed personnel are exposed to for the five consecutive years [22].

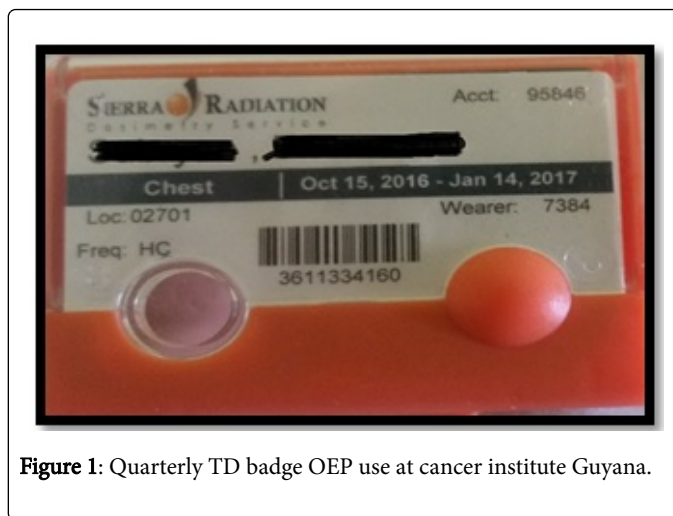


Figure 1: Quarterly TD badge OEP use at cancer institute Guyana.

Methodology

This research project is a retrospective study to assess radiation dose OEP in radiotherapy received in five (5) consecutive years (2010-2014) at cancer institute Guyana.

This research was completed by: Access and digitized the dosimetry reading for the OEP at CIG radiotherapy facility for the years 2010-2014. The deep dose equivalent (whole body exposure dose) was converted from millirem (mrem) to milliSieverts (mSv) where 1 mrem=0.01 mSv [23]. The control dose reading was digitized for each year. The readings were analyzed annually to the dose limit and recommendations were made. The researcher compared the annual dose readings for occupationally exposed personnel to the national and international dose limit (20 mSv/year) (Table 1).

Category of Occupationally Exposed Personnel	
Technical Team	Technicians
	Radiation Therapist
	Medical Physicist
	Radiologist
Medical Team	Radiation Oncologist
	General Manager

Table 1: The category of OEP at cancer Institute.

The primary source for ionizing radiation from a LINAC of 6MV to OEP is scattered radiation. The results obtained retrospectively at Cancer Institute, Guyana for the OEP was well below the national and international (ICRP) dose limit per quarter (5 mSv) and yearly (20 mSv). Cancer apart from radiotherapy service, Cancer Institute, Guyana (CIG) also offers other services that use ionizing radiation such as CT, X-rays, mammograms and brachytherapy [24-28]. Two significant changes occurred at CIG during these 5 years, in October 2012 the old Linear Acceleration (LINAC) was decommissioned and February 2013, a replacement LINAC was commissioned in which there was a downtime in the LINAC where there was no radiotherapy as shown in Figure 1, there was a significant drop in the Dose in 2012 and 2013 during the down time of the LINAC. In March 2013 the Low Dose Rate (LDR) brachytherapy services using cesium 137 ceased, this could be a contributing factor for the dose readings in the years LDR service was offered [29-32].

Results and Discussion

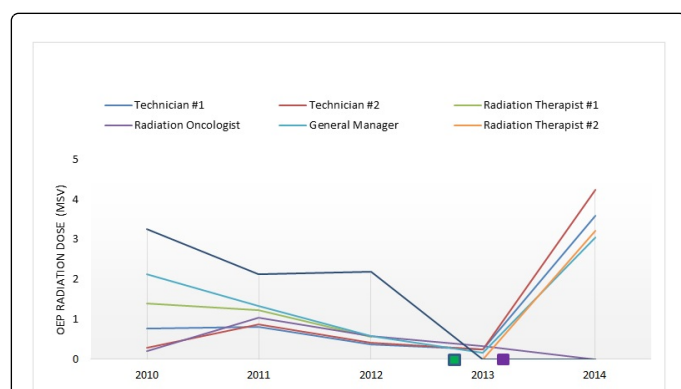


Figure 2: OEP annual Dose readings for the years 2010-2014 at CIG Radiotherapy Facility. Annual TD reading for the OEP in the Radiotherapy facility at Cancer Institute, Guyana which includes technicians, radiation therapist, radiation oncologist and the general manager. Each OEP dose was well below the national and international (ICRP) dose limit however 2012 and 2013 has the lowest readings and 2014 being the highest TD dose readings.

TD's can be affected by other sources of radiations such as UV rays, if the TD's exit the facility with the OEP, this can cause the electrons to rise to the excited state and be trapped by the crystals (LiF) and read off as a dose from the institution. The control badge is a separate dosimeter that can be physically be placed by personnel, the results shows that the controls badge location varied, however in 2013 and 2014 the placement began to rectified where the readings were consistent. The purpose of the control dosimeter is to eliminate background readings from the TD's.

Recommendations

- The overall OEP dose is dependent on the control badge, the control badge should always kept in a low background location and should never be reassigned to OEP for individual monitoring.
- The OEP should adhere to the sierra radiation recommendation for TD badges.
- Continuous education (e.g. workshops, conference) for OEP to educate and remind them of effects of radiations.

- Cancer institute uses a monthly TD or real time dosimeter badge to reduce uncertainties.

Conclusion

Although the occupationally exposed personnel's doses are three times below the national and international dose, it is essential that institutions that perform activities involving radiation exposures follows the protocols established and practice optimization to keep the dose As Low As Reasonably Achievable (ALARA principle). Background radiation, which is higher for radiotherapy than diagnostic modalities is a permanent feature of the environment presently and thus cannot be removed completely however it can be restricted to reduce the amount of radiation OEP receives.

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