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Knowledges, beliefs and practices on radiation protection of non-radiologists physicians who use ionizing radiation and participate in radioscopically guided procedures

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REVIEW ARTICLE

KNOWLEDGES, BELIEFS AND PRACTICES ON RADIATION PROTECTION OF NON-RADIOLOGISTS PHYSICIANS WHO USE IONIZING RADIATION AND PARTICIPATE IN RADIOSCOPICALLY GUIDED PROCEDURES

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Abstract

Background: Technical innovations have spread the use of ionizing radiation in daily clinical practice. About one third to half medical decisions are guided by radiological examinations. This review aims to evaluate current literature relating non-radiologists physicians' knowledge and practices of radiation safety.

Method and Material: A literature search from the MEDLINE and CINAHL databases was performed where original articles were retrieved, published in the English language from the past 10 years.

Results: While almost all physicians use lead aprons not all of them use thyroid protectors and very few of them use lead gowns and goggles. Also the majority of physicians do not use a dosimeter badge. The major reason for not using radiation protection equipment is their unavailability. Physicians have low levels of knowledge about radiological safety. Longer length of service, having attended a radiation protection and safety course, increased frequency of ordering imaging per day and specialty are factors that affect positively physicians' level of knowledge. Although occupational radiation exposure has been associated with leukemia and nonmalignant thyroid nodular disease, increased risk of cancer, cataract, headache and fatigue, eye symptoms with most common the red eyes, very few physicians have read articles on radiation safety or have received training.

Conclusions: The inadequate level of radiation knowledge can lead to increased radiation exposure and risk for complications to healthcare professionals and patients. Healthcare organizations must ensure the adequate procurement of personal protective equipment so it is available to physicians who use ionizing radiation.

Keywords: Knowledges, beliefs, practices, radiation protection, non-radiologists physicians, ionizing radiation.

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INTRODUCTION

The first usage of ionizing radiation in healthcare setting was more than 100 years ago. The ionizing radiation is used by physicians for different purposes. Technical innovations have spread the use of ionizing radiation in daily clinical practice. About one third to half medical decisions are guided by radiological examinations.[1] For example, neurosurgeons use radiation to visualize blood vessels and implants intraoperatively.[2]

Physicians routinely are exposed to ionizing radiation during their daily practice, which has been associated with a variety of complications. Despite this, the utilization of ionizing radiation in healthcare settings increases continuously. In this line, healthcare professionals should be compliant with protection guidelines when ordering imaging or when they use ionizing radiation. There are three principles for the protection of healthcare professionals and patients from ionizing radiation: dose limits, optimization and justification.[3] It is well known that personal protective equipment reduces occupational radiation exposure.[4]

Ionizing radiation exposure leads to impairment of cellular function or cell death, which can contribute to the onset of cancer. The effects of ionizing radiation are dependent on the dose of radiation applied, the length of time spent in the radiation field, and the amount of protection employed.[5] Because the correct use of ionizing radiation is very important for the safety of both healthcare professionals and patients, the efforts of reducing their exposure to ionizing radiation has led to the development of the As Little As Reasonably Achievable (ALARA) principle. The International Radiation Commission strongly recommend healthcare professionals not exceed 20 mSv of exposure per year. Due to the fact that many physicians who are not specialized in radiology use ionizing radiation in their daily clinical practice, they have to know the radiation dosage of these exams and all the equipment and techniques they have to use to protect themselves, their colleagues and the patient.[6] Physicians do not know the exact dose of radiation that patient are expose to. In particular, patients receive 16 times greater dose of radiation than physicians believe.[7] Inadequate knowledge for radiation may limit the physicians` ability to protect themselves and patients. So, according to the International Commission on Radiological Protection, healthcare professionals must have all the necessary knowledge and be aware about the danger of radiation exposure.[3,8]

This review aims to evaluate current literature relating non-radiologists physicians' knowledge and practices of radiation safety.

METHODOLOGY

The search of literature was performed using MEDLINE and CINAHL. Keyword search with MeSH, and citation analysis were conducted. Inclusion criteria were applied for population (non-radiologists physicians who use ionizing radiation and participate in radioscopically guided procedures), exposure (radiation safety), and outcome (practices and knowledge of participants). The following key words were used: “Orthopedic Surgeon” OR “Orthopedic” OR “Cardiologist” OR “Urologist” OR “Neurosurgeon” OR “Physician” AND “knowledge” OR “awareness” OR “practices” AND “radiation safety” OR “radiation risks” OR “radiation exposure” OR “radiation”. The final articles selected were original ones from peer reviewed journal, which were published the last 10 years (2015-2024) and written in the English language. Exclusion criteria included qualitative research, which were older than 10 years old, and the study population being radiologists. The process of literature review is shown in the following flowchart.

RESULTS

Totally, the review included 22 articles. Out of all of them, 15 were for practices of occupational radiation exposure, 12 for knowledges of occupational radiation exposure and 11 for implications of occupational radiation exposure.

Practices of occupational radiation exposure

The exposure to ionizing radiation differs among physicians. According to a US study, most neurosurgeons performing surgeries weekly using radiation, do not use a dosimeter but do wear a lead apron and a thyroid shield.[2]

Urologists, especially endourologists, is a specialty of physicians with high frequency of radiation exposure with more than 15 times per week. Usually, they use lead aprons and thyroid shields

but fewer of them use lead eyeglasses and gloves.[9] In Turkey, all urologists use lead aprons but half of them use thyroid protectors. However, very few of them use a combination of lead gowns, goggles, and thyroid protectors together. At the same time the majority of them do not use a dosimeter, since they believe they are not at risk due to the short period of exposure.[10] According to the ESUT/EULIS survey, the majority of urologists use lead apron and thyroid shield during their practice, about half of them use lead shield and very few use glasses and gloves.[11]

Another specialty of physicians that use ionizing radiation very frequently is orthopedic. They use ionizing radiation either for diagnostic practices or for operative management or for follow-up of patients. All orthopedics in the UK and Scotland use lead aprons/gowns and about half of them use thyroid protection when using x-rays.[12] A study showed that the protective equipment an orthopedic surgeon use is lead apron and thyroid shield for every case but only few of them wear lead glasses.[4] All orthopedics and general surgeons in the USA wear thyroid shields when using ionizing radiation. Most of them, also, report that they want to wear lead but they can't due to lack of availability.[13] According to a study, about half of orthopedics in Brazil use lead apron and very few of them use thyroid protector. More than 10% of orthopedics do not use personal protective equipment, with the main reason being that personal protective equipment hinds the surgical procedure. On the other hand very few physicians do not use personal protective equipment because the hospital does not provide it. Although, physicians were concerned about the complications of ionizing radiation, almost all of them did not use a dosimeter.[14]

Almost all spinal surgeons in Brazil wear lead aprons when working with ionizing radiation, more than half of them use thyroid protection and very few of them wear lead glasses and lead gloves. The majority of physicians though, reported that they do not use a dosimeter badge. Regarding the practice they use to protect themselves and patients from exposure to ionizing radiation it mainly includes standing one or two steps away from the fluoroscope, removing their hand from the field during fluoroscopy, using the fluoroscope in pulse mode and standing behind the radiation source. On the contrary, neurosurgeons use the thyroid shield, navigation systems, and stay behind the X-ray source more often than orthopedic surgeons.[15]

In Tunisia all cardiologists wear lead apron and thyroid shield but only few of them use lead glasses and cap. At the same time a result worth noting is that most of cardiologists never wear a dosimeter due to unavailability. Also, the majority of cardiologists never visit or consult other doctors for health issues related to the exposure of ionizing radiation.[16] In India, cardiologists who performed coronary interventions in the catheterization laboratory try to reduce the area of exposure of the patient and once every 6 months calibrate the equipment for optimal frequency. However, they appear to be neglectful of selecting the frame rate for fluoroscopy, terminating timely the Cine recording, and moving away from the x-ray unit. Cardiologists tend to position the image detector closer to the patient's chest but only half of them use a dosimeter and most of them place it on the chest under the lead apron. Regarding personal protective equipment, all cardiologists wear lead apron, most of them wear thyroid shields and few of them wear lead goggles and lead caps.[17]

Almost all cardiologists in Africa use a lead apron when they are in the catheterization laboratory, and most of them use thyroid protection. Half of cardiologists never use radiation protection eyeglasses and none of them uses radiation protection gloves, while the major reason for not using radiation protection tools being their unavailability.[18]

Most emergency physicians discuss with their patients about the potential dangers of radiation before conducting the exam, and one third of them observe the benefits and drawbacks of the diagnostic radiological exam on a pregnant patient requesting for a lead vest to be worn by the patient.[19]

Most females do not wear female-specific lead due to lack of availability and discomfort.[4] In recent years there has been an increased concern about fetus radiation dose and fetus damage for women who are pregnant and due to that fear, female invasive cardiologists stop working when they get pregnant. When females use lead aprons of 0.5 mm Pb, the levels of radiation that their abdominal is exposed to are very low. Thus, lead aprons are an appropriate radiation safety practice for female physicians who use ionizing radiation.[20]

Consultant physicians often fail to inquire whether patients have undergone previous radiographic imaging. The purpose of the question regarding the previous X-rays is to report the clinical necessity of the exams. The majority of them lacked awareness of the concept of ALARA because they failed to take part in courses that promote radiation safety. Only one out of three physicians evaluates the patients' effective dose and its measurement unit. Most physicians supported that the lack of education regarding the biological effects of radiation during medical school had caused the increase in demand for radiography and CT-scopes.[21]

Knowledges of occupational radiation exposure

Physicians in Saudi Arabia have low levels of knowledge about radiological safety. The highest percentage of correct answers of physicians is about modalities that have more radiation followed by most common complication of radiation exposure and the lowest percentage of correct answers is about the safety of the patient's relative to enter the CT room with the patient during the imaging process.[22] In Canada, physicians are not educated on radiation safety. As a result, their knowledge about radiation is very low.[9]

Almost none of the neurosurgeons in the USA could identify the safety limit for occupational radiation and about half of neurosurgeons identify the relationship between distance and radiation dose reduction.[2]

Orthopedics in the UK and Scotland have low levels of radiation training and low levels of knowledge.[12] In USA, orthopedics, general surgeons and emergency physicians underestimated the effective radiation doses of all imaging and especially pelvic X-ray, hip X-ray, and pelvic CT scan.[13] Also, orthopedics from Brazil have low levels of knowledge of ionizing radiation. That`s the reason they are afraid of it, only 1 in 3 physicians feel safe using ionizing radiation, move away from the equipment during the imaging and keep their hand out of the primary beam.[14]

Cardiologists found to have medium levels of knowledge since they gave higher percentages of correct answers regarding practices' influence on operator exposure over time and the risk of radio-induced cataracts after X-ray exposure for more than 10 years and lower percentages of correct answers regarding the minimum distance from which X-rays become safe and the suitability of cataract a physician to work in the catheterization room.[16]

Additionally, urologists did not know the appropriate fluoroscopy doses and claimed that there is no relevant literature. Their overall knowledge of fluoroscopy was moderate and half of them had not read literature about the fluoroscopy protection and the potential damage it can cause to them and to patients.[10]

A study conducted in Iraq found that 71.9% of non-radiologists physicians answered correctly to the definition of radioactive radiation, 40.6% of participants were aware of the ALARA principle, 21.9% knew the unit of Radioactivity, and 15.6% knew the radiation dose of a single chest X-Ray.[23] In Iran, 87.44% of 41 urologists, neurologists, surgeons and orthopedics used dosimeter in the right place during procedures with ionizing radiation. The physicians had moderate level of knowledge about operator time (52%) and distance (50.6%). More than half of physicians didn't wear personal protective equipment for eyes (66.1%), thyroid (77.4%), and aprons (64.5%). The majority of physicians were aware of the sensitivity of fetuses or pregnant mothers (88.3%) and only 16% of them answered the questions about organ radiosensitivity correctly.[24] Similarly, another study from Iran found that physicians who work with ionizing radiation have a moderate level of knowledge.[3]

Emergency physicians underestimate the overall dose of ionizing radiation and they were found to have moderate level of knowledge of ionizing radiation. Only one third of physicians answered that a one-time abdominal CT increases the lifetime risk of developing cancer in children. One third of physicians responded correctly that the exam with the lowest risk to the fetus is the chest X-ray, as opposed to the lumbar and abdominal x-rays and the pelvic and abdominal ones.[19]

Consultant physicians have moderate level of knowledge about ionizing radiation. Just one to three physicians believed that MRI radiation exposes patients to ionizing radiation. The same percentage of physicians knew how to evaluate the radiation dose of patients and how to calculate the risk of cancer in patients following medical physics and radiobiology classes. A lot of the participants advocated for the necessity of retraining programs for radiation protection, the presence of a radiation safety officer

in hospitals and educational centers were considered essential.[21] Training seems to improve the level of knowledge physicians have about radiation protection. Surgeons and anesthetists who attended a training program about radiation protection answered correctly significantly more questions about the ALARA principle, the distance from the source of radiation, the dosimeter, the annual dose limit and the dose limit for a pregnant woman.[19]

Longer length of service,[3,19,22] having attended a radiation protection and safety course,[22] increased frequency on ordering imaging per day[22] and specialists[19] are factors that affect positively the level of knowledge of physicians.

Implications of occupational radiation exposure

Fluoroscopy is commonly used for diagnostic and therapeutic purposes. The occupational radiation exposure has been associated with leukemia and nonmalignant thyroid nodular disease,[2] increased risk of cancer,[9,11,21] cataract,[16] headache, fatigue and eye symptoms with the most common one being the red eyes.[10] Cardiologists seem to be aware of the cancer risk of radiation use. Surgeons and anesthetists feel at risk of a cataract.[25]

Very few physicians, less than 1 to 10, have read articles on radiation safety[26] or have received recent training.[11,14,19,27] The only training they have received took place more than 4 years ago.[14] For these reasons, education on radiation safety is crucial.

CONCLUSIONS

Physicians utilize ionizing radiation for both diagnostic and treatment purposes. The level of knowledge and practice of the physicians who use ionizing radiation and are not radiologists, in terms of radiation protection is insufficient. The inadequate level of radiation knowledge can lead to increased radiation exposure and risk for complications to healthcare professionals and patients. ALARA is the foundation of radiation safety along with optimal use of protective equipment. There is a need for increased awareness and training on radiation safety for all doctors' specialties. Educational programs targeted to physicians will increase the levels of compliance of to radiation safety practices. Also, there is unavailability of most radiation protective equipment and this increases the physician`s exposure to ionizing radiation. Healthcare organizations must procure a sufficient amount of personal protective equipment so it is available to physicians who use ionizing radiation.

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ANNEX

FIGURE 1.