

## Five Years Review of Occupational Dosimetry Program at A Tertiary Care Hospital and Comparison With UNSCEAR 2008 Report

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### ABSTRACT

**AIM:** According to the UNSCEAR 2008 report, physicians, technicians, nurses and others involved in the medical field with a total number of monitored staff exceeding 7.5 million workers constitute the largest single group of occupationally exposed to man-made sources of radiation. The objective of this work was to compare our tertiary care medical Centre occupational radiation dose levels to

the ones published in the UNSCEAR 2008 report.

**MATERIALS AND METHODS:** Examination of the personal dosimetry records of the past five years from 2012 to 2016 is conducted and average radiation doses received by the staff are calculated including the total accumulated last 5 years doses. The radiation doses were measured using thermo luminescence dosimeters (TLD). The total number of monitored staff was 538 and 274 from our medical center and from the other centers that we cover respectively.

**RESULTS:** The levels of occupational exposures in our hospital and other medical institutions compares very well with the internationally and nationally reported results. The annual average for the five years period under examination in this work was 0.4, 0.8 and 0.5 mSv for the diagnostic radiology, nuclear medicine and radiation therapy groups respectively. Our minimal detection limit for personal dosimetry reporting is 0.1 mSv.

**CONCLUSIONS:** The results of the measured annual doses were well below the ICRP recommended annual dose limit of 20 mSv. Our results compare very well with the UNSCEAR 2008 report. In general the application of ionizing radiation in Medicine is a safe practice for the occupationally exposed workers.

**Key words:** Personal Dosimetry; TLD; UNSCEAR 2008; Dose Limits; Medicine

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### INTRODUCTION

Systematic reviews of the occupational radiation dose records in the medical field serve many purposes. First it is a way of promoting

the as low as reasonably achievable (ALARA) concept in radiation protection regulations at the national level. Secondly it allows the identification of areas in need for optimization of radiation protection practice at the local level. It may also serve as assurance to the employees that their work place has adequate radiation protection measures and infrastructure or there is a need to improve the safety of their workplace depending on radiation dose levels observed. An occupational exposure is a term used by the International Labor Office that specifies radiation dose received by workers during their assigned work activities<sup>[1]</sup>.

The current trends in occupational exposure worldwide are; the average exposure of medical workers is decreasing but the number of monitored workers is increasing<sup>[2]</sup>. In diagnostic radiology the radiology technologist stands in a shielded control room, shielding is commonly installed to protect against scatter radiation from the patient, the room walls and the leakage of the X-ray tube. Therefore radiation doses received by the technologist are very low or even non-measurable.

In fluoroscopic guided procedures the amount of scatter radiation received by the operators and medical staff who stands close to the patients is much higher than the routine diagnostic procedures, but the use of lead aprons, glasses, thyroid shields and mobile shields reduces the amount of radiation dose due to scatter by 90%. Therefore the occupational doses received are still below the permissible occupational annual dose limits<sup>[3]</sup>. In addition to the advanced imaging techniques aimed to reduce the amount of radiation exposure to the patients and the staff all of previously mentioned contributing factors are responsible for the current worldwide trend in occupational exposure in medicine.

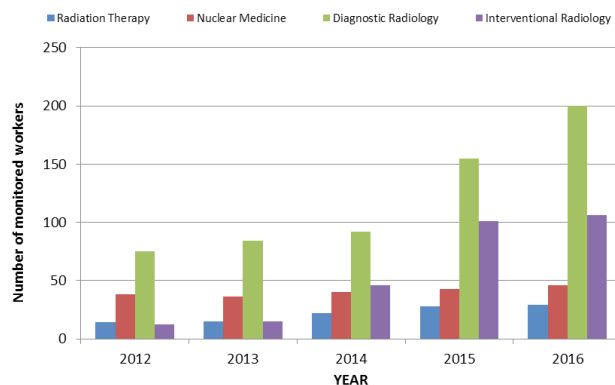
According to the UNSCEAR 2008 report, physicians, technicians, nurses and others involved in the medical care field constitute the largest single group of workers occupationally exposed to man-made sources of radiation. The 2008 report included data from occupational radiation doses of about 7.5 million workers in medicine alone. The objective of this work was to compare our tertiary care medical Centre occupational radiation dose levels to the ones published in the UNSCEAR 2008 report.

## METHODS

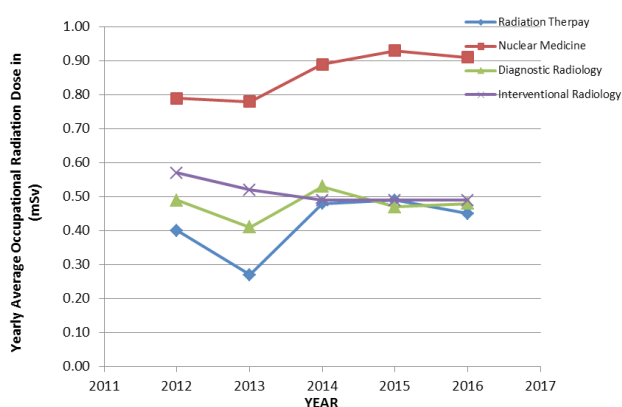
Examination of the personal dosimetry records of the past five years from 2012 to 2016 is conducted and average radiation doses received by the staff are calculated. The radiation doses were measured using thermo luminescence dosimeters (TLD). Our personal dosimetry service laboratory is a nationally licensed one and undergoes bi-annual rigorous quality assurance testing exercise conducted by the national authority granting the license to our medical city. Our licensed laboratory also provides services to other medical centers in the country as described in the results section. The TLD reader used at our institution is Harshaw 6000 TLD reader.

The reported personal doses in this study are based on the reading of  $H_p(10)$  which is the dose received by tissue at 10 mm below the skin surface and is considered equivalent to the dose delivered to the whole body, often noted as whole body dose on the personal dosimetry report.

In order to ensure the quality of the measurements; our dosimetry services undergo a rigorous quality control exercise administered by the national regulatory authorities twice per year and results are communicated to the licensee. Such quality control on the measured dose levels is mandatory to all licensees in order to maintain their practice license as service provider of occupational radiation



**Figure 1** Histogram showing the number of monitored staff per year for the years of 2012 to 2016.



**Figure 2** The annual average whole body radiation dose for 4 main occupational categories per year at our institution for the years 2012 to 2016.

dosimetry measured using TLD in the country.

The monitored workers are grouped according to their area of practice in radiology, nuclear medicine and radiation therapy; other groups are also included as detailed in this study. The total number of monitored staff was 538.

During a monitoring year, TLD badges are prepared by the radiation protection physics section for distribution at the beginning of each quarter (every 3 month). Any staff who had not returned his TLD badge for reading at any quarter of the monitoring year was excluded from the survey and the average annual dose calculations.

In the past 10 years, we have had serious issues with the badges return rate from the different users groups; Nowadays with more effort being deployed in training and awareness activity the return rate is now reaching 90% in average per quarter. Both increase in staff awareness and institutional enforcement policy approaches are required to improve the compliance rate in regularly wearing the individual TLD badge and in returning it at the end of the monitoring period of 3 months (quarter).

Compliance return rate of 100% will improve the reported occupational doses results, statistics and will be closer to the reality of medical occupational exposures.

## RESULTS

The levels of occupational exposures in our hospital and other medical institutions compares very well with the internationally and nationally reported results. The annual average for the five years period under examination in this work was 0.4, 0.8 and 0.5 mSv for the diagnostic radiology, nuclear medicine and radiation

therapy groups respectively. Our minimal detection limit for personal dosimetry reporting is 0.1 mSv as the majority of other laboratories in the world and described in the UNSCEAR 2008 report.

The values reported by the UNSCEAR (most recent) were: 0.5, 0.7 and 0.5 for diagnostic radiology, nuclear medicine and radiation therapy groups respectively. We can see from the above that our results are in close agreement with the UNSCEAR; lower for diagnostic radiology 0.4 in comparison with 0.5 and higher for nuclear medicine 0.8 compared to 0.7 and the same for radiation therapy at 0.5 mSv.

## DISCUSSION

UNSCEAR conduct regular global surveys of medical radiation exposure and occupational exposure to identify trends in radiation exposure and to estimate the worldwide exposure levels<sup>[4]</sup>.

### Monitoring Practice

In general, monitoring practice is such that more workers are individually monitored than is strictly necessary to meet regulatory requirements<sup>[5]</sup>, with the consequence that only a fraction of those monitored receive measurable doses.

Such observation is perfectly accurate. Many of the monitored groups in our institution are unlikely to receive an annual dose in excess of 30% of the annual dose limits; and therefore are not required to be individually monitored by International and National Regulations.

Workers in our institution and many others are only monitored in order to ensure close observations of any possible deficiencies in the applied radiation protection practice, and to sense any change in the world- wide trend in medical occupational radiation dose levels. It also presents a kind of assurance to the individual worker that he is practicing in a safe environment.

Radio-phobia is a general common feeling among health professionals and the fact of using a radiation dose monitoring device ensures lot of workers in mostly the ones having great fear from potential exposure to very low levels of radiation present commonly present in their work environment.

The UK Health and safety executive reported that 145 out of 385 (37%) monitored worker had zero dose<sup>[6]</sup>.

The number of monitored worker with zero doses has been increasing since the year 2000<sup>[7-9]</sup>.

The IAEA Safety standard<sup>[10]</sup> specifies environmental monitoring as a method for the individual dose estimations when individual monitoring is not practical and workers enters controlled area only occasionally. In our institution we do not individually monitor dental workers based on long and continued environmental risk assessment. Rooms equipped with x-ray units both conventional or panoramic had a fixed TLD badges fixed on the surface of major walls in the room and also at selected locations to monitor the environmental scattered radiation levels over extended period of time. Every year, quarterly (3 months) basis monitoring period is used to report the measured radiation dose data.

Multiple risk assessment exercises performed during the past 15 years presented the evidence that no measurable dose to staff is possible under the current state of practice. Safe equipment design, structural shielding and good work practice are the major contributing factors supporting this conclusion<sup>[11]</sup>.

### Current occupational radiation dose trends

Medical radiation workers generally experience very low radiation

exposures except for those performing fluoroscopically-guided procedures and potentially those administering radionuclides for nuclear medicine procedures<sup>[12]</sup>.

Most of occupationally exposed workers or occupational groups have already acquired the necessary knowledge in radiation protection and biological effects of exposure to ionizing radiation in their study programs prior to becoming a licensed professionals working in hospitals.

The current trend in low occupational exposure in the medical field is the fruit of many years of efforts exerted by national regulatory authorities and the application of radiation protection programs has translated into this acceptable trend of low doses allocated to all monitored workers in the medical field.

The sound advanced technologies applied today made radiological equipment safer to use by including multiple safety systems. Advanced engineered safety features and dose reduction systems are now widely available on all x-ray based imaging modalities in the market today has contributed positively to the current trend. Implementation of increasingly stricter regulations governing manufacturing of radiological equipment especially at the design and premarket stages has its share of merit also.

The national regulatory authorities requiring hiring qualified Radiation safety officers to work in hospitals and implementation of effective radiation protection programs. The advanced medical physics accredited curriculum, certifying medical physics boards making sure to certify only high quality medical physicist working in the medical field with responsibilities in radiation protection. Most of the time radiation protection is an integral part of the board certified medical physicist clinical responsibilities along with their main work objectives in patient safety and radiation dosimetry.

## CONCLUSIONS

The average occupational radiation dose for diagnostic radiology group in our center is lower than the most current UNSCEAR reported dose level, 0.4 compared to 0.5 mSv respectively. For nuclear medicine our average is 0.8 mSv and the UNSCEAR is 0.7 mSv.

The annual doses for all of monitored medical staff in this study are much less than the annual maximum dose limit of 20 mSv.

Such worldwide trend of Acceptable levels of medical staff exposure to ionizing radiation gives the workers assurance that their work place is safe.

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