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Original

Compliance with Radiation Protection Principles in Radiotherapy Units

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Abstract

Background: One of the most harmful agents in hospital settings is ionizing radiation such as X-rays that physicians and other staff expose in surgeries and diagnostic tests. Therefore, the aim of this study was to measure X-ray dose in the diagnostic radiology units of hospitals affiliated to North Khorasan University of Medical Sciences. **Methods:** This is a descriptive-analytical, cross-sectional study, in which all of the hospitals' diagnostic radiology units including CT scan, mammography, fluoroscopy and radiography were studied. X-ray dose was measured by a dosimeter-radiometer device (MKS-05 Terra-P). The International Radiation Protection Association (IAEA) checklist was used to check the observance of the Radiation Protection Principles. **Results:** The results of this study showed that the X-ray doses in the CT scan, mammography, and fluoroscopy units of Bojnord Imam Ali Hospital were 0.16, 0.08 and 0.01 µSv/h, respectively. The doses of X-ray in the radiology units of Imam Ali (PBUH), Imam Reza (PBUH), Esfarayen and Shirvan Hospitals were 0.12, 0.12, 0.11, and 0.11 µSv/h, respectively. **Conclusion:** According to the results, the X-ray doses in the diagnostic radiology units of hospitals were lower than the standard limit proposed by the International Radiation Protection Association. However, it is proposed to use appropriate protective lead aprons to further protect the exposed staff in the units in question.

Keywords: X-ray; Radiological; Hospital; Radiology

Introduction

Ion beams have the greatest benefits in medicine for diagnosis and treatment.[1] X-rays are used in various sectors of the industry, including the radiography of metals and the separation of faulty and broken parts of metal objects and also are of great use in medical imaging due to having potential to pass through solid and liquid environments.[2, 3] The average dose received by the general population is estimated at 2.5 mSv, 15% of which is related to medical imaging.[4] X-ray imaging is such that photons decrease when passing through various tissues of the body, and the

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difference between photons on the detector results in a two-dimensional image.[5]

The goal of medical imaging is to diagnose and examine diseases by creating images of the internal structure of the body that can provide valuable information before the treatment begins and the outcomes are followed up.[6] X-rays are widely used in various hospital units such as radiology, CT scan, mammography, and fluoroscopy as an appropriate tool to diagnose diseases and evaluate patient treatment outcomes.[7, 8] Recent advances in and increased use of ionizing radiation diagnostic methods have led to an increase in the number of tests and exposure to ionizing radiation.[9] If the dose exposed exceeds the permissible limit, it will pose a serious hazard for the operator and the patient, which is often related to the type of equipment and procedure, or both. Therefore, the greatest care when working with ionizing radiation should be taken to ensuring that the doses to which staff expose are within reasonable and permissible limits.[10]

Initially, despite the benefits of this beam, its adverse effects on living organisms were not taken into account. As a result of the adverse effects of radiation, personal protective equipment was introduced, and laws were approved to determine the permissible levels for the protection of staff and patients.[3, 11] Therefore, the International Commission on Radiological Protection (ICRP) has issued guidelines for the determination of permissible occupational doses.[12] The National Council on Radiation Protection and Measurements (NCRP) has also issued guidelines in the United States. Accordingly, the effective annual and cumulative doses should be 50 mSv/year and 50 mSv/age, respectively, for the occupational exposure.[13] The three basic parameters for reduction of radiation damage are distance, time and individual protection. In the context of medical exposure, the principle of protection is of paramount importance.[14] Therefore, due to the importance of monitoring the role of radiation protection in the healthcare centers, the current study was aimed to measure the dose of environmental radiation and investigate the status of compliance with protection principles in the X-ray generation centers of hospitals affiliated to North Khorasan University of Medical Sciences.

Methods

In this descriptive cross-sectional study, the study population consisted of the radiology, fluoroscopy, mammography and CT scan units of Imam Reza (PBUH) and Imam Ali (PBUH) Hospitals in Bojnord, Imam Khomeini Hospital of Shirvan, and Imam Khomeini Hospital of Esfarayen. Sampling was done by random census method using dosimeter-radiometer device (MKS-05 TERRA, ECOTEST, Ukraine) so that three places in each unit were studied, consisting ofstaff entrance door, the control room and patient transfer door. In order to increase the accuracy of the measurements, in each place, three points, ie, front of the knee, front of the back, and front of the head, were measured and the average of these three heights was calculated.

A total of 189 samples were measured. The checklist of International Radiation Protection Association (IAEA) provided by the Atomic Energy Organization was also used to check the physicians' and patients' compliance with and knowledge about the protection principles. In this table, the presence or absence of certain variables such as lead apron, patient lead apron, No Entrance sign, complete closure of the control room, and the room leaded wall up to a height of 180 cm, expired films, gonad shielding, the air conditioner during work, as well as lack of using radiation area sign and lack of complete closure of the radiography room door are investigated.

Results

In this study, a total of seven units in the hospitals included were studied. According to our measurements in Imam Ali (PBUH) Hospital,, the average doses in the control room, at the staff entrance and at the patient entrance in the radiology unit were 0.13, 0.13, 0.1 µSv/h, in the fluoroscopy unit 0.1, 0.12 and 0.11 µSv/h, in the mammography unit 0.09, 0.11, and 0.15 µSv/h, and in the CT scan unit 0.1, 0.1, and 0.15 µSv/h, respectively. In the radiology unit of Imam Reza (PBUH) Hospital in Bojnord, the corresponding results were 0.12, 0.14 and 0.11 µSv/h, respectively. In the radiology unit of Imam Khomeini Hospital in Shirvan, the average doses in the three points were 0.11, 0.11, and 0.17 µSv/h and in the radiology unit of Imam Khomeini Hospital in Esfarayen, 0.11, 0.09, and 0.08, µSv/h, respectively. The results are shown in Tables 1 and 2 in detail.

The results from the checklist of the protection principles showed that all studied units had lead apron, patient lead apron, No Entrance sign, complete closure of the control room, and the room leaded wall up to a height of 180 cm, and that in none of the units, expired film was used.

There was no gonad shielding in two units, no ventilator during working in one unit, no radiation area sign in one unit and no complete closure of the radiography room door in one unit.

Table 1. Average X-ray doses (µSv/h)

Unit	Point of measurement	Radiology			CT scan			Mammography			Fluoroscopy		
Hospital		Head	back	knee	Head	back	knee	Head	back	knee	Head	back	knee
Imam Ali(PBUH) Hospital of Bojnord	Control room	0.12	0.13	0.14	0.10	0.09	0.10	0.09	0.10	0.08	0.10	0.10	0.09
	Staff entrance	0.14	0.09	0.09	0.11	0.11	0.10	0.10	0.11	0.12	0.13	0.14	0.11
	Patient entrance	0.09	0.12	0.10	0.12	0.13	0.13	0.13	0.15	0.17	0.10	0.11	

Table 2. Average X-ray dose (µSv/h)

Hospital	Point of measurement	Imam Reza (PBUH) Hospital of Bojnord			Imam Khomeini Hospital of Shirvan			Imam Khomeini Hospital of Esfarayen		
Unit		Control room	Staff entrance	Patient entrance	Control room	Staff entrance	Patient entrance	Control room	Staff entrance	Patient entrance
Radiology	Head	0.13	0.16	0.10	0.11	0.11	0.22	0.09	0.09	0.06
	back	0.12	0.13	0.11	0.11	0.10	0.14	0.13	0.10	0.06
	knee	0.13	0.12	0.11	0.12	0.12	0.11	0.11	0.09	0.13

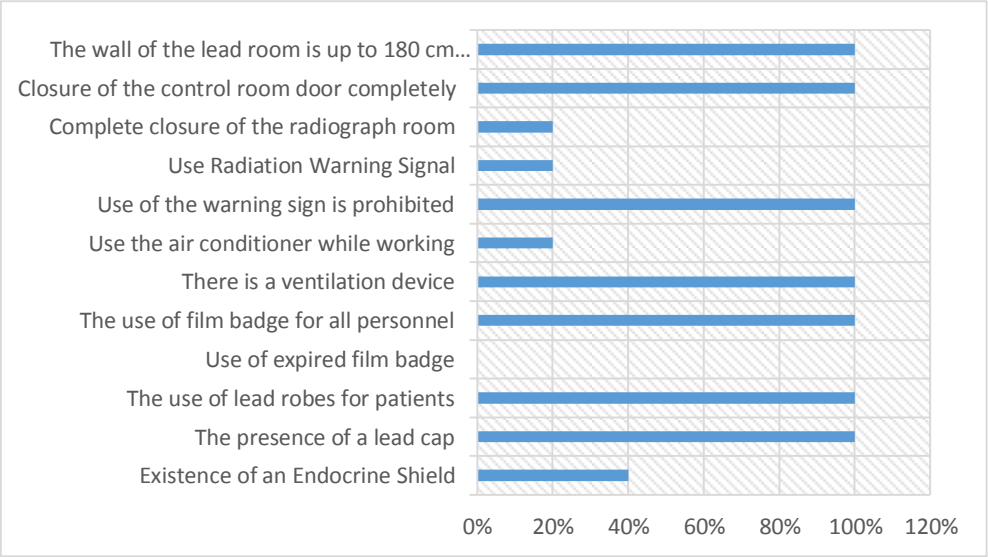

Figure 1. The frequency of compliance with radiation protection principles

Discussion

The main objective of the present study was to measure X-rays dose and compliance with radiation protection principles in the radiotherapy units of hospitals affiliated to North Khorasan University of Medical Sciences. All tables are based on the reports from the measurement of the parameters and the results of the questionnaire-based reports in the hospital of interest. The results of this study showed that X-ray doses of the CT scan, mammography, and fluoroscopy units of Imam Ali Hospital of Bojnord were 0.16, 0.80 and 0.1 µSv/h, respectively. Furthermore, the doses of X-ray in the radiology units of Imam Ali (PBUH), Imam Reza (PBUH), Esfarayen and Shirvan Hospitals were 0.12, 0.12, 0.11, and 0.11 µSv/h, respectively. In all studied units, lead apron, patient lead apron, No Entrance sign, complete closure of the control room, the room leaded wall up to a height of 180 cm, and use of batch film for all personnel were investigated and the efficiency was 100%.

The results also showed that all of the units had ventilator but the use of the air conditioner was reported only from one (14.2%) unit, indicating that this issue was disregarded. The presence of gonad shielding was reported in two (28.5%) units, radiation area sign in one (14.2%) unit, and complete closure of the radiography room door in one (14.2%) unit, which indicates lack of paying due attention to this issue in most units. In general, in some areas of Iran, measurements have been made to assess the dose of x-rays and compliance with radiation protection principles but comprehensive and written information has not yet been provided on relevant control and measurement programs to make a comparison between radiation dose radiography unit staff expose and international standards and results reported from other countries; therefore, it is essential to develop a relevant database. Our results also highlighted the need to follow the instructions mentioned and to monitor their implementation by respective staff.

Conclusion

Four hospitals are affiliated to North Khorasan University of Medical Sciences, each of which has one radiology unit. In addition to radiology unit, Imam Ali Hospital of Bojnord also has a mammography unit, a CT scan unit and a fluoroscopy unit. Therefore, in the present study, a total of seven units were investigated and the results from the checklist of protection principles showed that, in all studied units there were lead apron, patient lead apron, No Entrance sign, complete closure of the control room, the room leaded wall up to a height of 180 cm, and no expired film was used, which is in compliance with the relevant standards. Other results also indicated that there was no gonad shielding in two (28.5%) units, air conditioner during work in one (14.2%) unit, radiation area sign in one (14.2%) unit and complete closure of radiography room door in one (14.2%) unit.

Conflicts of interest

The authors report no conflicts of interests.

Acknowledgment

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