Radiation protection practice of medical doctors of surgical and interventional specialties in Saudi Arabia

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Received: 5 June 2020 / Accepted: 14 September 2020

Abstract – This study aimed to evaluate the radiation protection practices of medical doctors of surgical and interventional specialties in different healthcare sectors of Saudi Arabia. A cross-sectional study of medical doctors in Saudi Arabia who utilize radiation to perform interventional procedures and surgical operations was conducted. Data were gathered about the basic demographic background of the respondents, their daily application of radiation protection, and variations among different specialties and institutions regarding radiation protection practices. A total of 182 responses were received from different specialties, including interventional radiology (22%), interventional cardiology (16.5%), orthopedic surgery (14.8%), urology (14.3%), and diagnostic radiology (12.1%). Responses were received from different healthcare sectors, including the Ministry of Health (47%), private sector (26%), and university hospitals (18%). Only 59% of the respondents reported applying the As Low As Reasonably Achievable (ALARA) principle of radiation protection. The specialties with the highest reported lack of the ALARA principle application were orthopedic surgery (89%), urology (69%) and endoscopy (57%). The highest reported non-adherence to the ALARA principle was in the Ministry of Defense hospitals (50%), private hospitals (44%) and Ministry of Health hospitals (43%). The use of a personal dosimeter was reported by 58% of the respondents and only 42% reported having training in radiation protection. The respondents reported a lack of regular checking of x-ray machines (28%) and protection aprons (40%), non-availability of radiation protection guidelines (48%), and a lack of policies for radiation dose monitoring (27%) in their institutions. It was concluded that the compliance with radiation protection practices was variable and generally poor among different specialties and healthcare sectors in Saudi Arabia. Similar poor practices were reported in the international literature of different countries. The concerned authorities worldwide are advised to take further actions in this regard.

Keywords: radiation protection / surgical / interventional radiology / Saudi Arabia

1 Introduction

Several specialties utilize radiation to perform interventional procedures and surgical operations. Radiation protection is critical for the safety of the patient and medical staff. Awareness and application of radiation protection might vary among different specialties and institutions due to differences in training backgrounds and a lack of strict enforcement of the radiation protection guidelines in some institutions. This study aims to evaluate the radiation protection practices of medical doctors of surgical and interventional specialties. It provides important data and information about radiation protection practices among different specialties and healthcare sectors in Saudi Arabia.

2 Methodology

Approval of the regional research ethics committee was obtained. A cross-sectional study that targeted medical doctors in Saudi Arabia who utilize radiation to perform procedures and operations was conducted. An online survey that consisted of 13 questions was created using Google Forms and distributed electronically among the doctors of different interventional and surgical specialties that utilize radiation to perform procedures and operations. The respondents answered anonymously. The questions aimed to gather information about the basic demographic information of the respondents, their daily application of radiation protection principles, and variations among different specialties and institutions regarding radiation protection practices. The survey was open to receive responses for a period of one month, from April 1st to April 30, 2018, with two electronic reminders sent during that
The data were recorded in an Excel sheet and analyzed by calculating the percentage of responses to each question. Multivariate analysis was performed to look for relations between certain responses to different questions.

## 3 Results

A total of 182 responses were received: 82% from consultants, 10% from specialists, and 8% from residents and fellows. The highest response rate came from respondents in interventional radiology (22%), followed by interventional cardiology (16.5%), orthopedic surgery (14.8%), urology (14.3%), and diagnostic radiology (12.1%) (Table 1). For the healthcare sectors, the highest percentage of respondents was from the Ministry of Health (47%), followed by the private sector (26%) and university hospitals (18%) (Tab. 2).

The majority of respondents (59%) reported applying the As Low As Reasonably Achievable (ALARA) principle of radiation protection, while 41% did not (Fig. 1). The specialties with the highest reported lack of ALARA principle application were orthopedic surgery (89%), followed by urology (69%) and endoscopy (57%). The healthcare sectors with the highest reported lack of adherence to the ALARA principle were the Ministry of Defense hospitals (50%), followed by private hospitals (44%) and Ministry of Health hospitals (43%), whereas the lowest reported percentage was in King Faisal specialist hospitals (27%).

The most frequently used radiation protection devices were lead aprons (used by 95% of the respondents), followed by thyroid shields (69%), while 5% of the respondents reported not using any radiation protection devices (Fig. 2). The use of a personal radiation dose monitoring device (dosimeter) was reported by 58% of the respondents, while 42% reported that they did not use one. The majority (58%) of the respondents reported not attending any radiation protection dedicated courses, workshops, lectures, or presentations since they started their postgraduate career; only 42% reported such activity.

A considerable percentage of the respondents reported that in their institutions, the x-ray machines that they use are not checked or calibrated regularly (28%), the radiation protection aprons they use are not checked or replaced regularly (40%), the radiation protection guidelines are not available (48%), and the policies for radiation dose monitoring are lacking (27%) (Tab. 2). The radiation exposure (as a product of the average weekly number of procedures that utilize radiation multiplied by the average time of radiation per procedure) was the highest in the interventional radiology specialty (552 minutes per week), followed by interventional cardiology (475 min/week) and diagnostic radiology (128 min/week), as shown in Table 1.

## 4 Discussion

Ionizing radiation is known to have hazardous effects that are categorized either as deterministic (i.e., have a radiation dose threshold, such as skin injury, hair loss, and cataract formation) or stochastic (i.e., have no dose threshold, such as cancer). Approximately 0.7% of all new cancer cases were attributed to diagnostic ionizing radiation in a recent study (Marant-Micallef et al., 2019). Radiation protection is essential in medical practice for the safety of the patients and medical staff; therefore, it is emphasized by scientific agencies and societies (Tsapaki et al., 2018). A previous study found significantly less adherence to personal radiation protection in Saudi hospitals than in Australian hospitals (Alahmari et al., 2016). Another study, published in 2016, reported a lack of essential radiation protection equipment in several hospitals of the Eastern province of Saudi Arabia.
A more recent study, published in 2018, concluded that the doctors working in emergency departments in Jeddah city of Saudi Arabia have poor knowledge about radiation doses and risks (Barnawi et al., 2018). Those studies were alarming regarding poor adherence to radiation protection and the current study continues to emphasize such concerns on a wider and different target.

In this study, 41% of the respondents reported not applying the ALARA principle of radiation protection either due to a lack of awareness or simply not adhering to it. ALARA has become an essential principle in radiation protection since its introduction in 1973 by the International Commission on Radiological Protection. This principle emphasizes the justification and optimization of radiation exposure and, as a result, lowers the radiation risks (Moores, 2016). In the current survey, orthopedic surgery and urology were the specialties with the highest reported percentages (89% and 69%, respectively) of not applying this crucial radiation protection principle. This particular practice in orthopedic surgery and urology was also reported in different parts of the world. In Ireland, 46% of orthopedic trainees reported not applying the ALARA principle (Nugent et al., 2015). In the United States and Europe, different studies reported that urology trainees lack sufficient knowledge and awareness about radiation safety (Harris et al., 2019; Söylemez et al., 2013). Several other studies in different parts of the world, including France and Turkey, concluded that orthopedic and urology surgeons have low knowledge and training in radiation protection and subsequently poor radiation safety practices (Fidan et al., 2019; Galonnier et al., 2016).

The specialties with the highest reported adherence to the ALARA principle were diagnostic and interventional radiology (86% and 85%, respectively). The obvious reason is that dedicated training and education about radiation protection are incorporated into radiology postgraduate programs, as 61% of the radiologists participated in this survey reported such training and education, in comparison to 32% of non-radiologists. Interventional cardiologists reported a relatively high percentage (67%) of postgraduate training in radiation protection. The percentage of non-radiologists and non-interventional-cardiologists who had postgraduate training in radiation protection was only 20%. Two recent studies from Saudi Arabia reported a low level of knowledge regarding radiation protection among radiographers and nurses with an observed increased level of knowledge among those who attended training courses (Aldhafeeri, 2020; Ataalla and Yousef, 2020). The vascular surgeons reported 100% adherence to the ALARA principle and postgraduate training in radiation protection, but since the number of respondents from this specialty was only 3 (1.7%), it is not reliable to take this percentage as representative of the specialty. Interventional radiology and interventional cardiology were the specialties that were mostly exposed to radiation (37% and

Table 2. Distribution of participants and certain radiation protection practices in different healthcare sectors.

<table>
<thead>
<tr>
<th></th>
<th>MOH (%)</th>
<th>Private hospitals (%)</th>
<th>University hospitals (%)</th>
<th>MOD (%)</th>
<th>NGHA (%)</th>
<th>KFSH (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents</td>
<td>86 (47)</td>
<td>48 (26)</td>
<td>33 (18)</td>
<td>20 (11)</td>
<td>21 (12)</td>
<td>11 (6)</td>
</tr>
<tr>
<td>No application of ALARA principle</td>
<td>37 (43)</td>
<td>21 (44)</td>
<td>14 (42)</td>
<td>10 (50)</td>
<td>9 (43)</td>
<td>3 (27)</td>
</tr>
<tr>
<td>No use of personal dosimeter</td>
<td>42 (49)</td>
<td>27 (56)</td>
<td>17 (52)</td>
<td>9 (45)</td>
<td>7 (33)</td>
<td>3 (27)</td>
</tr>
<tr>
<td>No education about radiation protection</td>
<td>56 (65)</td>
<td>22 (46)</td>
<td>23 (70)</td>
<td>10 (50)</td>
<td>11 (52)</td>
<td>6 (55)</td>
</tr>
<tr>
<td>No regular checking or calibration of x-ray machines</td>
<td>33 (38)</td>
<td>18 (38)</td>
<td>14 (42)</td>
<td>4 (20)</td>
<td>1 (5)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No regular checking or replacement of protection aprons</td>
<td>46 (53)</td>
<td>23 (48)</td>
<td>18 (55)</td>
<td>6 (30)</td>
<td>3 (14)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>No radiation protection guidelines</td>
<td>48 (56)</td>
<td>28 (58)</td>
<td>25 (76)</td>
<td>9 (45)</td>
<td>6 (29)</td>
<td>3 (27)</td>
</tr>
<tr>
<td>No policy for radiation dose monitoring</td>
<td>30 (35)</td>
<td>16 (33)</td>
<td>10 (30)</td>
<td>2 (10)</td>
<td>5 (23)</td>
<td>2 (18)</td>
</tr>
</tbody>
</table>

Note: the sum of respondents’ percentages exceeds 100% as there are participants working in multiple sectors. MOH: Ministry of Health; MOD: Ministry of Defense; NGHA: National Guard Health Affairs; KFSH: King Faisal Specialist Hospitals.

Fig. 1. Distribution of participants’ responses to the question: do you apply the ALARA principle in your practice?

(Salama et al., 2016). A more recent study, published in 2018, concluded that the doctors working in emergency departments in Jeddah city of Saudi Arabia have poor knowledge about radiation doses and risks (Barnawi et al., 2018). Those studies were alarming regarding poor adherence to radiation protection and the current study continues to emphasize such concerns on a wider and different target.
32% of total radiation time, respectively). This means that 69% of the total estimated radiation exposure was in those two specialties and only 31% was for all the other remaining specialties. Several studies confirmed higher radiation exposures to interventional radiology and interventional cardiology staff with documented increased rates of the side effects of radiation, like eye lens opacities (Martin, 2018).

The use of personal protective devices was not adequate among the respondents. Most of the respondents did not use leaded eyeglasses (78%), ceiling-mounted leaded screens (70%), or table-mounted shields (72%). These radiation protective devices are important for minimizing the risks to the medical staff. Eye lens protection by lead glasses must be emphasized and even further protection by ceiling-mounted lead screens needs to be considered, as the latter was described as the best way of keeping doses low to the eye lens and upper body (Martin, 2018). Thyroid shields were not used by 31% of the respondents; this is also an alarming practice. The thyroid is a radiosensitive organ and there is a well-established relation between diagnostic radiation exposure and the increased risk of thyroid cancer (Han and Kim, 2018). Even other thyroid diseases were also found to have statistically higher prevalence in exposed medical workers in a study from Italy, compared to controls (Vimercati et al., 2019).

The radiation protection practices varied among different healthcare sectors, with the highest adherence to the ALARA principle (73%) reported in King Faisal specialist hospitals. The rates of use of personal dosimeters, regular checking of x-ray machines and protective aprons, and availability of radiation protection guidelines were also highest in King Faisal specialist hospitals, according to this survey results (Tab. 2). This higher adherence to radiation safety practices appears to be, in general, due to the experiences and effectiveness of the radiation protection program in King Faisal specialist hospitals (Al-Haj et al., 2012). The wide variations in adherence to radiation protection between different healthcare sectors mandates more active supervision by the national authorities, like the National Center for Radiation Protection, and by the administrations in each and every sector and institution.

The main limitation of this study is the relatively small sample size, though no other bigger or even smaller studies could be found in the literature that covered the same important topic in such a wide variation of specialties and healthcare sectors in Saudi Arabia.

5 Conclusions and recommendations

Compliance with radiation protection practices was variable and generally poor among different specialties and healthcare sectors in Saudi Arabia. Recommendations can be made to the National Center for Radiation Protection and the administrative authorities in different healthcare sectors to enforce a strict application of radiation protection practices. Larger national studies are needed to determine the rate of adherence to radiation protection practices in different institutions and by different specialties. The Saudi Commission for Health specialties and the scientific societies of some specialties that showed poor radiation protection practices (especially orthopedic surgery and urology) are encouraged to emphasize radiation safety practices in their postgraduate curricula, training programs, and scientific meetings. Continuous radiation protection training of all healthcare professionals who deal with radiation is recommended. Since there were similar poor radiation protection practices of certain surgical specialties reported in the international literature of different countries, the same recommendations can be made to the concerned authorities worldwide.

Conflict of interest

The author declares that he has no conflicts of interest in relation to this article.

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**Cite this article as:** Alshumrani G. 2021. Radiation protection practice of medical doctors of surgical and interventional specialties in Saudi Arabia. *Radioprotection* 56(1): 49–53