

Research Article

Investigate the Radiation Safety Awareness Among Medical Workers at Government Hospital, Bo

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Abstract

Background: Radiation safety awareness among healthcare professionals was essential to protect both workers and patients in settings where ionizing radiation is utilized, such as government hospitals. This study focuses on assessing the level of radiation safety awareness among medical staff at the Government Hospital in Bo. **Methods:** Employing a mixed-methods approach, the study incorporated quantitative surveys and qualitative interviews targeting a diverse group of medical workers, including doctors, radiologists, nurses, and other healthcare personnel. **Results:** The results indicate considerable variation in radiation safety awareness across different professional roles, with significant gaps particularly noted among nursing staff. Although many participants acknowledged the importance of radiation safety, their understanding of specific protective measures and regulations was inconsistent. Awareness levels were significantly impacted by factors such as years of experience, educational background, and availability of training opportunities. The analysis showed a highly significant difference ($p < .001$) in awareness levels based on educational backgrounds, with a mean difference of 1.392 (95% CI: 1.32 to 1.46). Notably, a significant disparity ($p < .001$) existed between the awareness levels of doctors and nurses compared to lab technicians and other healthcare workers, with a mean difference of 3.223 (95% CI: 2.99 to 3.45). Overall, the total knowledge level was found to be low, with a mean score of 2. A mere 12.3% of respondents reported consistently adhering to safety protocols, and a considerable proportion of medical professionals displayed insufficient knowledge (58.1%) and inadequate practice (63.8%). Comparatively, a Swedish survey indicated that 59% of medical staff had "low knowledge" regarding X-ray radiation. **Conclusion:** The study underscores the urgent need for comprehensive radiation safety training programs and the incorporation of radiation safety education into medical curricula to foster a stronger safety culture within healthcare settings. Implementing effective radiation safety workshops and conducting continuous assessments are recommended to enhance knowledge and compliance among medical workers, ultimately safeguarding healthcare personnel and patients from the risks associated with radiation exposure.

Keywords

Radiation, Protection, Safety, Hospital, Government, Bo, Awareness

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1. Brief Historical Overview

Wilhelm C. Röntgen's landmark discovery of X-rays on November 8, 1895, sparked considerable interest in their potential applications, not only for medical purposes but also across various daily activities. Initially, during the onset of radiation diagnosis, the potential risks associated with ionizing radiation were largely overlooked, with the focus predominantly on its benefits. Early pioneers in radiology were subjected to high levels of radiation, which resulted in various haematological disorders, cataracts, and even cancer [9, 1]. Röntgen himself conducted his first test by imaging the bones of his wife's hand using X-rays [13]. The initial radiation exposure for early radiologists was estimated to be around 1 Gy/year, and the adverse effects of X-rays have since prompted extensive research into radiation protection measures. Consequently, personal protective equipment (PPE) and stringent guidelines were developed to safeguard the health of both healthcare professionals and patients [19].

Radioactivity is a naturally occurring phenomenon, and our environment has inherent radiation sources. Radioactive materials and radiation find various beneficial applications, including power generation, medical diagnostics, industrial uses, and even agriculture. Nevertheless, assessing and regulating the potential risks posed to workers, the public, and the environment from these applications was essential. Activities involving medical radiation, nuclear facility operations, and the management of radioactive waste must comply with established safety standards [8]. In hospitals, X-ray machines and radiation-emitting devices are integral for diagnosing and treating diseases. Staff members in radiology, nuclear medicine, and radiation oncology typically receive specialized training in managing radiation equipment and handling radioactive materials.

The importance of radiation safety is particularly pronounced in healthcare settings where X-rays and CT scans are routinely conducted. These diagnostic procedures utilize ionizing radiation, which could be detrimental if not properly regulated. It was vital to ensure that healthcare workers were adequately trained in radiation safety protocols and that medical facilities were equipped with the necessary tools and systems to minimize radiation exposure.

As of 2021, the utilization of X-rays and CT scans in Sierra Leone remained inadequately documented. Despite the critical need for radiation safety awareness among medical personnel, research on this topic specific to Sierra Leone, particularly at Bo Government Hospital, was limited. However, it is reasonable to infer that the use of advanced imaging technologies such as CT scans may not be as prevalent in Sierra Leone compared to developed countries due to constraints in resources and the availability of modern medical technology. Instead, medical imaging in Sierra Leone might primarily focus on basic X-rays and ultrasounds, which are generally considered to confer a lower radiation risk.

This brings to the forefront the issue of radiation safety

awareness levels among medical professionals at Bo Government Hospital. As an institution delivering various diagnostic and therapeutic services that involve radiation—such as X-rays and CT scans—ensuring the safety of both patients and healthcare workers is of utmost importance.

2. Literature Review

Radiation has been utilized for numerous beneficial purposes since the late 19th century. Presently, various sources of radiation, including X-ray machines, linear accelerators, and radionuclides, serve essential roles in clinical and research applications. However, the use of radiation in these contexts could also pose potential hazards to the personnel working within hospitals and medical facilities. It was crucial to ensure proper safety measures were in place to protect healthcare workers from unnecessary exposure to radiation while reaping the benefits of its medical applications [20].

Radiation safety awareness in medical settings is of paramount importance to protect both patients and healthcare workers from the potential harmful effects of ionizing radiation used in diagnostic and interventional procedures [6]. While medical imaging and X-rays have become indispensable tools in modern medicine, they come with inherent risks. The awareness revolves around understanding the potential adverse health effects associated with ionizing radiation, such as cataracts, skin erythema, and cancers, which can vary depending on the dose and duration of exposure [3]. The cornerstone of radiation safety awareness was the acknowledgement that there was no entirely safe dose of ionizing radiation. Therefore, medical professionals follow the ALARA concept, striving to minimize exposure to the lowest level possible while still achieving the required diagnostic therapeutic goals. This concept involves implementing various radiation protection measures, such as using shielding equipment, optimizing imaging techniques, and ensuring proper training for healthcare personnel to handle radiation-emitting devices safely [4].

Radiation is energy that moves through space or matter. In 2006, the United States population was exposed to ionizing radiation from two main sources: natural background radiation (50%) and man-made radiation (50%). Background radiation originates from natural sources like the soil, rocks, building materials, and water, with about 40% coming from water. Man-made radiation includes various sources like medical procedures such as computed tomography (CT) scans (24%), nuclear medicine (12%), and interventional fluoroscopy (7%) among others. Medical radiation, in particular, accounts for 48% of man-made radiation and represents the largest contribution to human exposure [7, 17].

Radiation exists in our environment and is divided into ionizing and non-ionizing. The most significant and energetic form was ionizing radiation, which poses public health con-

cerns. Around 80% of our exposure to ionizing radiation comes from natural sources, primarily radon gas, while the remaining 20% comes from man-made sources, mainly medical X-rays [3]. The use of ionizing radiation in medical imaging has increased significantly, exposing both patients and healthcare workers to radiation hazards. Medical and dental X-rays are now the major man-made sources of radiation exposure. Studies have shown a concerning rise in adverse health effects due to ionizing radiation exposure over the past two decades. Moreover, there was evidence of inadequate knowledge about radiation among healthcare workers at risk of occupational exposure, highlighting a substantial problem [3].

The adverse health effects of ionizing radiation, including cataracts, skin erythema, and cancers, depend on the dose and duration of exposure. However, it was widely assumed that there is no truly safe dose of ionizing radiation. To ensure radiation safety, the 'ALARA concept' was applied, which aims to minimize radiation exposure to "As Low as Reasonably Achievable (ALARA)" while still adhering to the limits on effective dose recommended by the International Commission on Radiological Protection (ICRP) [3]. Electronic devices that utilize fast-moving electrons have the potential to emit ionizing radiation, with fluoroscopes being one example. X-rays, first used in 1896, enable non-invasive imaging of internal human structures. In the United States, medical procedures involving ionizing radiation contribute to 51% of the average annual radiation dose, with the remaining 49% originating from natural sources like cosmic rays, radon, and soils. X-rays, a common form of radiation in hospitals, are produced when high-voltage electronics interact with matter. These energy beams, akin to light and gamma rays, can penetrate thick materials. To ensure safety, X-ray machines, and their rooms have built-in shielding, typically using materials like lead or concrete, and the useful beam is controlled through a cone or adjustable collimator [20].

Radiation safety and its awareness are inextricably linked; therefore, the provision of radiation safety without concern for its awareness among medical workers is unprofessional and potentially deadly. Radiation safety awareness was a major concern due to its poor practices in most developing countries including Sierra Leone. Hence, the main objectives of this study include; the evaluation of the current level of radiation safety awareness among medical workers, to examination of the potential risks associated with inadequate radiation safety awareness among medical workers, and to identification of strategies and the factors influencing radiation safety awareness among medical workers at Government Hospital, Bo.

2.1. Types and Sources of Radiation

Radiation can be broadly classified into two main types based on its effects on matter; ionizing radiation and non-ionizing radiation [3].

Ionizing Radiation: Ionizing radiation has enough energy to remove tightly bound electrons from atoms, leading to the formation of charged particles (ions). This type of radiation can cause significant damage to living tissues and DNA, for example; X-rays which are produced artificially, X-rays are widely used in medical imaging for diagnostic purposes, gamma rays produce high-energy electromagnetic radiation emitted during radioactive decay processes, alpha Particles which consist of two protons and two neutrons and are emitted during the decay of certain radioactive materials, and beta particles with high energy electrons [18].

Non-ionizing Radiation: Non-ionizing radiation has lower energy and does not have sufficient power to ionize atoms or molecules. While it was generally considered less harmful to human tissues, prolonged exposure to certain types of non-ionizing radiation can still cause health effects for example; UV rays from the sun can cause skin damage and increase the risk of skin cancer, radiofrequency (RF) radiation produced by various communication devices, such as cell phones, microwaves used in microwave ovens and wireless communication systems, and infrared radiation commonly emitted as heat from various sources.

Source of Radiation: The sources of radiation could be natural or man-made radiation. Natural sources of radiation include; cosmic radiation which has high-energy particles from space that interact with the Earth's atmosphere and surface, terrestrial radiation emanating from naturally occurring radioactive materials present in soil, rocks, and building materials, and radon gas; a naturally occurring radioactive gas released from the Earth's crust. Medical imaging was an example of man-made radiation.

2.2. Health Effect of Ionizing Radiation

Improper use of ionizing radiation can lead to several health effects for patients, healthcare workers, and the general public. The biological effects of ionizing radiation are categorized into two types: deterministic effects, which cause tissue reactions and are directly related to the radiation dose, and stochastic effects, which occur randomly and are associated with the probability of developing cancer or genetic mutations [14]. It is essential to take necessary precautions and adhere to safety measures when dealing with ionizing radiation to minimize its potential harmful consequences [1, 16]. It was important to note that the risk of health effects from radiation exposure was influenced by factors such as age, sex individual susceptibility, and the type of radiation involved. To ensure radiation safety, various organizations and regulatory bodies set exposure limits and guidelines to minimize the potential health risks associated with radiation. Implementing proper safety measures, using shielding, and following the principle of ALARA was crucial in mitigating the health effects of radiation exposure.

2.3. Role of Government, and Regulatory Body

The government plays a crucial role in radiation safety by establishing a national policy that outlines comprehensive radiation safety measures. This policy was enforced by a regulatory body responsible for developing and implementing strategies and procedures to ensure compliance with radiation safety laws and regulations. By working together, the government ensures the effective implementation and enforcement of radiation safety measures across the country.

Sierra Leone was the first country to introduce a radiation protection ordinance in June 1967. The Nuclear Safety and Radiation Protection Authority (NSRPA) Act No. 7 of 2012 was passed by parliament on July 19, 2012, to establish the NSRPA as the regulatory and supervisory body responsible for the safe use of radioactive substances and their applications, including licensing, inspection, and enforcement. This Act aimed to provide adequate protection to the public, workers, and the environment against the harmful effects of ionizing radiation, while also aligning with international regulations and agreements with the International Atomic Energy Agency (IAEA) [10].

In 2022, the NSRPA Act was amended by parliament through Act No. 14 of 2022 to further enhance radiation safety standards. This amendment requires all base stations to comply with regulatory standards and monitor ultraviolet radiation, magnetic resonance imaging, ultrasound, and lasers, among other things. The law also ensures that all facilities using radiation are licensed and have appropriate radiation safety measures in place [2].

The NSRPA in Sierra Leone also licenses radiation health workers and ensures that they have the necessary qualifications and up-to-date knowledge in radiation safety. Research has been conducted on radiation safety awareness among medical workers at government hospitals in Sierra Leone, highlighting the importance of continued education and training in radiation safety.

2.4. Safety Facilities

Safety facilities in radiation refer to designated areas or features within a facility that were specifically designed and equipped to ensure the safe handling, storage, and use of radioactive materials and radiation-emitting devices. When designing an X-ray room, careful consideration must be given to the location and layout from a radiation protection perspective [2].

The safe and efficient environment reduces unnecessary exposure to ionizing radiation while providing accessible and effective imaging services for patients [1]. Common safety facilities in radiation include; radiation shielding rooms, X-ray examination rooms, radioactive materials storage facilities, radioactive waste storage and disposal areas, radiation monitoring stations, lead glass, warning signs at the entrance of the door, emergency response and decontamination rooms, training and education, and PPE storage areas. Incorporating safety facilities in radiation-related settings, facilities can

significantly reduce the risk of radiation exposure and ensure the safe and responsible use of ionizing radiation in various applications. The lack of proper shielding in some facilities highlights the need for improved radiation safety practices and adherence to international guidelines to ensure the safe and responsible use of X-ray equipment [1, 5].

2.5. Radiation Protection of Medical Workers

Radiation protection of medical workers was of utmost importance as they were at risk of regular exposure to ionizing radiation during various medical procedures. Implementing effective radiation protection measures ensures the well-being of healthcare professionals while allowing them to provide essential medical services. Some key aspects of radiation protection for medical workers include; training and education, PPE, optimization, distance and shielding, reporting and follow-up, individual monitoring, work time and rotation, combination control, and emergence response [4].

The International Commission on Radiological Protection (ICRP) recommends a maximum permissible dose limit of twenty mille Sieverts (20 mSv) per year for radiation workers. According to [1, 2, 15], states that; certain research published studies indicate that, in some countries like Sudan and Palestine, there was a lack of sufficient availability of radiation protection devices. In these regions, access to essential safety equipment, such as lead aprons, lead gloves, and other protective gear, was inadequate. This lack of adherence to safety protocols poses potential risks for radiation workers and emphasizes the need for improved awareness, access to protective equipment, and strict implementation of radiation safety measures in medical facilities [1, 10].

2.6. Practice of Radiology Workers

The knowledge and performance of radiology workers regarding radiation protection significantly impact the exposure of patients, operators, and the public to radiation. Insufficient awareness of radiation safety may lead to unsafe practices by radiographers, resulting in potential health risks. The positive correlation between radiographers' attitudes and their knowledge, highlights the importance of promoting radiation safety education and training to ensure the safe and responsible use of ionizing radiation in medical imaging [1, 17]. Radiology workers, including radiologic technologists, radiographers, and radiologists, need to have a comprehensive understanding of radiation physics, safety protocols, and best practices [9].

2.7. Importance of Radiation Safety Awareness

Radiation safety awareness was a fundamental aspect of medical practice, benefiting patients, medical workers, and the public alike. It ensures the responsible use of ionizing radiation and upholds the principles of patient-centred care, safety, and professionalism in the healthcare setting. Radiation safety awareness among medical workers was of para-

mount importance for several reasons such as patient safety, occupational safety, public safety, minimizing health risks, compliance with regulations, quality of medical care, emergency preparedness, professional development, ethical responsibility, and public trust. The factors affecting the influence of radiation safety awareness among medical workers and the general public include; the availability and quality of radiation safety education and training programs that significantly impact awareness [18].

3. Methodology

This research employed a descriptive research design to investigate radiation safety awareness among medical workers at the Bo Government Hospital. This design was best suited to investigate the current level of radiation safety awareness, identify influencing factors, and gather in-depth information from the target population [19].

In this case, the research would have focused on describing the level of radiation safety awareness among medical workers at the Bo Government Hospital, as well as factors influencing their awareness. The research used a cross-sectional approach, where data was collected at a single point in time. This approach was suitable for obtaining a snapshot of the current state of radiation safety awareness among medical workers.

The sample size of the study was estimated at 384 [4, 11]. The study included a total of 384 participants. Semi-structured questionnaires were distributed among 384 participants, and of these, 309 (80.47%) of these questionnaires were filled and returned. While 1 (0.26%) was partially complete. All of the questionnaires were collected within the specified time frame, and 74 (19.27%) questionnaires were not returned.

3.1. Radiation Safety Awareness Among Medical Workers

The Radiation Safety variable, which investigates medical

workers' awareness of radiation safety is indicated in Table 1 below.

Table 1. Radiation Safety Awareness among Medical Workers.

Radiation Safety Awareness	Frequency	Percent
Yes	106	34.3
No	203	65.7
Total	309	100.0

Source: Field Survey 2024

Medical workers were asked whether they had radiation safety awareness, and their responses were categorized into two groups. Approximately one-third of the medical workers (34.3%) responded affirmatively, indicating that they possess radiation safety awareness ($n = 106$). The majority of medical workers (65.7%) indicated that they did not have radiation safety awareness ($n = 203$). These results provide an understanding of the distribution of medical workers' radiation safety awareness. The total valid sample size for the Radiation Safety Awareness variable was 309, encompassing all the medical workers in the study.

3.2. Radiation Safety Awareness and Its Potential Risks

The study examined several dimensions of radiation safety awareness among medical workers. The medical workers' knowledge of radiation safety was investigated using a scale. The mean knowledge score was 2, with a median of 1, indicating that knowledge levels tended to be low among medical workers. The standard deviation was 1, suggesting some variability in knowledge scores. The range of knowledge scores was from 1 to 4, with a variance of 1.

Table 2. Radiation Safety Awareness and its Potential Risks.

Knowledge Scale	Mean	2
	Median	1
	Std. Deviation	1
	Range	4
	Variance	1
Knowledge Update	Regularly (Every 3-6 months)	16 5.2%
	Occasional (Once a year)	32 10.4%

	Rarely (Every few years)	34
		11.0%
	Never	227
		73.5%
Awareness of Potential Risks Associated with Inadequate Radiation Safety	Yes	109
		35.3%
	No	23
		7.4%
	No idea	177
		57.3%
Compliance Rate with Radiation Safety Practices	Always comply with safety practices	38
		12.3%
	Mostly comply with safety practices	24
		7.8%
	Sometimes compliance with safety practices	19
		6.1%
	Rarely comply with safety practices	16
		5.2%
	Never comply with safety practices	212
		68.6%
Personal Protective Device for Reducing Radiation Exposure	Know	141
		45.6%
	No idea	168
		54.4%
Awareness of diagnostic Imaging of X-rays Increases Risk of Cancer	Yes	193
		62.5%
	No	14
		4.5%
	No idea	102
		33.0%

Source: Field Survey 2024

In Table 2 above, medical workers were asked how often they updated their knowledge of radiation safety. The majority (73.5%) reported never updating their knowledge. Occasional updates (10.4%) and rare updates (11.0%) were less common, while regular updates (5.2%) were the least frequent. Regarding awareness of potential risks associated with inadequate radiation safety, 35.3% of medical workers answered "Yes," indicating they were aware of these risks. A smaller proportion (7.4%) answered "No," and the majority (57.3%) had "No idea" about

these risks. Medical workers were asked about their compliance with radiation safety practices. Only 12.3% reported "Always comply with safety practices," while 68.6% reported "Never comply with safety practices." Smaller percentages reported mostly complying (7.8%), sometimes complying (6.1%), or rarely complying (5.2%) with safety practices.

Regarding awareness of personal protective devices for reducing radiation exposure, 45.6% of medical workers reported being aware, while 54.4% had "No idea" about these devices.

In terms of awareness of the link between diagnostic imaging using X-rays and an increased risk of cancer, the majority (62.5%) answered "Yes," indicating awareness of the risk. A smaller percentage (4.5%) answered "No," while a significant portion (33.0%) had "No idea" about this association.

These findings provide insights into the level of radiation safety knowledge, practices, and awareness among the study medical workers. Table 2 shows the radiation safety awareness and its associated potential risks.

3.3. Awareness of Radiation Safety Knowledge, Principles, and Guidelines

These findings highlight variations in medical workers' knowledge of radiation safety principles and guidelines, with many medical workers indicating a lack of awareness or uncertainty. The radiation safety knowledge, principles, and guidelines are shown in Table 3 below.

Table 3. Radiation Safety Knowledge, Principles, and Guidelines.

QUESTIONS	ANSWERS	FREQUENCY	PERCENT
According to ICRP, which of the following is the principle of radiation protection?	as low as reasonably achievable (ALARA)	25	8.1%
	as high as reasonably achievable (AHARA)	6	1.9%
	as fast as reasonably achievable (AFARA)	6	1.9%
	as slow as reasonably achievable (ASARA)	8	2.6%
	No idea	264	85.4%
From the ICRP recommendation, how much is the 1-year maximum permissible dose limit for adult radiation workers?	0.5 mSv	6	1.9%
	5 mSv	17	5.5%
	20 mSv	33	10.7%
	No idea	253	81.9%
	CT scan	57	18.4%
Which of the following Uses Ionizing Radiation?	Ultrasound	44	14.2%
	Mammography	45	14.6%
	MRI	44	14.2%
	No idea	119	38.5%
	Yes	136	44.0%
Time, Distance, and Protective Equipment are Important in Radiation Exposure Protection	No	90	29.1%
	No idea	83	26.9%
	2 meters	26	8.4%
	5 meters	32	10.4%
	1 meter	56	18.1%
How far from the X-ray, do you need to stand without any protection during the radiological guided procedure?	6 meters	50	16.2%
	No idea	141	45.6%
	6	4	1.3%
	0.02	13	4.2%
	0.2	22	7.1%
The average dose for a posterior-anterior (PA) chest radiography, in (mSv) is:	0.28	37	12.0%
	2	45	14.6%
	No idea	192	62.1%

Source: Field Survey 2024

Table 3 above investigates medical workers' knowledge of radiation safety principles and guidelines. Medical workers were asked to identify the principle of radiation protection according to the International Commission on Radiological Protection (ICRP). The majority of medical workers (85.4%) answered: "No idea," while only a small percentage correctly identified "as low as reasonably achievable (ALARA)" (8.1%). Other options, such as "as high as reasonably achievable (AHARA)," "as fast as reasonably achievable (AFARA)," and "as slow as reasonably achievable (ASARA)," received lower responses (1.9% each). Medical workers were asked about the 1-year maximum permissible dose limit for adult radiation workers according to ICRP recommendations. Again, the majority (81.9%) responded with "No idea." Only a minority correctly identified the limit as "20 mSv" (10.7%), with smaller percentages choosing "5 mSv" (5.5%) and "0.5 mSv" (1.9%). Inquiring about the use of ionizing radiation, medical workers were presented with various medical imaging modalities. Among the options, "CT scan" (18.4%), "Mammography" (14.6%), and "MRI" (14.2%) were correctly recognized as using ionizing radiation. "Ultrasound" (14.2%) was incorrectly identified by some. The majority (38.5%) answered "No idea." Medical workers were asked if time, distance, and protective equipment are important in radiation exposure protection. A significant proportion (44.0%) correctly answered "Yes," indicating awareness of the importance of these factors. Some medical workers (29.1%) responded "No," while others (26.9%) answered "No idea." Regarding the safe distance from the X-ray source during radiological-guided procedures, medical workers' responses varied. Among the medical workers, only (8.4%) correctly answered "2 meters" as the distance from the X-ray source during radiological-guided procedures. Various options such as "1 meter" (18.1%) and "5 meters" (10.4%) were among the options selected, but the majority (45.6%) indicated "No idea" and "6 meters" (16.2%), were also chosen by some medical workers. Medical workers were asked about the average dose for a posterior-anterior (PA) chest radiography. Most medical workers (62.1%) responded with "No idea." Among those who provided an answer, "0.28 mSv" (12.0%), "2 mSv" (14.6%), "0.2 mSv" (7.1%), and only a minority (4.2%) correctly answered "0.02 mSv" as the average dose for PA chest radiography.

3.4. Challenges to Implementing Radiation Safety Practices

This aims to identify the challenges uncouned in implementing radiation safety practices. The finding results are summarized in Table 4 below.

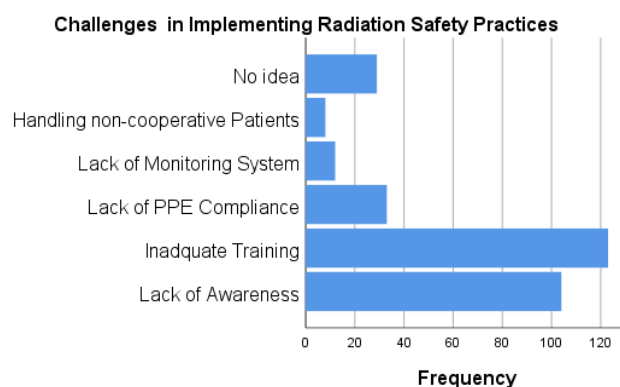


Figure 1. Challenges to Implementing Radiation Safety Practices.

Medical workers were asked to identify the challenges or barriers to implementing radiation safety practices. Approximately one-third of the medical workers (33.7%) cited a lack of awareness as a significant challenge. The most commonly reported barrier was inadequate training, with 39.8% of medical workers identifying this issue; some medical workers (10.7%) noted challenges related to a lack of compliance with personal protective equipment (PPE) requirements. A smaller portion of medical workers (3.9%) identified the absence of a monitoring system as a barrier; a few participants (2.6%) mentioned challenges associated with handling non-cooperative patients, and some participants (9.4%) indicated that they had no specific idea about the challenges or barriers.

These findings provide valuable insights into the various challenges and barriers healthcare professionals face when implementing radiation safety practices. The total valid sample size for the challenges to Implementing Radiation Safety Practices variable was 309, encompassing all participants in the study.

3.5. Improving Radiation Safety Practices at the Hospital

In the study, medical workers were asked to provide suggestions for improving radiation safety practices at the hospital. Table 4 presents the descriptive analysis of their suggestions to improve radiation safety in Bo Government Hospital.

Table 4. Improving Radiation Safety Practices at the Hospital.

Suggestions for Improving Radiation Safety Practices	Frequency	Percent
Comprehensive Training Programs	196	63.4
Regular Refresher Courses	56	18.1

Suggestions for Improving Radiation Safety Practices	Frequency	Percent
Availability of PPE	20	6.5
Regular Equipment Maintenance	23	7.4
Continuous Monitoring System	14	4.5
Total	309	100.0

Source: Field Survey 2024

The table provides insights into the recommendations made by the study medical workers to enhance radiation safety practices at the hospital. The suggestions and their corresponding frequencies and percentages are summarized in Table 4 above. The most commonly recommended improvement, with 196 medical workers (63.4%), suggests implementing comprehensive training programs. This suggests that a significant portion of medical workers believe that thorough education and training are essential to improving radiation safety awareness and practice, and approximately 18.1% of medical workers (56 individuals) suggested the need for regular refresher courses in radiation safety. This recommendation highlights the importance of continuous learning and updates in this critical area. About 6.5% of medical workers (20 individuals) emphasized the importance of ensuring the availability of PPE for radiation safety practices. This indicates a need for adequate protective measures for healthcare professionals. Approximately 7.4% of medical workers (23 individuals) recommended regular maintenance of equipment used in radiation procedures. Proper equipment maintenance was crucial for en-

suring the accuracy and safety of radiological processes. And 4.5% of medical workers (14 individuals) suggested implementing a continuous monitoring system. This recommendation underscores the importance of real-time monitoring to identify and address radiation safety issues promptly.

In conclusion, the study medical workers provided valuable suggestions for improving radiation safety practices at the hospital. These recommendations highlight the significance of comprehensive training, continuous education, equipment maintenance, and the availability of PPE in enhancing radiation safety awareness and practices among healthcare professionals. These insights can guide the hospital in implementing targeted initiatives to enhance radiation safety and minimize the associated risks.

4. Findings Relations

4.1. Professional Designation, Radiation Safety Awareness, and Knowledge Scale

The study examined the correlations among medical workers' professional designation, radiation safety awareness, and knowledge scale. The results of the correlation analysis are presented in Table 5.

Professional Designation vs. Radiation Safety Awareness: The Pearson correlation coefficient between professional designation and radiation safety awareness was -0.022. This correlation was not statistically significant ($p = 0.702$), indicating that there was no significant linear relationship between professional designation and radiation safety awareness among the study participants.

Table 5. Professional Designation, Radiation Safety Awareness, Knowledge Scale.

Valid	Professional Designation	Radiation Safety Awareness	Knowledge Scale
Professional Designation	1		
Radiation Safety Awareness	-.022	1	
Knowledge Scale	-.027	-.122*	1

Source: Field Survey 2024 * Correlation is significant at the 0.05 level (2-tailed).

Professional Designation vs. Knowledge Scale: The Pearson correlation coefficient between professional designation and knowledge scale was -0.027. This correlation was also not statistically significant ($p = 0.632$), suggesting that there was no significant linear relationship between professional designation and knowledge scale.

Radiation Safety Awareness vs. Knowledge Scale: The Pearson correlation coefficient between radiation safety awareness and knowledge scale was -0.122, and this corre-

lation was statistically significant at the 0.05 level (two-tailed, $p = 0.032$). The negative correlation suggested that as radiation safety awareness increases, knowledge scale scores tend to decrease. However, the correlation was relatively weak.

In summary, there was no significant correlation between professional designation and radiation safety awareness or knowledge scale. However, there was a weak but statistically significant negative correlation between radiation safety

awareness and knowledge scale, indicating that higher awareness may be associated with slightly lower knowledge in this context.

4.2. Length of Experience, Radiation Safety Awareness, and Knowledge Scale

The study explored the correlations between length of experience, radiation safety awareness, and knowledge scale among the participants. The results of the correlation analysis are summarized in Table 6.

Table 6. Length of Experience, Radiation Safety Awareness, and Knowledge Scale.

	Length of Experience	Radiation Safety Awareness	Knowledge Scale
Length of Experience	1		
Radiation Safety Awareness	-.108	1	
Knowledge Scale	.130*	-.122*	1

Source: Field Survey 2024

*. Correlation is significant at the 0.05 level (2-tailed).

Length of Experience vs. Radiation Safety Awareness: The Pearson correlation coefficient between length of experience and radiation safety awareness was -0.108. Although this correlation was not statistically significant at the conventional 0.05 level ($p = 0.058$), it suggests a weak negative relationship between length of experience and radiation safety awareness. As the length of experience increases, radiation safety awareness tends to decrease slightly.

Length of Experience vs. Knowledge Scale: The Pearson correlation coefficient between the length of experience and knowledge scale was 0.130, and this correlation was statistically significant at the 0.05 level (two-tailed, $p = 0.022$). The positive correlation indicates that as the length of experience increases, knowledge scale scores tend to increase as well, albeit weakly.

Radiation Safety Awareness vs. Knowledge Scale: The Pearson correlation coefficient between radiation safety awareness and knowledge scale was -0.122, and this correlation was statistically significant at the 0.05 level (two-tailed, $p = 0.032$). The negative correlation suggests that higher radiation safety awareness may be associated with slightly lower knowledge scale scores.

In summary, there was a weak but statistically significant negative correlation between length of experience and radiation safety awareness, suggesting that more experienced individuals may have slightly lower awareness. Additionally, there was a weak but statistically significant positive correlation between length of experience and knowledge scale, indicating that more experienced individuals tend to have slightly higher knowledge scores. Lastly, there was a weak but statistically significant negative correlation between radiation safety awareness and knowledge scale, implying that higher awareness may be associated with slightly lower knowledge in this context.

5. Factors Influencing Radiation Safety Awareness

Factors that can influence radiation safety awareness among medical workers at the Bo Government Hospital or in any healthcare setting can be multifaceted. These factors can either enhance or hinder the level of awareness and adherence to radiation safety practices. Here are some key factors that may influence radiation safety awareness:

- 1) **Training and Education:** The quality and frequency of radiation safety training and educational programs can significantly impact awareness levels. Adequate training ensures that medical workers understand the risks associated with radiation and the necessary safety protocols.
- 2) **Experience:** Years of experience in working with radiation-emitting equipment can influence awareness. More experienced professionals may have a better understanding of radiation safety due to their exposure to various situations.
- 3) **Job Role:** Different medical roles involve varying degrees of radiation exposure. Radiologists, radiographers, and nuclear medicine specialists, for example, may have higher awareness levels compared to other medical staff.
- 4) **Access to Information:** The availability of up-to-date information, guidelines, and resources related to radiation safety is crucial. Accessible information promotes awareness and helps individuals stay informed about best practices.
- 5) **Hospital Policies:** The presence and enforcement of hospital policies and protocols related to radiation safety play a significant role. Clear and

well-communicated policies can guide behaviour and ensure consistency in safety practices.

- 6) **Organizational Culture:** The overall culture within the hospital regarding safety and accountability can influence radiation safety awareness. A culture that prioritizes safety encourages staff to be more aware and vigilant.
- 7) **Compliance Monitoring:** The degree to which radiation safety practices are monitored and enforced can impact awareness. Regular audits and checks can remind staff to adhere to safety guidelines.
- 8) **Peer Influence:** Colleagues and peers can influence one another's behaviour. Positive peer pressure, where staff encourages each other to follow safety protocols, can enhance awareness.
- 9) **Patient Load and Stress:** High patient volumes and stressful work environments can lead to rushed or overlooked safety practices. Staff may be less aware when they are under pressure.
- 10) **Technology and Equipment:** The type and state of radiation-emitting equipment can affect awareness. Modern equipment with safety features can enhance awareness, while outdated or malfunctioning equipment can pose risks.
- 11) **Communication:** Effective communication among healthcare teams and between staff and patients is essential. Clear communication ensures that everyone understands safety measures and expectations.
- 12) **Feedback Mechanisms:** The existence of feedback mechanisms where staff can report safety concerns or incidents promotes continuous improvement and awareness.
- 13) **Regulatory Compliance:** Adherence to regulatory requirements and standards related to radiation safety is crucial. Compliance with legal obligations can drive awareness.
- 14) **Personal Attitudes:** Personal attitudes and beliefs about radiation safety can influence awareness. Some individuals may be more conscientious and safety-oriented by nature.
- 15) **External Factors:** External factors such as changes in regulations or incidents at other healthcare facilities can raise awareness and prompt reassessment of safety practices.

Developing treatments and tactics to raise medical professionals' awareness of radiation safety requires a thorough understanding of these elements and how they interact. Improving patient care and creating a safer work environment can result from addressing these factors.

6. Discussion

Based on the degree of educational backgrounds exhibited different levels of awareness, the study showed a highly significant difference ($p < .001$) in radiation safety awareness.

With a 95% confidence interval spanning from 1.32 to 1.46, the mean difference in awareness levels was roughly 1.392.

When it came to awareness, the doctors and nurses differed from lab technicians and other healthcare workers. According to the analysis, there was a significant difference ($p < .001$) in the level of radiation safety awareness between the various professional certifications. Radiation safety awareness varied greatly between medical professionals with diverse titles, including physicians, nurses, lab technicians, and others. With a 95% confidence interval spanning from 2.99 to 3.45, the mean difference in awareness levels was roughly 3.223.

Based on the duration of experience, the analysis also showed a highly significant difference ($p < .001$) in radiation safety awareness. With a 95% confidence interval spanning from 1.98 to 2.23, the mean difference in awareness levels was roughly 2.107. This suggests that experience level has a significant influence on radiation safety awareness, with more seasoned people typically having greater awareness levels. The research revealed a significantly significant difference ($p < .001$) in knowledge of the adult radiation workers' maximum allowable dose limit of one year. With a 95% confidence interval spanning from 3.65 to 3.80, the mean difference in awareness levels was roughly 3.725. This suggests that medical practitioners' awareness of the allowable radiation dosage limits varies significantly, and this knowledge gap requires attention.

A highly significant difference ($p < .001$) in awareness of the radiation protection principle was established by the analysis. With a 95% confidence interval spanning from 4.42 to 4.68, the mean difference in awareness levels was roughly 4.553. This indicates that medical staff members have differing degrees of comprehension and knowledge regarding the basic concepts of radiation safety. A statistically significant variation ($p < .001$) was found in the knowledge of the average dosage for posterior-anterior (PA) chest radiography. With a 95% confidence interval spanning from 4.10 to 4.36, the mean difference in awareness levels was roughly 4.233. According to a related study, just 17.2% of participants were accurate in estimating the average radiation dose in millisieverts (mSv) for a single CXR.

7. Summary

According to the study, the majority of medical professionals (65.7%) reported not being aware of radiation safety, while only 34.3% claimed to be aware of it.

With a mean knowledge score of 2, the total level of knowledge was rather low. Only a small number of medical professionals said they routinely updated their understanding of radiation safety, while the majority said they never did. Radiation safety protocol compliance was found to be usually low, with only 12.3% of respondents saying they "always comply with safety practices." This investigation supported the findings of the [12].

According to the findings of their study, a significant number of medical professionals have insufficient practice

(67, 63.8%) and substandard knowledge (61, 58.1%) [12]. According to a comparable Swedish survey, 59% of medical professionals reported having "low knowledge" regarding x-ray radiation (1 to 3 on a scale of 1-6 signifying "inadequate" to "very good"). According to [11], 41% of the remaining medical professionals had an excess of "good knowledge or very good knowledge" (4-6).

8. Recommendations

The following ideas and recommendations were made in light of the research's findings as steps that could be implemented to help medical staff at the Bo Government Hospital become more knowledgeable about radiation safety, the following recommendations were made;

- 1) Provide all medical personnel with regular, thorough radiation safety training, regardless of their level of expertise or professional title.
- 2) To make sure that healthcare professionals remain current on best practices, offer refresher training on radiation safety.
- 3) Ensure that all personnel participating in radiological procedures have access to and availability of personal protective equipment (PPE).
- 4) Create a continuous monitoring system to track safety procedures and radiation exposure in real-time.
- 5) Think about creating explicit hospital radiation safety regulations and guidelines, along with procedures for managing patients who are unwilling to cooperate.

Abbreviations

PA	Posterior Anterior
PPE	Personal Protective Equipment
CT	Computed Tomography
ICRP	International Commission on Radiological Protection
ALARA	As Low as Reasonably Achievable
AHARA	As High as Reasonably Achievable
DNA	Deoxyribonucleic Acid
NSRPA	National Survey of Radiation Protection Activities
MIR	Machines (Magnetic Resonance Imaging)

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Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest.

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