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Full Length Article

Occupational Radiation Dose for Medical Workers at a University Hospital

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Abstract

Occupational radiation doses for medical workers from the departments of diagnostic radiology, nuclear medicine, and radiotherapy at the university hospital of King Abdul-Aziz University (KAU) were measured and analysed. A total of 100 medical radiation workers were monitored to determine the status of their average annual effective dose. The analysis and the calibration procedures of this study were carried out at the Center for Radiation Protection and Training-KAU. The monitored workers were classified into subgroups, namely, medical staff/supervisors, technicians, and nurses, according to their responsibilities and specialties. The doses were measured using thermo luminescence dosimeters (TLD-100 (LiF:Mg,Ti)) placed over the lead apron at the chest level in all types of workers except for those in the cath lab, for whom the TLD was placed at the thyroid protective collar. For nuclear medicine, a hand dosimeter was used to measure the hand dose distribution. The annual average effective doses for diagnostic radiology, nuclear medicine, and radiotherapy workers were found to be 0.66, 1.56, and 0.28 mSv, respectively. The results of the measured annual dose were well below the international recommended dose limit of 20 mSv.

Keywords: Occupational radiation dose; radiation workers; TLD; radiation protection

1. Introduction

Recently, radioactive sources have been used in many applications, such as medicine, research, education, industry, and agriculture, for a wide variety of beneficial purposes. The combination of improved health services and an ageing population has resulted in an increased use of radionuclides and radiation in diagnosis and treatment [1]. All medical and occupational exposure to ionizing radiation represents the major part of exposure to low radiation doses. The researchers estimated that cancer risk incidence directly increases with absorbed dose. It is important to establish a model to determine the carcinogenic effects for this low radiation dose [2]. The objective of the International Commission on Radiological Protection (ICRP) is to provide a system and useful standards for radiation protection including medical, occupational, environmental, and exposure controls against radiological accidents without unduly limiting the beneficial practices giving rise to radiation exposure [3,4]. The term "occupational exposures" refers to the exposure of

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people at work to ionizing radiation from natural and man-made sources as a result of operations within a workplace, except for exposures excluded from the standards and exposures from practices or sources exempted by standards [5–11,12]. It was recommended for workers exposed to medical radiation sources to follow and apply all the requirements established in the International Basic Safety Standards for Protection against Ionizing Radiation and the Safety of Radiation Sources. Dose estimation for radiation workers is an important factor for government and organizations to evaluate radiation risks and establish protective measures[13,6,7]. Nuclear medicine staff members receive some of the highest radiation doses of any medical personnel. In addition, the nurses, technicians, physicians, and others involved with nuclear medicine constitute the largest group of workers occupationally exposed to man-made radiation sources. Many hospital workers are consequently subjected to routine monitoring of professional radiation exposures [14,15,5]. The radiation dose to workers is expressed in terms of effective dose and equivalent dose for extremities and eye lens as stated by the International Commission on Radiological Protection (ICRP) report number 60. The personal dose equivalent Hp (10) is now the internationally recommended operational quantity in the field of radiation protection by individual monitoring. It is the dose received by tissue (effective dose) at a 10-mm depth from the skin surface and is considered to be the dose to the whole body. From the basic safety standards (BSS) recommendation, the equivalent doses limits should apply i) to the whole body, as represented by the operational quantity Hp (10); and ii) to the extremities, via the operational quantity Hp (0.07). The BSS defines the Hp (0.07) dose as the dose at a depth of 0.07 mm and is considered to be the dose received by the skin of the workers. The dose limit for workers proposed by the ICRP was established as an annual effective dose. An effective dose limit of 20 mSv each year has been set for persons employed in radiation work [3,15–18]. It is important to measure the radiation doses received by personnel and evaluate the parameters concerning total radiation burden. Thermoluminescent dosimetry is the most suitable method to carry out measurements on personal dosimeters [19–24]. The main objective of this study was to investigate the annual occupational radiation dose history among the workers of KAU University hospital. The study concentrated on three medical departments at KAU University Hospital—diagnostic, radiotherapy and nuclear medicine—during the period from 2009 to 2010. The objective of this study was to track these departments' occupational dose history, to determine the highest exposure area and to check the radiation protection instructions carried out at these departments.

2. Materials and Methods

In this study, thermoluminescent dosimeters (TLD) were used. The TLDs consist of cards with holders containing a Harshaw detector crystal of LiF:Ti,Mg (TLD-100) to provide measurements of skin and deep doses. All workers wear the badge in proper places during their work. The upper-left side of the chest is the most important area to wear the dosimeter outside the lead apron because the highest radiation exposure is expected in this part of the body. A $^{90}Sr/^{90}Y$ internal irradiator (0.5 mC_i) was applied for calibration and QC analysis. The calibration process was totally automated in the reader to significantly reduce time and costs. The dosimeters were then taken back to KAU-Radiation Protection Center and Training where the dosimeter reading facility is available. A Model 6600 TLD Reader with a computer program was used to evaluate the TLD's reading. As a good approximation, both the whole-body dose (effective dose) Hp (10) and the skin dose Hp (0.07) for the period from 2009 to 2010 were taken from KAU-Center for radiation protection and training data base. According to the 1993 report by the International Commission on Radiation on Radiological Units and Measurements [24], whole-body doses are reported in terms of the personal dose equivalent, Hp (10). For photons with energies below 10 MeV, the value of the personal dose equivalent Hp (10) gives a conservative estimate of the effective dose for radiation incidents on the front of the body [25]. TLDs distributed to personnel were collected during the evaluation of personnel dose equivalents. Reading of TLDs was performed quarterly. Five non-irradiated TLDs of the same type as those used to measure personal doses were used to measure the background radiation dose, which was subtracted from the measured dose values. The TLD cards were read out on a Harshaw 6600 automated TLD reader. The TLD card labels included a bar-coded number and the wearer name and institution. The calibration of the TLDs was performed in the KAU-Radiation Protection Center and Training laboratory and the Secondary Standard Dosimetry Laboratory at King Abdul Aziz City for Science and Technology (KACST). It is important to mention that a single TLD badge was recommended for workers wearing lead aprons except for the nuclear medicine workers, for whom more than one badge was recommended. Pregnant workers were issued a supplementary badge, worn inside the apron at waist level, to monitor the dose to the foetus.