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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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.\textsuperscript{5, 11} Therefore, the International
Commission on Radiological Protection (ICRP) has
issued guidelines for the determination of permissible
occupational doses.\textsuperscript{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.\textsuperscript{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.\textsuperscript{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 of staff 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 leded
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>
<thead>
<tr>
<th>Unit</th>
<th>Point of measurement</th>
<th>Radiology</th>
<th>CT scan</th>
<th>Mammography</th>
<th>Fluoroscopy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Imam Ali (PBUH) Hospital of Bojnord</td>
<td>Control room</td>
<td>0.12</td>
<td>0.10</td>
<td>0.09</td>
<td>0.10</td>
</tr>
<tr>
<td></td>
<td>Staff entrance</td>
<td>0.14</td>
<td>0.11</td>
<td>0.10</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Patient entrance</td>
<td>0.09</td>
<td>0.12</td>
<td>0.13</td>
<td>0.13</td>
</tr>
</tbody>
</table>

Table 1. Average X-ray doses (µSv/h)

<table>
<thead>
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</thead>
<tbody>
<tr>
<td>Radiology</td>
<td>Control room</td>
<td>0.13</td>
<td>0.11</td>
<td>0.12</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>Staff entrance</td>
<td>0.12</td>
<td>0.11</td>
<td>0.11</td>
<td>0.11</td>
</tr>
<tr>
<td></td>
<td>Patient entrance</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Table 2. Average X-ray dose (µSv/h)

The wall of the lead room is up to 180 cm...
Closure of the control room door completely
Complete closure of the radiograph room
Use Radiation Warning Signal
Use of the warning sign is prohibited
Use the air conditioner while working
There is a ventilation device
The use of film badge for all personnel
Use of expired film badge
The use of lead robes for patients
The presence of a lead cap
Existence of an Endocrine Shield

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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