REVIEW ARTICLE

Islamic Perspective on Eye Protection from Occupational Radiation Exposures in Interventional Fluoroscopy Procedures: A Review Article

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ABSTRACT

The healthcare staff in the interventional fluoroscopy room are exposed to the scattered radiation from the patient during the procedures. Excessive occupational radiation exposures to their eyes are associated with the formation of radiation-induced cataracts. Therefore, recommendations are set up to reduce occupational eye exposure but are often overlooked. Thus, there is a need to incorporate additional value into the recommendations. This review is conducted to incorporate the Islamic perspective into the recommendations on eye protection from occupational radiation exposures. Common themes were derived from the recommendations found in several guidelines and articles. The relevant Islamic perspective was then identified and linked. The main themes are the responsibilities of the staff in protecting their eyes and the responsibilities of the employers to ensure that their staff are protected. There were several subthemes identified for each main theme. The relevant Islamic perspectives which are related to the subthemes, eyes, and concept of radiation protection were discussed in this review. The incorporation of the Islamic perspective is an effort to motivate the Muslim staff and employers to see additional values and thus follow the recommendations on eye lens protection.

Keywords
Radiation protection, Interventional radiology, Occupational health, Islamic

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INTRODUCTION

Interventional fluoroscopy staff is involved in minimally invasive procedures such as angioplasty, needle biopsies, and drainage under fluoroscopic guidance.[1] During the procedures, they received occupational exposures as they are working in close proximity with the patient.[2,3] The occupational exposures can be defined as the radiation exposures received by the staff while performing their work.[4] The staff are exposed to the scattered radiation which originated from the patient's body that has interacted with the primary x-rays radiation.[4] It is common for the main staff who stands near the patient to receive more radiation exposure than the other assisting staff who stands further away.[5]

Since not all parts of their body are shielded from radiation during the radiation exposure, the interventional fluoroscopy staff are classified as those exposed to a non-uniform radiation field.[2,3] They also have a higher risk of developing lens opacities especially when they did not use protective equipment for their eyes.[2,6] An excessive radiation exposure to the eye lens could lead to the formation of radiation-induced cataracts. A cataract is the opacity or cloudiness of the clear eye lens which could lead to vision impairment.[7]

Thus, it is important to have a radiation protection programme for the staff's eyes. This is to keep the risk to

the interventional fluoroscopy staff to the levels that are comparable with those working in other occupations .[4] Additionally, to prevent their eyes tissues from having damage that would result in the radiation-induced cataract.[8] The general principles of radiation protection include justification of exposure, optimisation of protection, and application of dose limit.[9]

One of the methods in radiation protection is applying radiation shielding. It involves the use of protective equipment which may be fixed at a place, movable, or worn by staff.[4] The concept of shielding is that the protective equipment is positioned between the staff and the radiation source. The equipment will then absorb a large intensity of radiation before they reach the staff.[4] Examples of shielding for eyes are lead glasses and ceiling -mounted lead shielding.

Another method of radiation protection is setting the equivalent dose limit to the eye lens of staff. Regular dose monitoring is then employed to ensure that staff does not exceed the dose limit. This is important so that the staff doses are maintained below the threshold dose that would result in radiation-induced cataracts. In 2011, the International Commission on Radiation Protection (ICRP) reduced the threshold dose for the eye lens to 0.5 Gy.[8] Subsequently, the equivalent dose limit for occupational lens exposure was reduced from 150 mSv to only an average of 20 mSv per year for periods of 5 years.[8]

With the reduction in threshold dose for radiation-induced cataracts, radiation shielding and dose monitoring to the eyes are more crucial. However, concerns over the cooperation of staff to protect their eyes were reported. There were 6% of staff who never use any protective equipment for their eyes.[10] As for monitoring the eye lens doses, the willingness of staff to wear dosimeters is unsatisfactory.[11] Staff simply forgot to wear their dosimeter, fail to return their dosimeters or some even leave the dosimeters in places that affected the true readings of radiation exposure.[11]

Therefore, there should be an effort to enable the Muslim staff to view the recommendations beyond their professional requirements and to relate them with Islam. This review aims to incorporate Islamic perspectives to the recommendations found in relevant guidelines and articles. The scope of the review is limited to the recommendations for the staff and manager in the hospital, not including the regulatory body and manufacturers of the medical equipment.

MATERIALS AND METHODS

Recommendations from twelve relevant guidelines and articles were classified into common themes in this review. The included guidelines were from several countries including two guidelines from Malaysia. The publication year was chosen from the year 2012 and onwards to only include the recommendations after the introduction of the new eye dose limit. The overview of the included guidelines and articles according to publication year, type, country, and association is presented in Table I below.

Table I: The mapping of the guidelines and articles which were included in the review

No	Criteria	Details
1.	Publication Year	2012[8,12] 2013[2] 2014[10] 2015[6,13] 2016 [1,4,14] 2017[3,11] 2018[5]
2.	Type	Guideline [1–5,10] Report[11–13] Review article [6,14] Statement[8]
3.	Country/Level	International[2,3,8,10,11,13] Europe region[12] Netherlands[5] Malaysia[1,4] Authors of several countries[6] Author of a single country[14]
4.	Association	International Commission on Radiological Protection, (ICRP)[8] International Atomic Energy Agency, IAEA[2,10] International Radiation Protection Association, (IRPA)[3,11,13] European Radiation Dosimetry Group (EURADOS)[12] Netherlands Commission on Radiation Protection[5] Ministry of Health Malaysia[1,4] University and Hospital research team[6,14]

The common themes for the recommendations were analysed using ATLAS.ti 8 for Windows. Both deductive and inductive approaches of coding data were used. The deductive codes were assigned based on the objectives of the review. Additional inductive codes were added as the analysis progresses. The codes were assessed for possible repetition and were combined accordingly.

After the themes were identified, Islamic perspectives related to themes were searched in relevant articles. The articles discussed the Islamic perspective of topics such as medical ethics, eyes, and radiation protection. Analysis was conducted using ATLAS.ti 8 for Windows and deductive coding based on the identified themes was used. Additional Islamic perspective related to the eye and the concept of radiation protection was also searched. Both themes from the recommendations and the relevant Islamic perspective were linked and discussed accordingly.

RESULTS

The two main themes were the responsibilities of the staff in protecting their eyes and the responsibilities of the employers to ensure that their staff is protected. There were three subthemes identified for each main theme as shown in Figure 1 below. Themes that were related to the regulatory body and manufacturer's responsibilities were excluded as they were not relevant to the review's objective.

The three main responsibilities of staff are to apply the concept of optimisation, use protective equipment and apply the other risk reduction techniques to reduce the number of radiations that reach their eyes. Meanwhile, the responsibilities of the employer or manager are to ensure the well-being of the staff, educate and train the staff, and conduct programmes that are related to radiation protection. Relevant Islamic perspectives were linked with the identified themes as listed in Table II. Additional Islamic perspectives related to the eye of Allah's gift and the concept of radiation protection were also included.

DISCUSSION

It is important to highlight that the responsibilities of employers and staff are interrelated with one another. For the staff to efficiently protect their eyes from radiation, the employer should equip his staff with up-to-date knowledge on radiation protection. Meanwhile, the staff must provide full cooperation in all radiation protection programs conducted by the employer.

Responsibility of Staff

Three major responsibilities of the staff can be summarised into one major point which is staff are responsible for their safety. To do so, they must be aware of the risk that they are dealing with in their work field. For encouraging the staff to see the value of radiation protection, the Islamic perspectives should be incorporated.

The staff needs to be aware that the patient is the source of scattered radiation in the room. Therefore, optimisation concept of keeping the patient dose as low as reasonably achievable (ALARA) must be applied.[2] Examples of applying optimisation concept is performing only medically necessary procedures and avoiding the need to repeat procedure due to the lack of techniques.[4] Applying ALARA concept during patient exposure involve the techniques of minimising the gap between patient and detector, minimising field size, reducing frame rate,[5] reducing exposure time, using last-image hold and pulse fluoroscopy, and removing grid for small and thin patients.[4]

Through optimisation, the staff reduce the radiation exposure to the patient and thus reduce the formation of scattered radiation during the procedure. Because of that, the staff received lower occupational doses to their eyes. The concept of optimisation is in line with the concept of Wasatiyyah (Moderation). Wasatiyyah means the best choice as stated in Hadith: "The Prophet (PBUH) was the

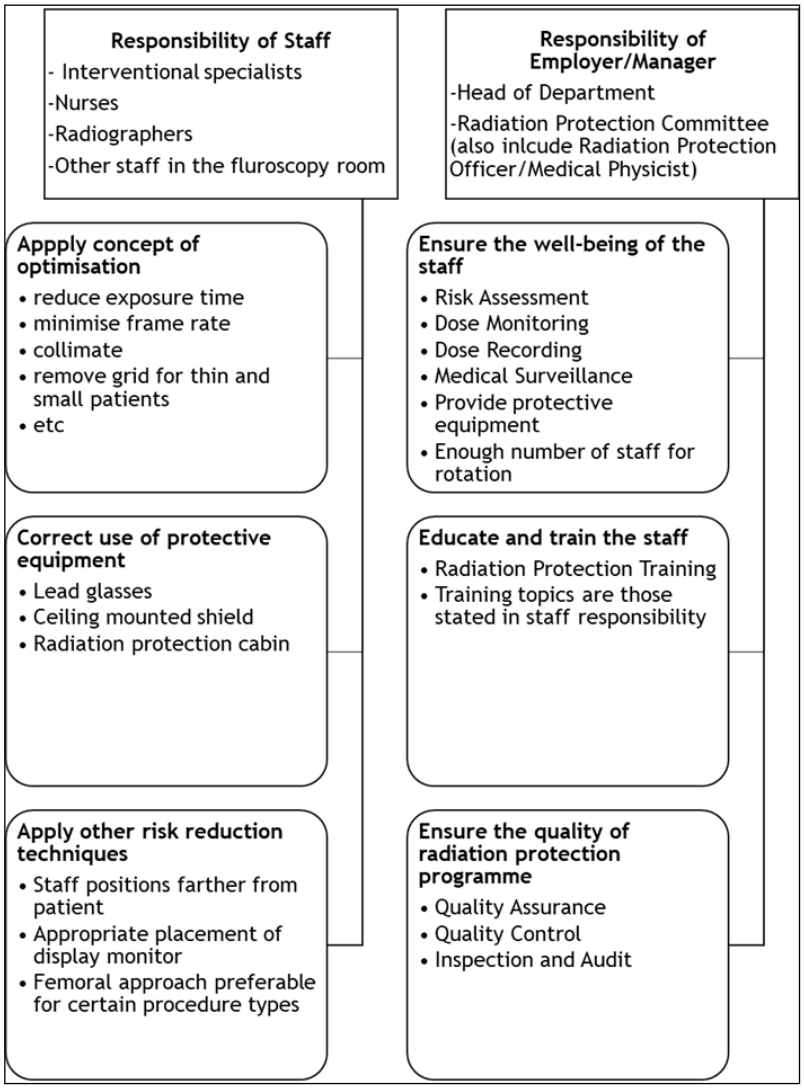

Figure 1: Classification of main and subthemes from the reviewed articles

best (awsat) of the Qurayshite descent".[15] In order to make the optimum decision while performing the interventional procedure, the staff should make the best use of the given Aql (intellect).[16]

Another method that significantly reduces the radiation from reaching staff's eyes is the correct use of protective equipment.[6] This can be achieved by using a ceiling suspended shield and lead glasses.[1,10] The value of the protective equipment for interventional procedures should be 0.5 mm lead equivalence.[4,5,14] Higher level of doses requires the staff to use both protective equipment instead of only one.[3] Moreover, the effectiveness of radiation shielding is affected by the comfort of wearing the lead glasses.[2,6,11,13] Although many suggested the use of a ceiling-suspended shield, only a few guidelines[5,12,14] explain the correct use of the shield. Other forms of protective equipment which are not widely available include protection cabin and patient protection pad.[5,6]

To further reduce the radiation risk, the staff should position themselves as far as reasonable from the patient while ensuring that the position enables them to work efficiently. Staff should stand near the image intensifier if the x-ray tube is near horizontal to prevent themselves from receiving backscatter from the patient. [1,4,14] Femoral approach is also preferable if it causes the main staff to be farther from the scattered radiation source.[12] In addition, the display monitor should be placed at the operator's eye level, so that the back tilting of the staff's head is avoided.[5]

By applying the protective equipment and additional protective methods as mentioned above, the staffs are fulfilling a command by Allah in which Allah prohibits us from putting ourselves in harm as stated in Al-Quran [4:29] "And do not kill yourselves (or one another). Indeed, Allah is to you ever Merciful".[18] In addition, Prophet Muhammad (PBUH) mentioned "Doing harm and reciprocating harm is not allowed".[17] Moreover, the Islamic teaching through its Maqasid (Objective) of its Shariah also includes the preservation of al-nafs (life).[16] Although, the radiation-induced cataract does not result in life-threatening situations, applying radiation can preserve the quality of life of the staff. Thus, the Maqasid Shariah principle can also be linked to this topic.

Table II: Islamic perspectives in relation to the identified themes

Themes	Islamic Perspective
Apply the concept of optimisation	Concept of Wasatiyyah (moderation).[15] Humans are bestowed with Aql (intellect).[16]
Correct use of the protective device	Preservation of life.[16] Concept of preventing harm.[17,18]
Apply other risk reduction technique	Preservation of life.[16] Concept of preventing harm.[17,18]
Ensure the well-being of the staff	Preservation of life.[16] Importance of human life.[17]
Educate and train the staff	Concept of Akhlaq and Adab.[19] Self-assessment and character purification.[19] Guide others to the righteous way of life.[18]
Ensure the quality of the radiation protection programme	Duties must be fulfilled with Ikhlas (honest).[19] Concept of Ihsan, Itqan, and Istiqomah.[16]
Eyes	Eyes are a gift from Allah.[20]
Radiation Protection Concept	Preservation of life.[16] Concept of preventing harm. [17,18]

Responsibility of Employer/Manager

To ensure the well-being of the staff, the employer plays a major role in the radiation protection programmes. Risk assessment should be carried out to identify the staff who could receive high doses to their eye lens based on several eye dose estimation methods as outlined in several guidelines.[2,5,11,14] Appropriate dose monitoring programme should be applied according to the risk assessment and extensive recommendations on dose monitoring were given in the guidelines.[1–3,5,6,11–14] Recorded dose must be periodically reviewed, the individual result must be given to the staff and investigation should be carried out in case of staff receiving high eye dose. [1,10]The medical surveillance of the eye health must be carried out for staff who have received high dose to the eyes and exceeded the 0.5Gy exposure to the eyes.[1,2,5,11]

The employer should also provide appropriate protective equipment to facilitate the protection of staff from radiation. There should be an inspection that the equipment follows the required safety standards. In addition, enough staff is also important to enable staff to be rotated and are not continuously working in the fluoroscopy procedures.[1] A verse in Al-Quran [5:32] should motivate the employer to preserve the well-being of the staff. Allah mentioned, "If anyone saved a life, it would be as if he saved the life of all mankind". The contribution of a person who preserves the life of even one person is as if he has protected the whole of humanity.[17] Similarly, an employer who provides measures to preserve the staff's well-being must have benefitted the whole community as well. Another measure that the employer can help the staff is by providing training on radiation protection to their eyes.

Up-to-date radiation protection training is a regulatory requirement and is very important.[1,13] The training must include the awareness of the risk of radiation towards the eye lens.[11] The topics to be covered are those previously mentioned in the staff responsibility such as the concept of optimisation, correct use of the protective device, and other methods to reduce high radiation dose to the eyes.[2,3,5,6]

The act of providing guidance and training by the employer can be aligned to the responsibility as a fellow Muslim to guide other Muslims to the righteous way of life. Allah mentioned in Al-Quran, "You are the best nation produced (as an example) for mankind. You enjoin what is right and forbid what is wrong and believe in Allah" [3:110].[18] In addition, the act of providing training should be seen as an act of showing concern and love to

fellow Muslims.[18] The Prophet (PBUH) has said, "None of you truly believes until one loves for his brother what he loves for himself."

In addition, the employer should realize that they are shaping the acquired character of the staff. The acquired character of an individual can be shaped through education and training.[19] Besides that, inborn character acts as the conscience and internal moral sense of an individual.[19] This inborn character always guides people to do good things as Allah has mentioned that He "created man in the best of moulds" [95:4]. Thus, the employer could also consider incorporating elements of self-assessment and character purification in the training programme to shape the Adab and Akhlaq of the staff.

Another important element is to ensure optimisation of radiation protection is being performed by establishing a quality assurance programme.[1] The programme must be continuously reviewed and amended accordingly to ensure optimal protection of staff.[2] Quality control should be incorporated in the programme to monitor the performance of fluoroscopy equipment over time as faulty equipment could result in more radiation dose to the staff and patients.[4] Regular inspections of protection equipment should also be carried out to maintain the necessary level of protection which should be provided by the equipment.[2] To ensure that the quality of the radiation protection programme is consistently at the optimum level, standard operating procedures and audit practices should be in place.[1]

While conducting this programme, the employer should always remember that Islam promotes Ikhlas (honesty) in fulfilling responsibilities.[19] Thus, the quality of the radiation programme should be maintained. The programme should be conducted with the concept of Ihsan, Itqan, and Istiqomah. Zainuddin has elaborated these concepts in relation to radiation protection.[16] Both Ihsan and Itqan would result in the excellence of output by constantly remembering that the purpose of doing something is to obtain the blessing of Allah. It can be incorporated into the goal of the radiation protection programme. Istiqomah (steadfastness or consistency) can be aligned to the need to regularly review the programme and performing audit.

Significance of the Islamic Perspective of the Recommendations

Eyes are a gift from Allah and therefore, must be cherished. Allah reminded about the need to be thankful for His gift by mentioning in Al-Quran, "It is He, Who has created for you (the sense of) hearing (ears), sight (eyes), and hearts (understanding). "Yet, only a few of you are grateful" [23:78].[20] By following the recommendation of radiation protection to the eyes, a person is being thankful to Allah and can be related to the act of worshipping Allah.

With that, employer and staff must always set their intentions (niyya) right which is to worship Allah and to seek Allah's blessing. Allah mentioned in Al-Quran that "He who disbelieves will suffer the consequence of it and he who acts righteously, they will pave the way for their own good" [30:44].[21] In addition, any deed in Islam is counted by Allah based on their intention. The Prophet (PBUH) said: "Deeds are judged by intention".[17,19] All deeds will be rewarded by Allah accordingly.[16] By incorporating the Islamic perspective in the recommendation, Muslim staff will be able to appreciate them with values that are in line with Islam. Hopefully, this will motivate them to comply with the recommendations.

CONCLUSION

Both employer and staff are responsible to ensure that the radiation protection programmes are successful. The staff is responsible for the safety of their eyes and the employers must ensure the safety of their staff. Their responsibilities as stated in the recommendations of several guidelines and articles were aligned with the Islamic perspective. Eyes are a gift from Allah and must be protected. Therefore, they should always set their intention of performing the radiation protection measures as acts of worshipping Allah. The incorporation

of the Islamic perspective is expected to motivate the Muslim interventional fluoroscopy staff and employer to follow the recommendations on eye protection from occupational radiation exposure.

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