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Original Article

RADIATION EXPOSURE REDUCTION TO AFTERLOADING

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ABSTRACT

Introduction: The radiation exposures to the staff personnel from patients with brachytherapy implants in abrachytherapy service were reviewed.

Materials and Methods: Exposures to the brachytherapy personnel, as determined by Thermolumencense Dosimeter (TLD) monitors, indicates a four-fold reduction in exposures after the implantation by the use of remote afterloading devices.

Results: Quarterly TLD monitor data for seven quarters prior to the use of remote afterloading devices demonstrated an average projected annual dose equivalent to the brachytherapy staff of 2.54 m Sv. After the use of the remote afterloading devices, the quarterly TLD monitor data indicate an average dose equivalent per person of 153 μ Sv. This is 76% reduction in exposure to brachytherapy personnel with the use of these devices.

Conclusions: In this study, one may conclude that significant reduction in radiation exposure are achieved when remote afterloading machine is used.

Key Words: Personnel exposures, brachtherapy service, remote afterloading, thermolumencense dosimeter (TLD).

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INTRODUCTION

The traditional method of monitoring radiation exposure to healthcare personnel is to use Thermolumencense dosimeter (TLD) monitors[1, 2, 8] by careful surveillance of a TLD monitoring program, a radiation safety officer can identify problem areas and ensure by modifying procedures, that the ALARA principle (As Low As Reasonably Achievable) was satisfied[3, 10]. In Particular regular reviews of exposure measurements to the personnel caring for brachytherapy patients are essential[7]. This is because situations can arise within the hospital, when radiation exposure to individual staff can vary [9].

A relatively recent development in the field of brachytherapy at Radiotherapy and Nuclear medicine department National Cancer Institute was the introduction of remote afterloading, which have primary purpose of reducing radiation exposure to the healthcare workers. The Microselectron LDR machine was used in March 1999, while a Microselectron HDR unit was brought into clinical use in Dec. 2001. This study reviewed the exposures to the staff working with the services. Results were collected prior to, during and after, the commencement of use the low dose rate afterloading equipment.

MATERIALS AND METHODS

The quarterly dose equivalent results to the brachytherapy personnel caring for hospitalized patients undergoing brachytherapy at the National Cancer Institute, Radiotherapy and Nuclear medicine department have reviewed from June to Dec 2002.

Personnel radiation exposure measurements were made using three lithium fluoride TLD chips supplied by Egyptian Atomic Energy Authority (E.A.E.A)-Radiation Protection Consultations and Services. These TLD chip monitors can provide estimates of shallow and deep dose equivalents for any exposures above their minimum detectable level of 100 μ Sv[11,12].

In this study deep dose values were determined and reported as a mean dose equivalent. The afterloading machines were Microselectron LDR with only seven channels active and Microselectron HDR with only one active channel.

RESULTS

The mean dose equivalent per person per quarter for seven quarters prior to the use of remote afterloading devices was given (Fig. 1 and Table 1). The mean quarterly dose equivalent per person prior to the use of remote after-loaders was 635.8 μ Sv. This was four times greater than the dose equivalent per quarter per person, (153.1 μ Sv), after the installation of the remote after-loaders Table (2).

Table 1: Exposure per person per quarter during manual afterloading.

Time period		Quarterly exposure (μ Sv)	Annual exposure (μ Sv)
3rd quarter	1997	700	
4th quarter	1997	540	2480 (predicted value)
1st quarter	1998	690	
2nd quarter	1998	590	
3rd quarter	1998	570	
4th quarter	1998	580	2430 (actual value)
1st quarter	1999	680	2720 (predicted value)

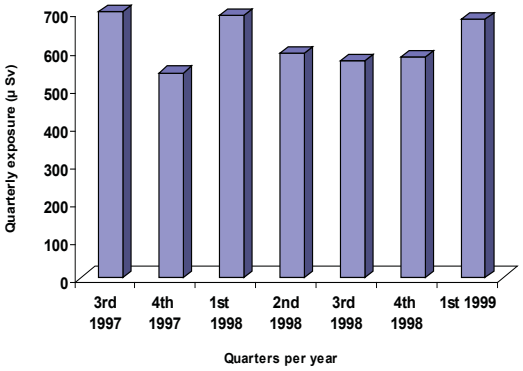

Fig. 1: Average exposure per quarter during the manual afterloading period.

The number of brachytherapy implant procedures performed each quarter ranged from 35 to 45 by LDR and HDR. The mean dose equivalent per person per brachytherapy procedures for the same period of time (during the remote afterloading period) was shown in (Fig. 2). Average exposure per quarter per person (μ Sv) before and after using the remote afterloading was shown in (Fig. 3). The reduction in exposure to brachytherapy personnel with the use of the remote afterloading devices represented 76% as was illustrated in (Fig. 3).

Table 2: Exposure per person per quarter after using the afterloading System.

Time period		Quarterly exposure (μ Sv)	Annual exposure (μ Sv)
2nd quarter	1999	150	
3rd quarter	1999	170	
4th quarter	1999	160	640(predicted value)
1st quarter	2000	140	
2nd quarter	2000	130	
3rd quarter	2000	150	
4th quarter	2000	110	530 (actual value)
1st quarter	2001	120	
2nd quarter	2001	160	
3rd quarter	2001	190	
4th quarter	2001	160	630 (actual value)
1st quarter	2002	180	
2nd quarter	2002	160	
3rd quarter	2002	170	
4th quarter	2002	140	650 (actual value)

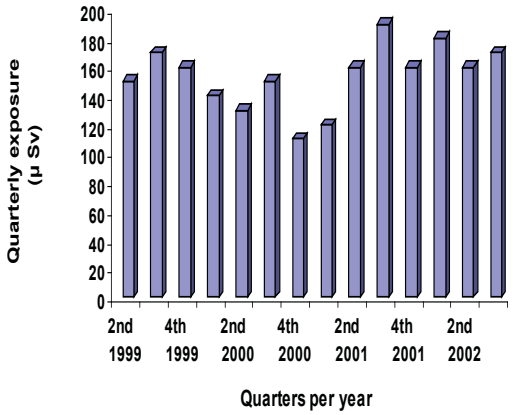

Fig. 2: Average exposure per person per quarter during the remote afterloading period (μ Sv).

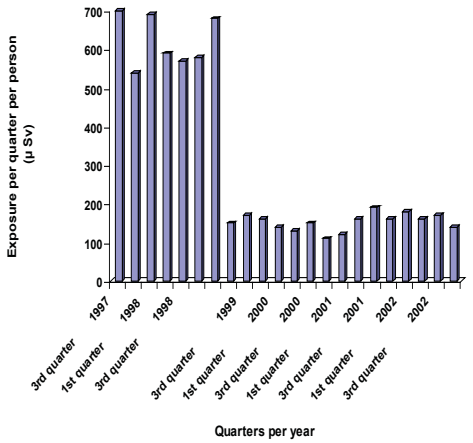

Fig. 3: Average exposure quarter person (μ Sv)before and after using the remote afterloading.

DISCUSSION

The recommendation of NCRP Report No.91[6,14] for occupationally exposed personnel is an effective dose equivalent limit of 50 m Sv per year with an accumulative exposure of 10 m Sv multiplied by the age of the person in years[10,14]. This report also recommends an annual effective dose equivalent limit for the general public of 5 m Sv. The general public is assumed to only have infrequent radiation exposures. The US Environmental Protection agency[6,13] estimated the radiation exposure received by medical workers in the United States is in the range 700 μ Sv to 1500 μ Sv per year these estimates are some one–thirtieth of the recommended NCRP limits of NCRP Report N[5,14].

The quarterly radiation exposure data for our brachytherapy staff from manual loading is, even below the maximum permissible dose for all medical workers according to the ICRP Report 60 (1990). However, with the use of remote afterloading the projected annual radiation exposure to our brachytherapy staff is reduced to less than 3.5% of the occupational annual limit and to 32% of the annual limit for the public[10].

In this study, one may conclude that significant reductions in radiation exposure for brachytherapy staff are achieved when remote afterloading machines are used. Adherence to the ALARA principle using the remote after loading has reduced the annual exposures for the staff to a level well below that of the ICRP Report 60 recommendations for annual exposure limits to the public[4,10].

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