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Original Research Article

Assessment of radiation protection (Knowledge and performance) practices among radiographers in Taif Hospitals Saudi Arabia

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Abstract: Radiation protection is very important issue. This study aimed to evaluate and asses the knowledge and performance of radiation protection during hospital practice among the radiology staff in radiology department in Taif Hospitals, King Abdul Aziz Specialist Hospital, King Faisal Hospital and Alhada military Hospital. A total of 50 radiographers participated in this study, using questionnaire and observation check list in knowledge about What Radiation protection include (ionizing radiation) effective shielding material (lead) , meaning of justification , the meaning of radiation dose limit , the meaning of optimization , time and distance so this study revealed that 98% of studied sample were of good knowledge about What Radiation protection include (ionizing radiation), 66% answer what ionizing radiation include (CT) , 100 % full percentage knows the most effective shielding material (lead) . 72 % of the sample knows the meaning of justification, 86% knows the meaning of limitation and 84% knows the meaning of optimization, 76% of them have a good knowledge about radiation protection rules (shielding, time and distance). so the knowledge and the awareness of workers about radiation protection in king Faisal , king Abdulaziz and Al-hada hospitals is very good and at high level. Finally poor performance and good performance are equal (50 %). There is a high significant difference between different hospitals regarding poor performance (p=0.000). The worst hospital was King Faisal Hospital with 80% poor performance, followed by Al-Hada Hospital with 42.9% poor performance and the last one was King Abdel Aziz Hospital with 28.6% poor performance. A similar study was done before in Al Taif hospitals also conduct that, radiographers have a good knowledge but poor performance.
Keywords: Radiation protection, performance, ionizing radiation, justification, limitation, optimization.

INTRODUCTION:

The radiation protection is the science and practice of protecting people and the environment from the harmful effects of ionizing radiation. Ionizing radiation is widely used in industry and medicine, and can present a significant health hazard. It causes microscopic damage to living tissue, which can result in skin burns and radiation sickness at high exposures (known as "tissue effects"), and a statistically elevated risks of cancer at low exposures ("stochastic effects"). [1]. Report on the clinical effects of inadvertent radiation under dosage in 1045 patients, clinical 214-225.

Radiation is energy that comes from a source and travels through some material or through space. Radiation has a wide range of energies that form the electromagnetic spectrum. The spectrum has two main and major sorts: Ionizing Radiation and Non-Ionizing Radiation. If the energy of radiation is high enough to remove electrons from atoms and creating positively charged ions, it is called ionizing radiation (alpha, beta,, gamma rays and x-rays) and if the energy of radiation is low so it can't remove atoms, it is called non-ionizing radiation (ultraviolet (UV), visible light, infrared, microwave and radio wave) [1]. Report on the clinical effects of inadvertent radiation. Radiation types are, Alpha Particles Some unstable atoms emit alpha particles (α). Alpha particles are positively charged and made up of two protons and two neutrons from the atom's nucleus.

Alpha particles come from the decay of the heaviest radioactive elements, such as uranium, radium and polonium. Even though alpha particles are very energetic, they are so heavy that they use up their energy over short distances and are unable to travel very far from the atom.

The health effect from exposure to alpha particles depends greatly on how a person is exposed. Alpha particles lack the energy to penetrate even the outer layer of skin, so exposure to the outside of the body is not a major concern. Inside the body, however, they can be very harmful. If alpha-emitters are inhaled, swallowed, or get into the body through a cut, the alpha particles can damage sensitive living tissue. The way these large, heavy particles cause damage makes them more dangerous than other types of radiation. The ionizations they cause are very close together--they can release all their energy in a few cells. This results in more severe damage to cells and DNA [2].

Beta Particles Beta particles (β) are small, fast-moving particles with β a negative electrical charge that are emitted from an atom's nucleus during radioactive decay. These particles are emitted by certain unstable atoms such as hydrogen-3 (tritium), carbon-14 and strontium-90. Beta particles are more penetrating than alpha particles but are less damaging to living tissue and DNA because the ionizations they produce are more widely spaced. They travel farther in air than alpha particles, but can be stopped by a layer of clothing or by a thin layer of a substance such as aluminium. Some beta particles are capable of penetrating the skin and causing damage such as skin burns. However, as with alpha emitters, beta-emitters are most hazardous when they are inhaled or swallowed [2].

Gamma Rays (γ) are weightless packets of energy called photons. Unlike alpha and beta particles, which have both energy and mass, gamma rays are pure energy. Gamma rays are similar to visible light, but have much higher energy. Gamma rays are often emitted along with alpha or beta particles during radioactive decay.

Gamma rays are a radiation hazard for the entire body. They can easily penetrate barriers, such as skin and clothing that can stop alpha and beta particles. Gamma rays have so much penetrating power that several inches of a dense material like lead or even a few feet of concrete may be required to stop them. Gamma rays can pass completely through the human body easily; as they pass through, they can cause ionizations that damage tissue and DNA [2].

X-Rays Because of their use in medicine, almost everybody has heard of x-rays. X-rays are similar to gamma rays in that they are photons of pure energy. X-rays and gamma rays have the same basic properties but come from different parts of the atom. X-rays are emitted from processes outside the nucleus, but gamma rays originate inside the nucleus. They also are generally lower in energy and, therefore, less penetrating than gamma rays. X-rays can be produced naturally or artificially by machines using electricity. Literally thousands of x-ray machines are used daily in medicine. Computerized tomography, commonly known as CT or CAT scans, uses special x-ray equipment to make detailed images of bones and soft tissue in the body. Medical x-rays are the single largest source of man-made radiation exposure. X-rays are also used in industry for inspections and process controls [3].

The radiation generally has biological effects, are typically divided into two categories. The first category consists of exposure to high doses of radiation over short periods of time producing acute or short term effects. The second category represents exposure to low doses of radiation over an extended period of time producing chronic or long term effects. High doses tend to kill cells, while low doses tend to damage or change them. High doses can kill so many cells that tissues and organs are damaged. This in turn may cause a rapid whole body response often called the Acute Radiation Syndrome (ARS) [2].

Radiation protection can be divided into occupational radiation protection, which is the protection of workers, medical radiation protection, which is the protection of patients, and public radiation protection, which is protection of individual members of the public, and of the population as a whole. The types of exposure, as well as government regulations and legal exposure limits are different for each of these groups, so they must be considered separately.

The main principle of radiation protection is:
-Justification: No unnecessary use of radiation is permitted, which means that the advantages must outweigh the disadvantages.

In proposed and continuing practices, the justification of practice must be such that the work uses radiation because it gives benefit (or gain) to the exposed individuals or to society that exceeds radiological risk that exceeds radiological risk. Justification in intervention provides more benefit in comparison to if there were no intervention.

-Limitation: Each individual must be protected against risks that are far too large through individual radiation dose limits.

Dose limit is used to apply controls on each individual's accumulation of dose. Dose limits are not:
• A line of demarcation between "safe" And "dangerous", Dose limits are not dangerous.
• The sole measure of the stringency of a system of protection. Dose limits do not include medical exposures and natural background radiation.

Annual Dose Limits (ADL): There are different categories of dose limits for: radiation workers;
- Members of the public; Patients; and female pregnant workers.

Table1: Annual Dose Limits for workers, patients and general public [5].

Class of individual	Annual dose limits (whole body)
Workers	<50mSv/year
patients	10mSv/year
General public	1mSv/year

Optimization: Radiation doses should all be kept As Low as Reasonably Achievable (ALARA). This means that it is not enough to remain under the radiation dose limits [5].

As permit holder, you are responsible for ensuring that radiation doses are as low as reasonably achievable, which means that the actual radiation doses are often much lower than the permitted limit. For any given radiation source within a practice, the magnitude of individual doses, the number of the magnitude of individual doses, the number of people exposed, and the likelihood of incurring exposures should be kept to as low as reasonably achievable, taking economic and social factors into considerations [5].

The main rules of radiation protection:

There are three factors that control the amount, or dose, of radiation received from a source. Radiation exposure can be managed by a combination of these factors [6].

1-Time: Reducing the time of an exposure reduces the effective dose proportionally. An example of reducing radiation doses by reducing the time of exposures might be improving operator training to reduce the time they take to handle a source.

$$[Dose = Dose\ rate\ x\ time] \qquad (1)$$

The longer the exposure time the higher is the dose received and vice versa.

2-Distance: Increasing distance reduces dose due to the inverse square law. Distance can be as simple as handling a source with forceps rather than fingers.

Reduction of radiation dose inversely proportional the square of the distance or it follows the inverse square law equation [6]. International commission on radiological protection 1996, Oxford.

$$\text{Intensity} \propto \frac{1}{\text{distance}^2} \qquad (2)$$

3-Shielding: The term 'biological shield' refers to a mass of absorbing material placed around a reactor, or other radioactive source, to reduce the radiation to a level safe for humans. The effectiveness of a material as a biological shield is related to its cross-section for scattering and absorption, and to a first approximation is proportional to the total mass of material per unit area interposed along the line of sight between the radiation source and the region to be protected. Hence, shielding strength or "thickness" is conventionally measured in units of g/cm2. The radiation that manages to get through falls exponentially with the thickness of the shield. In x-ray facilities, walls surrounding the room with the x-ray generator may contain lead sheets, or the plaster may contain barium sulphate. Operators view the target through a leaded glass screen, or if they must remain in the same room as the target, wear lead aprons. Almost any material can act as a shield from gamma or x-rays if used in sufficient amounts [7].

Biological shield- 2005 by United States Nuclear Regulatory Commission, Retrieved on 13 August 2010**.** In radiology, there are four aspects of radiation protection to be considered. First, patients should not be subjected to unnecessary radiographic procedures. This means that the procedures are ordered with justification, including clinical examination, and when the diagnostic information cannot be obtained otherwise. Second, when a procedure is required, it is essential that the patient be protected from excessive radiation exposure during the examination. Third, it is necessary that personnel within the facility be protected from excessive exposure to radiation during the course of their work. Finally, personnel and the general public in the vicinity of such facilities require adequate protection [6].

Radiation protection principles and rules can help in protecting the workers and patients from radiation.

- Radiation sources should ONLY be used when it gives net benefit with tolerable risk to those using it and those that will be affected by its usage.
- Dose received should be ALARA.
- Dose limit should be a minimum requirement to be fulfilled.
- Increasing the distance.
- Usage of the shielding.
- Decreasing the time.

A Survey study to assess level of knowledge among dentist in radiography, radiographic equipment and radiation protection in Jeddah, Saudi Arabia by Nagla Faraz 2015 shows that**:** It is required to implement internationally recommended standards to improve awareness and knowledge among dentists regarding dental radiography and radiation protection. Furthermore, improvement in undergraduate education level and establishment of postgraduate courses on dental radiology are strongly recommended [8].

THE AIM:

To evaluate the knowledge and practices of radiation protection rules and principles among radiology department (General X ray and computed tomography) in, Armed Forces Hospital in Al-hada, King Abdul Aziz Specialist Hospital (KAASH) and King Faisal Hospital, and to mention some recommendations according to the rustles obtained.

MATERIALS AND METHODS:

Study design: This was a descriptive cross section study.

Study tools: The first is a questionnaire about knowledge about radiation protection rules and principles among radiology department (General X ray and computed tomography) staff. Such as:

- Gender.
- Age.
- Number of years of experience.
- Nationality.
- Is your department providing you all the shielding tools you need to protect pt. and co-patients including: (whole body shielding apron - gonad shielding - neck shielding ,etc …)

-The second tool was the observation check list for evaluation of radiation protection practice among some members of radiology

Department in (General X ray and computed tomography). Such as:

Worker Protective clothing being used Close the door during examination. Optimum radiation dose (Not high or low) .

Settings of the study:

- Radiology department, Armed Forces Hospital in Al-hada, Taif, Saudi Arabia
- Radiology department, King Abdul Aziz Specialist Hospital (KAASH) –Taif, Saudi Arabia.
- Radiology department King Faisal Hospital – Taif, Saudi Arabia.

Sample of the Study:

The total number of the study sample was 50 members from the radiology staff in (General X ray and computed tomography) (male & female)

STATISTICAL ANALYSIS:

Collected data was analyzed by using computer program for data analysis (SPSS)

RESULTS AND DISCUSSION

Table 2: Frequency distribution of demographic characters of studied sample

Demographic characters	Frequency	
	N0.	%
Hospital name		
king faisal hospital	15	30.0
king AbdulAziz hospital	14	28.0
al-hada hospital	21	42.0
Total	50	100.0
Medical x-ray imaging		
CT	18	36.0
conventional	22	44.0
Others	10	20.0
Total	50	100.0
Department		
O.P.D	32	64.0
E.R	18	36.0
Total	50	100.0
Gender		
Male	23	46.0
Female	27	54.0
Total	50	100.0
Age		
25-30 years	35	70.0
31-40 years	12	24.0
41-50 years	3	6.0
Total	50	100.0

		Nationality
Saudi	38	76.0
non-saudi	12	24.0
Total	50	100.0
		Degree of education
diploma	30	60.0
bachelor	20	40.0
Total	50	100.0
		Years of working
less than 3 years	20	40.0
less than 5 years	8	16.0
less than 10 years	14	28.0
over than 10 years	8	16.0
Total	50	100.0

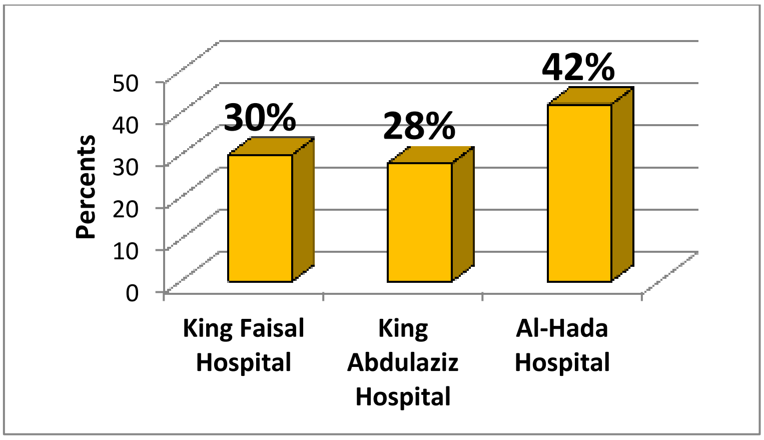

Fig.1 :Distribution of studied sample by hospitals type

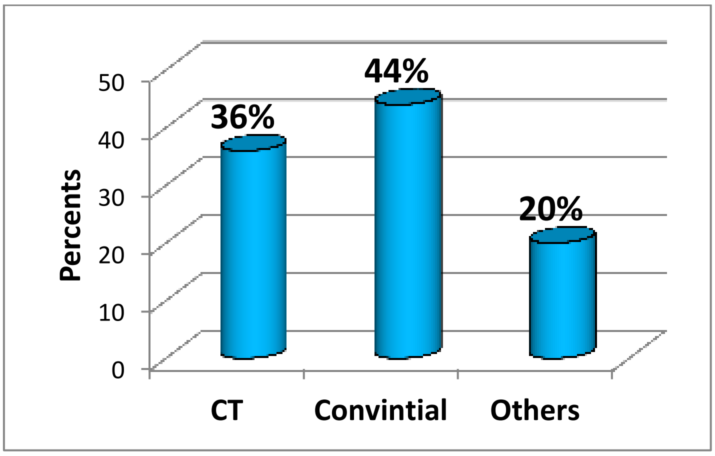

Fig.2: Distribution of studied sample by Medical x-ray imaging.

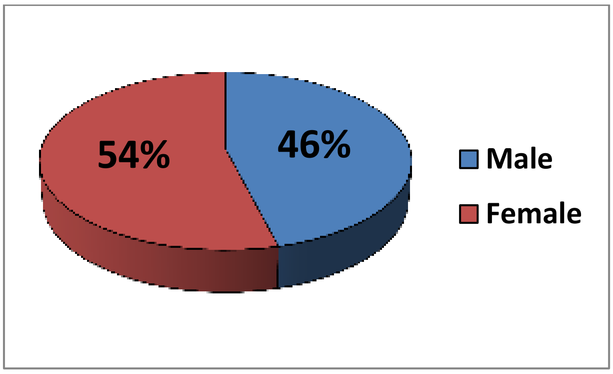

Fig.3 : Gender of studied radiographers

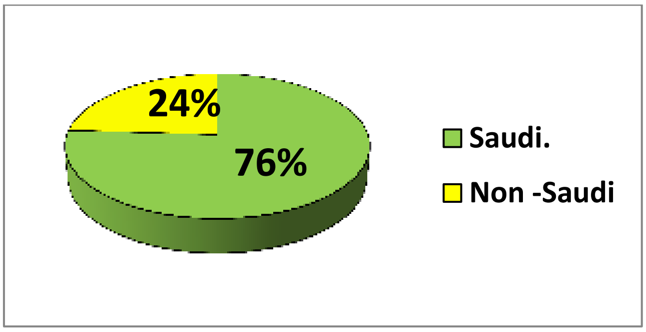

Fig.4:Nationality of of studied radiographers

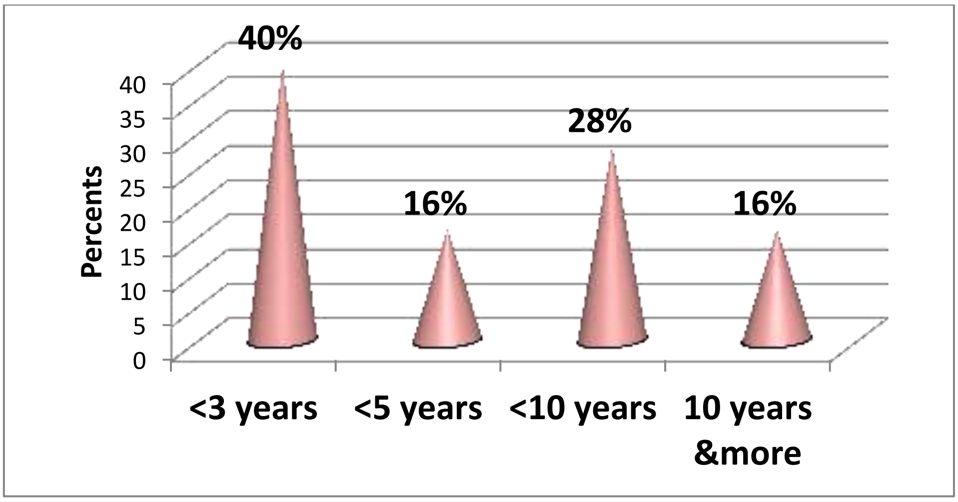

Fig.5 : Experience of studied radiographers

Table 3: Frequency of knowledge items about radiation protection principles and rules

Knowledge items	Frequency	
	N0.	%
Radiation protection include the protection from		
ionizing radiation	49	98.0
non ionizing radiation	1	2.0
Total	50	100.0
Ionizing radiation include		
Ct	33	66.0
Mri	1	2.0
u/s	14	28.0
Mammogram	2	4.0
Total	50	100.0

increasing the distance from the source of radiation		
will reduce the amount of radiation received	37	74.0
will increase the amount of radiation received	8	16.0
will not change the amount of radiation received	5	10.0
Total	50	100.0
which of the following would be the most effective shielding material		
Lead	50	100.0
what does a collimator do		
it reduce the exposure time by ionizing the radiation before it hits the film	12	24.0
it holds the film in place during an exposure	2	4.0
it provides shielding from radiation	36	72
Total	50	100.0
is your department providing you all the shielding tools you need to protect pt. and co. Patients including (whole body shielding apron - goanad shielding - neck shielding , etc ...)		
Yes	35	70.0
No	15	30.0
Total	50	100.0

Knowledge items	Frequency	
	N0.	%
a passive personal dose meter such as a film badge or tld will		
absorbed the radiation and become radioactive	3	6.0
flash or alarm when the dose limit has been exceeded	1	2.0
measure the dose you receive	45	90.0
help protect you from the radiation and reduce the dose you receive	1	2.0
Total	50	100.0
international annual dose limits for whole body for workers is		
10msv/year	13	26.0
100msv/year	3	6.0
<50msv/year	34	68.0
Total	50	100.0
International annual dose limits for whole body for pt. Is		
10msv/year	29	58.0
100msv/year	5	10.0
<50msv/year	16	32.0
Total	50	100.0
justification means no unnecessary use of radiation is permitted		
True	36	72.0
False	14	28.0
Total	50	100.0
limitation means that each individual must be protected against risks that are far too large through individual radiation dose limits		
True	43	86.0

False	7	14.0
Total	50	100.0
optimization means that radiation doses should all be kept as low as reasonably achievable		
True	42	84.0
False	8	16.0
Total	50	100.0

Knowledge items	Frequency	
	N0.	%
radiation protection principle are		
shielding, time and distance	28	56.0
limitation, optimization and justification	18	36.0
none of the above	4	8.0
Total	50	100.0
radiation protection rules are		
shielding, time and distance	38	76.0
limitation, optimization and justification	9	18.0
non of all above	3	6.0
Total	50	100.0

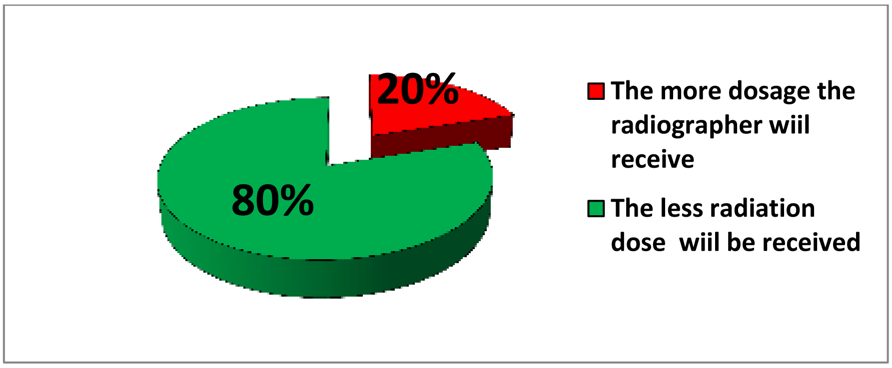

Fig.6 : Awarnes of studied radiographers about the effect of less time spent near a radioactive source or an x-ray tube

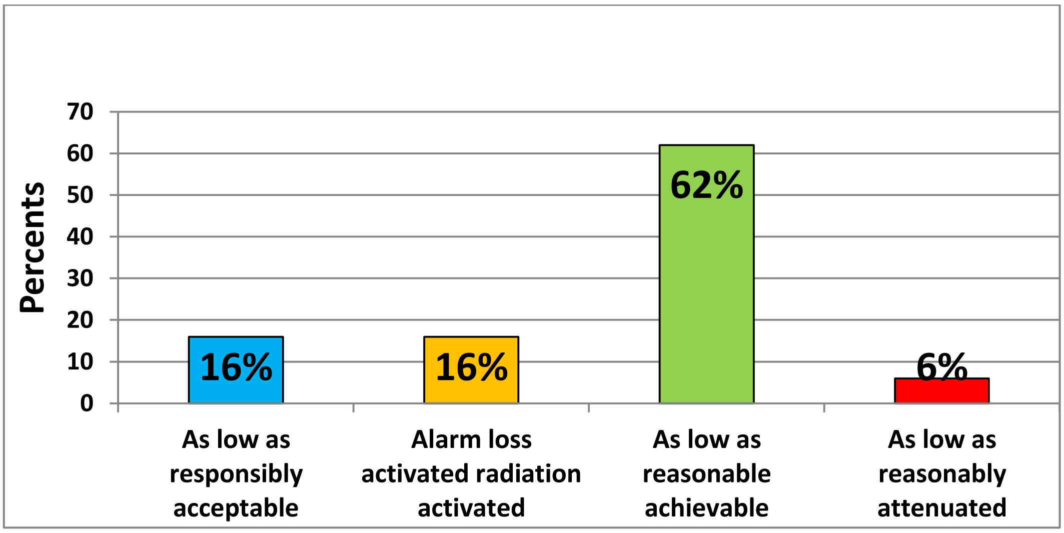

Fig.7 :Awarnes of studied radiographers about meaning of ALARA

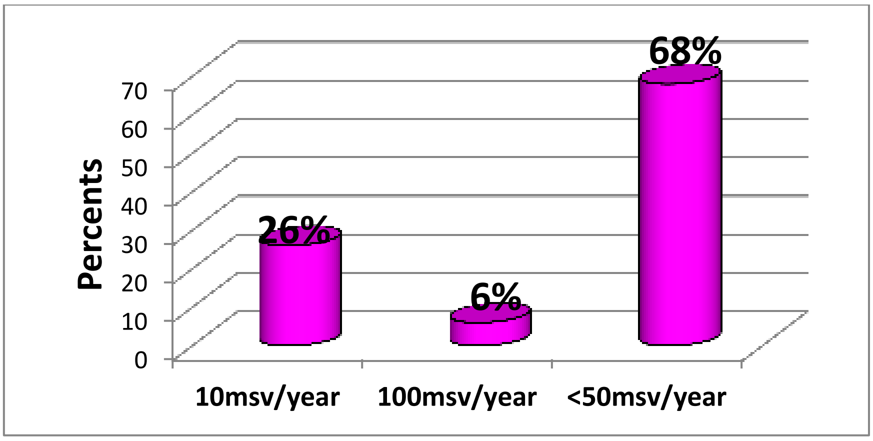

Fig.8:Awarnes of studied radiographers about international annual dose limits for whole body for workers

Table 4: Radiological workers performance distributed by hospital type

Performance groups	Hospital names			Total
	King faisal hospital	King AbdulAziz hospital	Al-hada hospital	
poor performance (0 - 14) total score	12 80.0 %	4 28.6 %	9 42.9%	25 50.0%
good performance(15-22 total score)	3 20.0 %	10 71.4%	12 57.1	25 50.0%
Total	15 100.0%	14 100.0%	21 100.0%	50 100.0%

P=0.000 HS **HS= High significant**

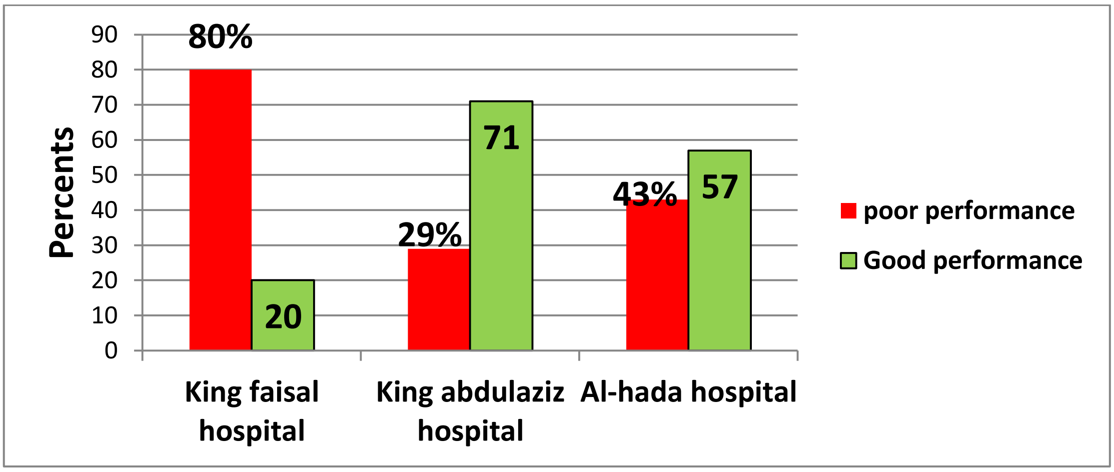

Fig.9 :Radiological workers performance distributed by Hospitals type

DISCUSSION:

This study aim to assess and evaluate the knowledge and practices of radiation protection rules and principles among radiographer in radiology department (General X ray and computed tomography) in, Armed Forces Hospital in Al-hada , King Abdul Aziz Specialist Hospital (KAASH) and King Faisal Hospital.

A total of 50 radiographer responded to this study from them there were (46%) male and (54%) female, their age between 20 and 50 years, table. Diploma holders are (60%) and bachelor are (40%). The result further showed that knowledge and compliance did not depend on years in practice according to Tilson [13] because out of 97% that had good knowledge of safety standards, 80% had less than 10 years in practice and majority were involved in continuing education.

The study found that there are no relation between level of education of participant and work expertise with their knowledge and around the performance and application of organ shield for patient and them self [13]. Also with concern to knowledge in this study (98%) has good knowledge about ionizing radiation and radiation protection principles and rules. According to A study was done in South West, Nigeria reported that the respondents comprised of 100 radiographers recruited for the study from teaching hospitals (58%), general hospitals (19%) and private diagnostic centers' (23%). The ages of respondents were between 20- 60 years. From the result, 98% of respondents had good knowledge of radiation protection probably because of their academic qualifications to practice as qualified radiographer. ([14]) (100%) of respondents knew that doors and walls consist of isolated materials such as lead .and (70%) knew the department provide tools. (62%) of staff not wearing TLDs during their work hours. and (90%) believe that TLD measure the dose that technician receive, (80%) Knew that the less time spent near to x-ray source the fewer doses will be received and majority of the sample knew the principles and rules of radiation protection .this indicate that there are a good knowledge and poor performance. (84%) from participant has a good knowledge and performance about 10 day rule Alara Fig (7). (94%) are not able to wear lead apron lead gloves and during work hours because they prefer to use distance rule than wearing lead apron.

According to international commission of radiation protection (ICRP) radiation safety standard for gonads shield to be used for protection of gonads when the pelvis is not part of anatomical area begin examined. Other study done by “Biological shield" in 2005 [7] by United States Nuclear Regulatory Commission. The study conducts that it’s significantly reduce the radiation dose of the body. The gonald shield must be routinely used in radiology field [14].

In this study we also focused on the practices of radiological workers. According to the checklist the good performance and the poor performance was equal but still un satisfactory with King Faisal Hospital (80%) of poor performance, Al-Hada Hospital (42.9%) of poor performance and the King Abdel Aziz Hospital (28.6%) of poor performance

CONCLUSION AND RECOMMENDATION:

This study investigated in Taif hospital in order to evaluate the knowledge and practices of radiation protection principles and rules among the radiology staff in radiology departments in these hospitals. Our study identify found the differences between the knowledge and practices among radiology technicians. High percentage of studied sample were of good knowledge about radiation protection principles and but their performance were not good enough compare to their knowledge so they need to hold continuous training courses of radiation protection from ionizing radiation and encourage them to use the safety devices in radiology department in order to developed staff knowledge

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