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AWARENESS AND KNOWLEDGE OF RADIATION PROTECTION AMONG MEDICAL PERSONNEL WORKING INRADIOLOGY DEPARTMENT

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Abstract

Background history: *Ionizing radiation is any kind of radiations capable of removing an orbital electron from an atom with which it interacts. This type of interaction between radiation and matteris called ionization. Radiology is a specialty of medical which uses imaging of body for diagnosisand treatment of a disease. This comprises of imaging modalities which include X-ray, Computed Tomography, Magnetic Resonance Imaging, Nuclear Medicine, Positron Emission Tomography, Ultrasonography and Interventional Radiology, Angiography and Mammography.*

Objective: *To evaluate the availability, practice, knowledge and awareness of radiation protection among medical personnel working in radiology department*

Material and Method: *A total of 127 medical personnel that includes radiologist, technologist, students and staff nurses who were working in various hospital branches during September 2024 to July 2025 were recruited for this observational study using a self-designed 11 items questionnaire.*

Results: *Majority of medical personnel working in a radiology department who participated in this study were aware of importance of radiation safety but significant lapses were found in practice and knowledge in thisregard. The practice about personnel protection devices was proper for lead apron and position of dosimeter around lead apron but their practice of film badge usage was not proper. Majority of them did not use film badge in order to detect their occupational absorbed dose. But only a few hospitals were conducting radiation safety meetings for the knowledge and awareness of radiation*

protection for all medical staff working in radiology department.

Conclusion: *In conclusion, majority of medical personnel working in radiology department were aware of knowledge and importance of radiation safety and practice other radiologic protection principle in practical field, and radiation safety meetings were continuously conducted and performed practically. Dose limit should not exceed to permissible limit so that it may reduce the risk and ensures safety for medical personnel working in radiology department. Knowledge, experience and education have strong direct effect in radiation protection against health hazards associated with radiation exposure.*

INTRODUCTION

Background history: Ionizing radiation is any kind of radiations capable of removing an orbital electron from an atom with which it interacts. This type of interaction between radiation and matter is called ionization. The most widely known types of ionizing radiations are X-rays, α-particles, β-particle. Radiology is a specialty of medical which uses imaging of body for diagnosis and treatment of a disease. This comprises of imaging modalities which include X-ray, Computed Tomography, Magnetic Resonance Imaging, Nuclear Medicine, Positron Emission Tomography, Ultrasonography and Interventional Radiology, Angiography and Mammography. Many of these modalities uses high energy radiations while some use magnets and sound waves. Radiology department is an integral part of hospital. It usually comprises of radiologist, radiologic technologists, and radiology staff nurses.

Medical image acquisition is carried out by radiologic technologist also known as imaging scientist and radiographer. All the medical personnel working in radiology department are highly qualified and have attained degree and training in medical imaging. Radiologist is responsible for viewing and interpretation of image. Radiologic technologist is skilled in using high profile imaging machines and fabricating quality images. Radiologic technologist is a person who comes direct in contact with patient and high energy radiations while performing a radiographic scan. Radiologic technologist should have knowledge of radiation protection and should be well trained to save one from the adverse effects of high energy radiation.

Radiations: Energy emitted and transferred through space is called radiation. There are two basic types of radiations that are electromagnetic radiations and particulate radiations.

Particulate Radiations: Particulate radiations include α-particles and β-particles. These are radiations by mean of fast-moving subatomic particles that have both mass and energy.

Electromagnetic Radiations: Electromagnetic radiations is s stream of mass-less particles called photons include X-rays and γ- rays. Energy is carried by oscillating electric and magnetic fields traveling through space with speed of light. X-rays and γ-rays occupy the highest energy, shortest wavelength of spectrum; X- rays and γ-rays' photons have energies in KeV, MeV range where visible light photons have energies of only few electron volts.

Ionizing Radiations: Ionizing radiation is any kind of radiations capable of removing an orbital electron from an atom with which it interacts. This type of interaction between radiation and matter is called ionization.

Fluoroscopy: Fluoroscopy produces a real-time image of internal structure at high dosage range but provide constant output of internal structures. Fluoroscopy gives us ease to have the constant image display during the interventional image guided procedures. After the radiations passes through the body by mean or x-ray tube, they fall on image receptor and are detected by it. A radiopaque contrast material is used to

visualize the internal structure, such as esophagus, stomach, intestine etc. Radiographic projections are used to diagnose the pathologies and fractures. Fluoroscopic procedures include • IVP • MCUG • Hysterosalpingography • Barium swallow • Barium meal • Barium follow • Barium enema.

Computed Tomography scanning or CAT scan. The word axial differentiates it from the conventional radiography mentioned above. A computer processes the data received by detectors and reconstructs it to view the image of the structures of body that has been scanned. CT is considered as emergency modality. It gives image of both soft tissues and hard tissues like bone, muscles, blood vessels, brain, heart, abdomen etc. CT is modality of choice for diagnosis of cancer. CT is use to analyze the presence, size, location of cancer, colon heath (CT colonography), pulmonary embolism (CT angiography), abdominal aortic aneurysm, bone scan and traumatic injuries. CT is a helical tomography that is latest generation that produces a 2D image of structure in a thin section of body. In CT, source moves around the body part along with detector in the same gantry at multiple angles. A computer then analyzes the information and reconstructed the detailed image of the body and its internal structures.

Mammography: Imaging of breast is called mammography. It was first attempted in 1920; it uses low energy radiation to image soft tissues of breast. It is noninvasive test and use to detect breast cancer at early stages. It involves the exposure of breast to ionizing radiations to produce the image of soft tissues of breast.

Angiography: Cardiac catheterization is the insertion and passage of small plastic catheter into arteries and veins to the heart to obtain x-ray picture of coronary arteries and cardiac chambers and to measure pressures in heart.

Angiographic Scan Harmful Effects of Ionizing Radiations: The biological effects of radiation depend on the amount of energy absorbed by the matter with which high energy radiations are interacted. After the interaction of high energy radiation with matter, it can expel firmly bounded electrons from circle of particle, making the molecule charged
or ionized. The biological effects of ionizing radiation can be of two types.

• Deterministic Effects of Radiation
• Stochastic Effects of Radiation

Deterministic Effects of Radiation: Deterministic effects of radiations are basically early effects of radiation. Radiation response in humans within few days to months, the dose must be substantial. Such responses are those that exhibit increasing severity with increasing radiation dose. There is usually a dose threshold.

Stochastic Effects of Radiation: Stochastic effects of radiation are basically late effects of ionizing radiations. Such response occurs in result of low doses delivered over long period of time. The principal late effects of low-dose radiation over long periods are radiation induces malignancy and genetic effects. Late effects of radiations are observed on linear, non-threshold dose-response relationship. Human Response to Ionizing Radiations is many and Early Effects of Radiations are 1. Acute Radiation Syndrome a. Hematological syndrome b. Gastrointestinal syndrome c. Central nervous system syndrome 2. Local tissue damage a. Skin b. Gonads c. Extremities 3. Hematologic depression 4. Cytogenetic damage Late Effects of Radiations 1. Leukemia 2. Other malignant diseases a. Bone cancer b. Lung cancer c. Thyroid cancer d. Breast cancer 3. Local tissue damage 4. Shortening of life span 5. Genetic damage a. Cytogenetic damage b. Doubling dose c. Genetically significant dose

Radiation Quantities and Units: Exposure: Exposure is a measure of amount of ionization produced in a unit mass of air and is proportional to the quantity of high energy photons. In customary unit, Roentgen (R) is a unit of exposure and is defined as amount of electric charge collected in unit mass of air. The SI unit for exposure is coulombs/kilogram or C/Kg, where $1R = 2.58 \times 10^{-4}$ C/kg

Radiation Absorbed Dose: The absorbed energy per unit mass of material is radiation absorbed dose. The customary unit for radiation absorbed dose is rad, whereas SI unit of radiation absorbed dose if Gray (Gy). 1 Gy = 100 rad 1 rad = 0.01 Gy the amount of energy absorbed by different materials for the same exposure of high energy radiation varies, depending on the energy of incident radiations and atomic number of the absorber.

Dose Equivalent: Dose equivalent is the term used for purpose of radiation protection and expressed on a common scale of effects produced by different types of radiations. Some types of radiations produce more biological damage per unit dose than other types of radiations. The dose equivalent is expressed as rem in customary units and Sievert (Sv) in SI units. 1 Roentgen = 1 rad = 1 rem

Concept of Radiation Protection: Today the importance of radiation protection in diagnostic radiology has shifted back to protection of medical personnel working in radiology department. Low doses of high energy radiations can cause latent harmful effects. It is well known that the human fetus is sensitive to high energy radiations in early pregnancy usually in first trimester. As medical personnel progress through training in radiologic technology, one will learn how to operate imaging system safely with minimal radiation exposure, by following standard radiation protection procedures.

Cardinal Principles of Radiation Protection: Cardinal principles of radiation protection is specially designed to provide safety in radiation areas for occupational workers. The three cardinal principles that are developed for nuclear activities i.e. time, distance and shielding are useful in diagnostic radiology. By following such cardinal principles radiation exposure can be minimized.

1. Keep the time of exposure to radiation as short as possible.
2. Maintain a large distance as possible between the source between the source of radiation and the exposed person.
3. Insert shielding material between the radiation source and the exposed person
4. It should be noted that personnel shielding is designed to attenuate scattered x-ray level effectively but not the primary bean exposure. As attenuation occurs x-rays loses its energy and penetration ability. A 0.5-mm lead apron is equivalent to half value layers for scatter radiation associated with a 100-kV beam. The half value layer is defined as the thickness of given material that reduces the intensity of the radiation 50%. Attenuation decreases by increasing the kvp. Lead aprons, lead shields, thyroid shields, lead glasses and gonadal shields are important personnel shields. The lead content of the apron should be verified. Lead aprons must be used and hanged carefully and should be tested for defects before being used.

Lead Eyeglasses: A single x-ray exposure of 200 rad (R) can cause cataracts formation in human eye. Eyeglasses made of lead that contain 0.5 – 0.75-mm of lead glasses should be worn by medical personnel specially when working in high energy radiations e.g. fluoroscopy and catheterization laboratory. Lead eyeglasses provide four time the protection of regular eyeglasses whereas glasses with photo chromatic lenses offers two time the protection of regular eye glasses and plastic lenses offer no eye protection from ionizing radiations. Note that lead glasses contain wraparound side shields that not only provide protection from radiations but also protect eyes from splash of blood while performing invasive procedures like femoral puncture in angiography.

Dosimeter: All personnel in radiology department performing scans in radiations must worn radiation badges. Radiation badges are dose measuring devices usually placed on collar or should be kept in pocket by medical personnel while performing procedure. Badge should always remain on person to whom it is assigned and should be stored in such area away from any potential radiation exposure. At the end of month, exposed badges are collected and sent for analysis. A report indicates staff member's radiation dose for that month and should inform institution's radiation safety officer.

Lead Aprons and Thyroid Shields: Lead apron made of 0.5-mm thick lead should be worn by personnel while performing radiologic scan. Lead apron provide protection against ionizing radiations and wraparound lead aprons are used that are long enough to cover the abdominal area, long bone (femur) and should extend to the knee or just below the knee. To check the integrity lead aprons should be examined under fluoroscopy at least once in a year. Lead aprons should be hanged properly in a hanging rack to prevent cracking. Thyroid shields are also made of lead as thyroid gland secrete thyroid hormone and is considered as the most sensitive gland effected by ionizing radiations. It is necessary to wear thyroid shields in presence of ionizing radiations.

Response to Overexposure: When protective measures are properly applied which include appropriate equipment selection and following basic principle of radiation protection known as ALARA, it should prevent all the medical personnel working in radiology department from excessive exposure. When radiation exposure exceeds from the recommended limit it is necessary to remove personnel from workplace otherwise it endangers all radiology department personnel and patients as well. All this review should be share with hospital administration, medical physicist and radiation safety officer. 1.10 Significance of study: Awareness and protection are essential for medical personnel working in the radiology department to ensure their safety and the safety of their patients. Medical personnel working in radiology, such as radiologic technologists, radiologists, and nurses, must be aware of the potential hazards associated with radiation exposure. They should have a good understanding of radiation physics, radiobiology, radiation protection, and safety procedures to minimize radiation exposure to themselves and their patients. Radiology personnel should wear protective equipment, such as lead aprons, thyroid shields, and lead glasses, to minimize exposure to radiation.

Objectives:
To evaluate the practices and knowledge of radiation protection among medical personnel working in radiology department in different hospitals.

Rationale: The rationale for improving awareness and knowledge of radiation protection among medical personnel in radiology departments is to ensure the safety of both staff and patients. By following established protocols and best practices, medical personnel can minimize their exposure to ionizing radiation and provide the safest possible environment for patient care.

Methodology:
The aim of this study was to evaluate the practices and knowledge of radiation protection among medical personnel working in radiology department in different hospitals
The study design was cross sectional.
The data was collected from Cancer care hospital and research center Lahore.
Convenience sampling technique used.

Sample Size:
This study was conducted at radiology department of different hospitals of Lahore. Considering a 95% confidence interval with a 5% margin of error and a 30% prevalence. The sample size comesto be 127.

Inclusion Criteria:

- X-ray and Fluoroscopic Technologist
- CT Scan Technologist
- Cath Lab Technologist
- Radiologist
- Medical students

General radiology staff nurse

Exclusion Criteria:

- MRI Technologists
- Sonographers

Results

Gender	Frequency	Percent
Male	60	47.2
Female	67	52.8
Total	127	100.0

Table 4.1 shows that there were (52.8%) female and (47.2%) male in this study radiologist, technologist, students of radiology and general staff

The implementation of radiation protection for technologists is inevitable. A sample of 127 was taken in which 67(52.8%) female and 60(47.2%) were male which include radiologist, technologist, students of radiology and staff nurses. The obtained results show that most medical personnel working in a radiology department who participated in this study were aware of importance of radiation safety but significant lapses were found in practice and knowledge in thisregard. Age of the participants:

The table 2 shows that the age of participants was divided into four groups as 20-30, 31-40, 41-50,51-60

Age	Frequency	Percent
20-30	100	78.7
31-40	22	17.3
41-50	4	3.1
51-60	1	.8
Total	127	100.0

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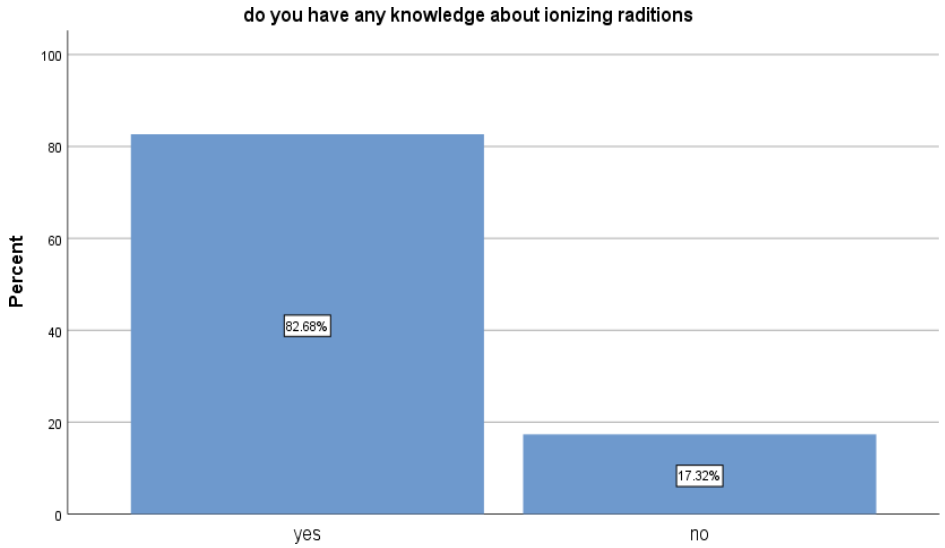
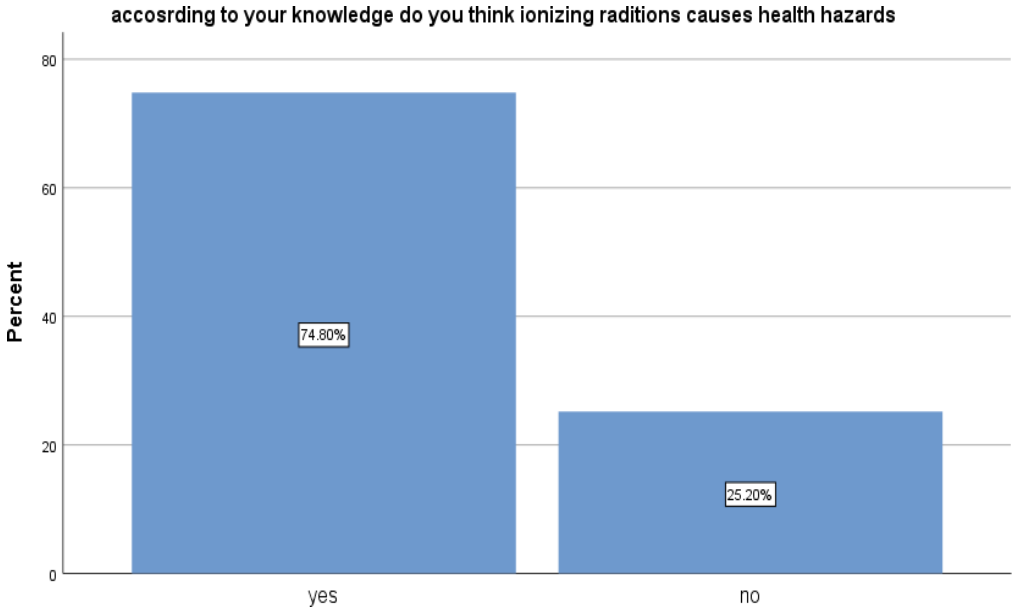
Knowledge about Ionizing Radiations:

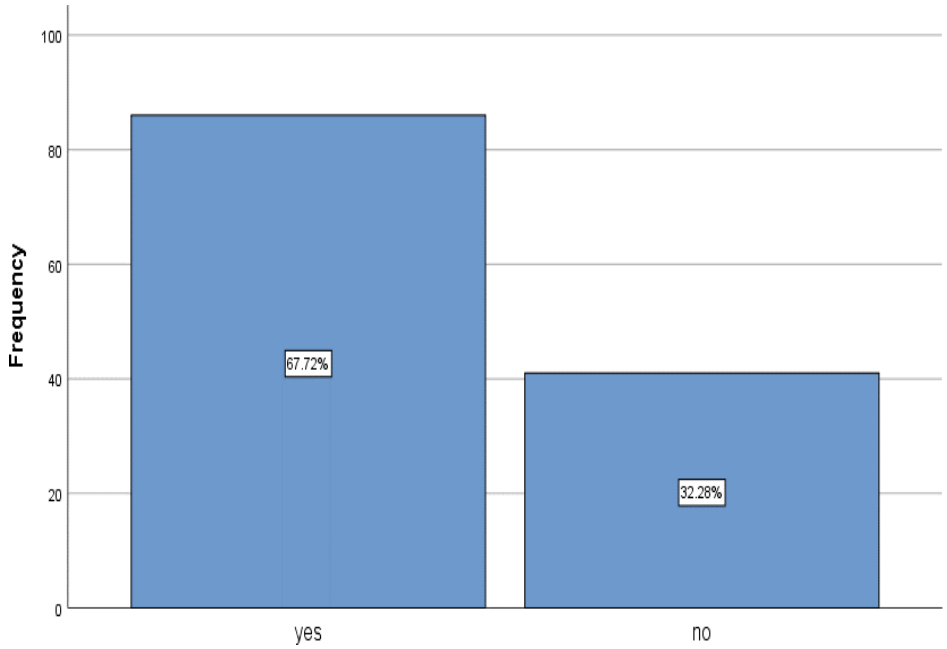


The figure shows that the figure shows that the medical personnel were asked about ionizing radiations. Majority (82.7%) mentioned yes as they were aware of ionizing radiations and (17.3%) mentioned no as one was not aware of ionizing radiations.

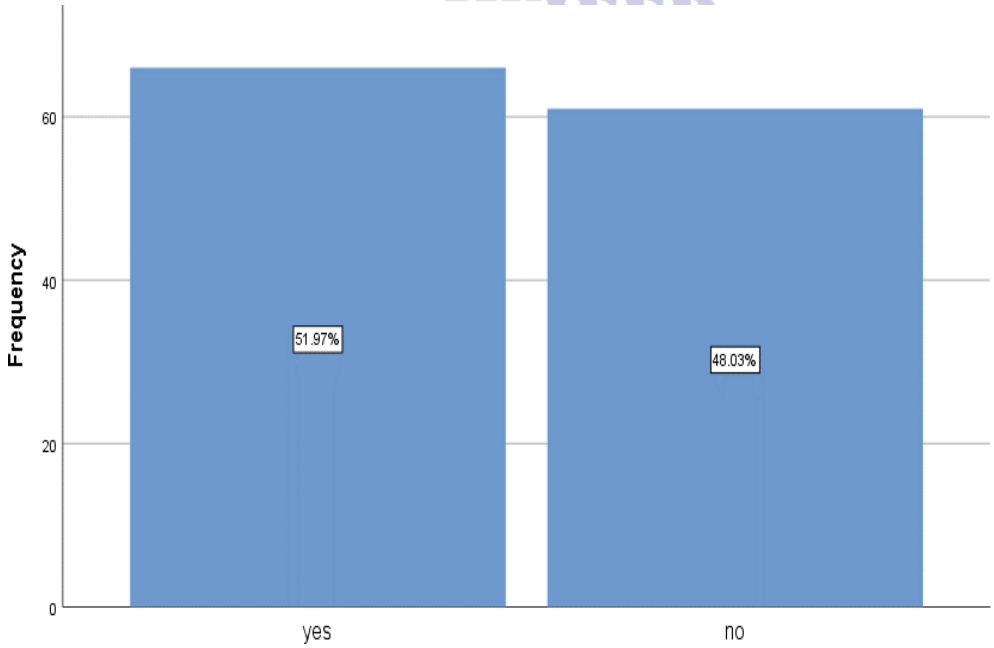


Knowledge about Health Hazards:

The figure shows that medical personnel were asked about knowledge of radiations causing health hazards. Majority (74.8%) mentioned yes as they know that radiations cause health hazardsand (25.2%) said no. Knowledge about Radiation Safety:

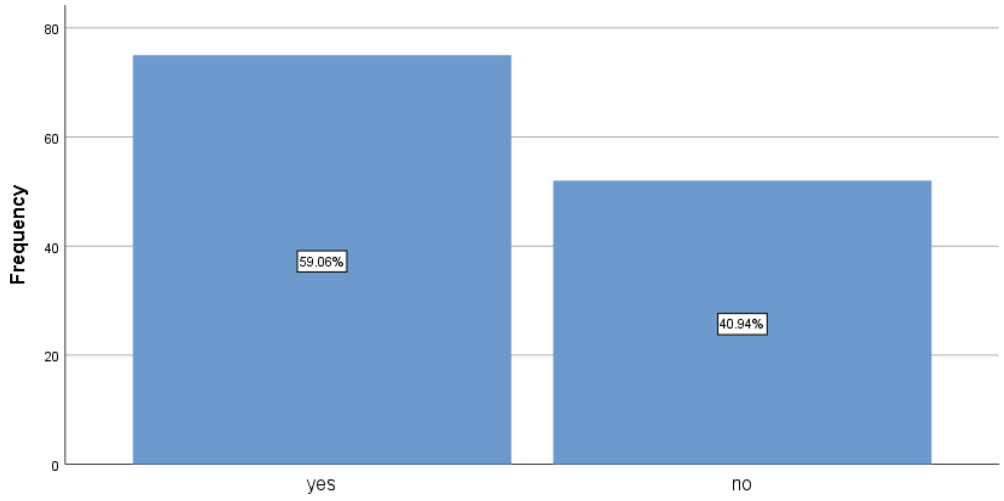


The figure shows that medical personnel were asked about radiation safety measures. Majority(67.7%) answered yes, they were aware of radiation safety measures and some of them mentioned the three-cardinal principle of radiation protection while (32.3%) answered no, they had no knowledge about radiation safety. ALARA:



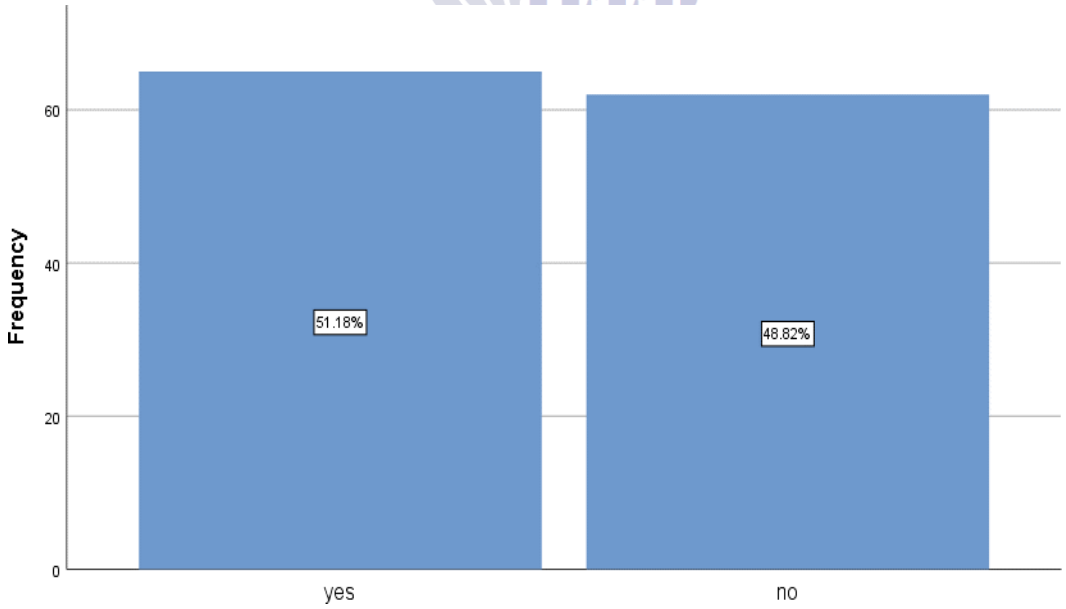
The figure shows that medical personnel were asked about the major concept of ALARA. (52.0%) were aware of the term ALARA where (48.0%) have no knowledge about concept of ALARA.

Availability of Protective Shielding:



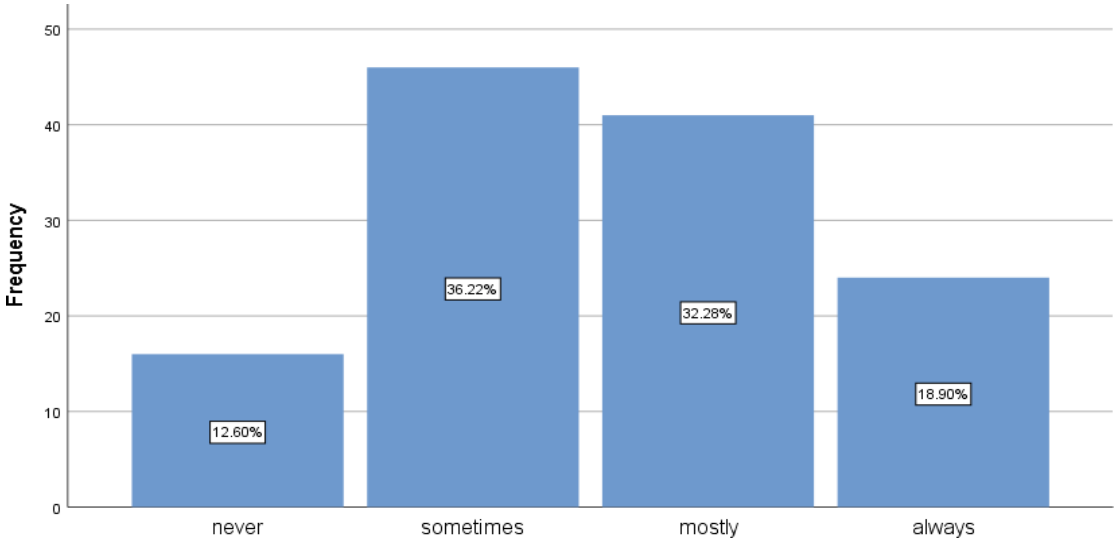
The figure shows that medical personnel were asked about availability of lead shielding like thyroid shielding, gonadal shielding and abdominal shielding. Majority (59.1%) mentioned that protective shielding is available in there radiology department and (40.9%) mentioned that there were no protective shielding in their hospital setting.

Availability of Film Badge/ Dosimeter:



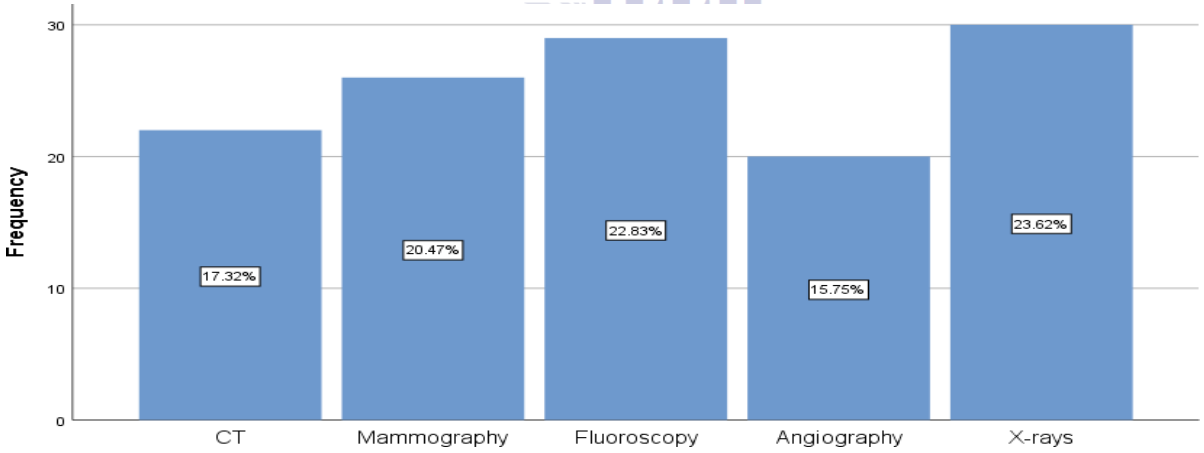
The figure shows that medical personnel were asked about availability of film badge. (51.2%)mentioned thatfilm badgesare available and (48.8%) mentioned no availability of film badge / dosimeter.

Usage of Lead Aprons:



The figure shows that medical personnel were asked about usage of lead apron. Majority (36.2%) mentioned that they use lead apron sometimes while performing radiographic exam, (32.3%) mentioned that they mostly use lead apron, (12.6%) mentioned that they never use lead apron and (18.9%) mentioned that they always use lead apron while performing radiographic exam.

Necessity of Gonadal Shielding:



CONCLUSION:

In conclusion, majority of medical personnel were aware of knowledge and importance of radiation safety and practice other radiologic protection principle in practical field, and radiation safety meetings were continuously conducted and performed practically. Dose limit should not exceed topermissible limit so that it may reduce the risk and ensures safety for medical personnel working in radiology department. Knowledge, experience and education have strong direct effect in radiation protection against health hazards associated with radiation exposure. Medical personnel working in radiology, such as radiologic technologists, radiologists, and nurses,

must be aware ofthe potential hazards associated with radiation exposure. They should have a good understanding of radiation physics, radiobiology, radiation protection, and safety procedures to minimize radiation exposure to themselves and their patients.

Radiology personnel should also follow strict protocols while performing radiological proceduresto ensure they are performed correctly and safely. They should be trained in emergency procedures in case of a radiation accident or exposure. The hope is that new generation of experts in field of radiology will promote awareness among all the medical personnel working in radiology department.

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