

## Medical Exposure of the Radiotherapy Department Staff at the Regional Oncology Centre in Agadir

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### Abstract

### Original Research Article

**Objective:** The purpose of this study is to estimate the annual dose received by the different categories of personnel following their exposure to ionizing radiation during their exercise at the external radiotherapy department of the Regional Center for Oncology in Agadir. **Materials and methods:** Operational dosimeters and a TERRA Survey meter were used to measure the dose rate and the dose around equipment operating with ionizing radiation. An Inspector detector is used to evaluate the reliability of these two measuring instruments. It is 7% and 7.83% respectively for operational dosimeters and the TERRA Survey meter. The annual exposure dose was calculated by multiplying the dose rate by the occupational treatment time. **Results:** The relative error recorded during simultaneous measurements at the same points by both measuring devices ranges from 5.88 to 9.78% with an average error of 7.83%. The average dose rate measured for category A ranges from 0.108 $\mu$ Sv/h to 0.158 $\mu$ Sv/h with an average value of 0.132 $\mu$ Sv/h. It is 0.101 $\mu$ Sv/h for category B. For category C, it is 0.073 $\mu$ Sv/h. The estimated annual doses for the three categories of personnel are 0.185mSv for category a, 0.141mSv for category B and 0.102 mSv for category C. **Conclusion:** The estimated annual exposure doses for the three categories of personnel are well below the dose limits set by national regulations and by the International Commission on Radiological Protection (ICRP). Consequently, the RCO in Agadir provides convenient radiation protection conditions for staff and patients.

**Keywords:** Medical Exposure, Radiotherapy, Regional Oncology Centre in Agadir.

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## INTRODUCTION

Ionizing radiation has many applications in various fields, mainly in medicine, agriculture, industry and research. In the medical field, ionizing radiation is used either for imaging or to treat patients suffering from tumors [1]. According to the World Health Organization, the medical use of ionizing radiation represents 98% of the dose of artificial origin received by the population each year in the world [2]. In this context, there are many medical techniques used to treat different tumors, including radiotherapy, which uses high-energy ionizing radiation to destroy cancer cells. Its objective is to deliver as precisely as possible the prescribed radiation dose to the volume of the tumor, while sparing the surrounding healthy tissues as much as possible [1].

In accordance with the provisions of the French Labour Code and the Institute for Radiological

Protection and Nuclear Safety, monitoring of workers' exposure to ionizing radiation is carried out whenever they are likely to be exposed to a risk due to ionizing radiation. On the basis of a dosimetric study, the employer classifies the personnel by category [3].

According to Moroccan regulations on protection against ionizing radiation, workers must be subject to special medical surveillance and individual assessment of the doses received [4]. This assessment must be based on individual control of external exposure and internal contamination.

In Morocco, the absence or rarity of previous studies on exposure to ionizing radiation of different categories of personnel working in a medical facility motivated us to undertake this study [5-7]. The objective of this work was to estimate the annual dose received by the different categories at the external

radiotherapy unit of the Regional Center for Oncology in Agadir.

## MATERIALS AND METHODS

The conducted study is of a quantitative descriptive type that aims to estimate the dose received by practitioners in the external radiotherapy department.

### Materials

To collect and perform dose rate and annual dose rate measurements during this work, we used eight operational dosimeters of PACK MGP DMC 3000, an Inspector detector and a MKS-05 TERRA Survey meter:

An operational dosimeter is a device that records the dose received by the worker exposed to X-rays using a sensor integrated in a plastic case. It also measures gamma and X-rays and can therefore be used in nuclear medicine.

An Inspector detector is a device dedicated to the health and safety sector. It is optimized to detect low levels of radiation and measure alpha, beta, gamma and x-ray radiation. It uses a Geiger-Muller tube to detect radiation. The Geiger tube generates an electrical pulse every time radiation passes through the filling halogen in the tube. Each pulse is electronically detected and recorded as a count. It displays the counts in the selected mode. The number of counts detected by Inspector varies from time to time due to the random nature of the radioactivity. A measurement is expressed more accurately as an average over time, and this average is more accurate over an extended period of time.

MKS-05 TERRA is an instrument for the protection of persons used in areas with radiation risk, this device can be carried up to 24 hours a day, and continuously detects the radiation dose or dose rate, it can also detect minute natural radiation, as well as X-ray radiation in the medical field. It also has the

possibility to manually set the alarm limits. When the expected value is reached, it is indicated on the display and triggers an acoustic signal.

### Estimate of the annual exposure dose

The annual dose  $D_r$  received by the different categories within the radiotherapy department of Agadir is a function of the dose rate  $D_m$  measured during the treatment and the occupational treatment time  $T_t$ :

$$D_r = D_m \times T_t$$

The number of patients treated per day is on average 35, or 700 per month. If integrated throughout the year, this number could reach 8400 patients treated. Practically the duration of treatment ( $t_t$ ) of a patient in the radiotherapy unit is 10 minutes on average. The total time of the treatment ( $T_t$ ) is therefore estimated at 1400 hours per year ( $T_t = t_t \times N_d$ ).

The annual doses received by the different categories of the radiotherapy unit are estimated by multiplying the average dose rate by the occupational treatment time.

### Data analysis

The analysis of dose rate data and the estimated annual dose was performed using Microsoft Office Excel 2007 software.

## RESULTS

To evaluate the annual exposure to ionizing radiation of the different categories of personnel working in the external radiotherapy department during their exercise. We performed dose and dose rate measurements around the treatment rooms and the surrounding areas in the Regional Center for Oncology in Agadir.

### Reliability of the operational dosimeter

In order to evaluate the reliability of the measurements made by the TERRA survey meter, we compared these measurements with those made at the same positions by the Inspector detector.

**Table-1: Measured doses at the same sites by the Inspector detector and the TERRA survey meter**

Measuring device / Measurement point	TERRA survey meter $D_1$ ( $\mu\text{Sv/h}$ )	Inspector $D_2$ ( $\mu\text{Sv/h}$ )	Difference $(D_2 - D_1)$ ( $\mu\text{Sv/h}$ )	Error $P\% = \left(\frac{D_2 - D_1}{D_1}\right) \times 100$
Accelerator control panel	1.02	1.08	0.06	5.88
Dosimetry room	0.92	1.01	0.09	9.78

The relative error recorded during simultaneous measurements at the same points by both measuring devices ranges from 5.88 to 9.78% with an average error of 7.83%. This difference could be explained by uncertainties due to the different measurement circumstances and characteristics of the two instruments. This comparison allows us to trust the measurements made with the TERRA survey meter.

### Average daily dose rates

For category A, the average measured dose rate varies between  $0.108\mu\text{Sv/h}$  and  $0.158\mu\text{Sv/h}$  with an average value of  $0.132\mu\text{Sv/h}$ . It is  $0.101\mu\text{Sv/h}$  for category B. For category C, it is  $0.073\mu\text{Sv/h}$  (Table 2).

**Table-2: Average daily dose rates for the three categories of staff at the RCO in Agadir.**

Staff	Site	Average dose rate in ( $\mu\text{Sv/h}$ )
Category A	Accelerator control panel	0.158
	Simulation control panel	0.131
	Dosimetry room	0.108
Category B	Rest room	0.101
Category C	Waiting area	0.073

**Average annual doses**

The average annual dose received for category ranges from 0.151 to 0.221mSv/year with an average

annual dose of 0.185mSv/year. It is 0.141mSv/year for category B and 0.102mSv/year for category C (Table 3).

**Table-3: Estimated average annual doses for the three categories of staff at the RCO in Agadir**

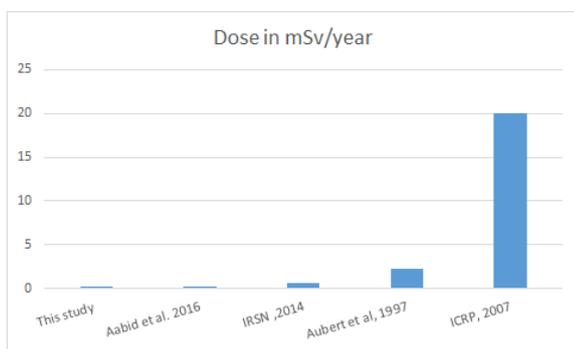
Staff	Site	Annual dose in (mSv/year)
Category A	Accelerator control panel	0.221
	Simulation control panel	0.183
	Dosimetry room	0.151
Category B	Rest room	0.141
Category C	Waiting area	0.102

**DISCUSSION**

The Measurements of dose rates and daily doses performed within the external radiotherapy department allowed us to estimate the external occupational exposure of the entire body of different categories of personnel working in the medical environment.

During the dose measurements carried out in radiotherapy at the RCO in Agadir, the annual dose likely to be received by category A personnel is in the order of 0.185mSv/year. For category B, the annual dose is about 0.141 mSv/year. The estimated annual dose to be received by category C is 0.102 mSv/year.

Figure 1 shows the annual doses received by Category A personnel during their occupational time.



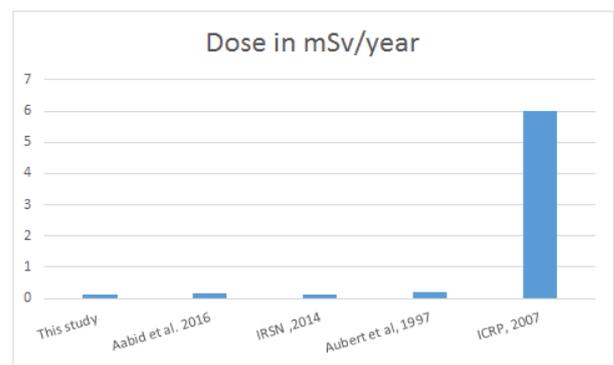
**Fig-1: Comparison of annual dose received by category A with respect to the international recommendation and to previous studies**

For category A: the annual dose likely to be received by the RCO staff in Agadir is 0.185mSv/year. This value is respectively much lower than 2.21mSv/year obtained during the monitoring of hospital workers carried out by OPRI through its assessment of the occupational exposure of medical workers in France in 1995 [9]. It is also less than 0.64

mSv/year, which was assessed during the monitoring of external exposure in the field of medical and veterinary activities carried out by IRSN in 2014 [3]. This dose is also below 0.223 mSv/year obtained in a previous study of the estimated annual dose received by category A staff around the Gamma knife treatment room at the national centre of rehabilitation and neurosciences in Rabat [5].

In addition, this value is much lower and represents less than 2% of the annual exposure limit recommended by the ICRP [10]. As a result, category A staff in the RCO radiotherapy unit in Agadir are far from being exposed to significant levels of radiation.

Figure 2 shows the annual doses received by category B staff during their occupational time.

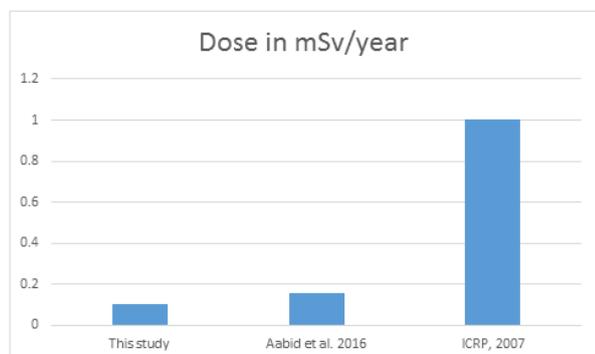


**Fig-2: Comparison of annual dose received by category B with respect to the international recommendation and to previous studies**

For category B: the annual dose likely to be received during treatment at the Agadir RCO is 0.141mSv/year. This value is lower than 0.19 and 0.14 mSv/year found respectively by OPRI [9] and IRSN during their monitoring of staff exposure in the medical field [10]. It does not exceed 2% of the annual exposure limit recommended by the ICRP [10], which is 6

mSv/year. In addition, category B personnel in the RCO radiotherapy unit in Agadir are far from being exposed to significant levels of radiation.

Figure 3 shows the annual doses received by category C staff.



**Fig-3: Comparison of annual dose received by category C with respect to the international recommendation and to a previous study**

For category C, patients and their caregivers, the annual dose received by this category is 0.102mSv/year for the RCO in Agadir. This value is below the annual exposure limit (1mSv/year) recommended by the ICRP [10]. As a result, patients and their caregivers attending the waiting room are far from being exposed to significant levels of radiation.

## CONCLUSION

In order to estimate the annual medical exposure dose of the different categories of personnel in the radiotherapy unit of the Regional Center for Oncology in Agadir, we conducted dose rate and dose measurements mainly around the treatment rooms and the surrounding areas. The results obtained in all three categories are comparable to those published in the literature. They are also far below the standards set by the International Commission on Radiological Protection for these categories.

Following this study, we recommend that our practitioners' knowledge of radiation protection be improved by organizing periodic continuing education sessions.

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