JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH
ISSN: 2576-0017
2024, VOL 7, NO S11

Assess of Knowledge of Nurses and Health Care Staff about Radiation Hazards

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ABSTRACT

Background: Ionizing radiation is widely used in medical settings for diagnostic and therapeutic purposes, exposing healthcare workers to potential health risks if safety measures are not followed. Nurse and health care staff working in radiology and nuclear medicine departments are particularly vulnerable to radiation hazards. This study evaluates their knowledge of nurse and health care staff about radiations hazards. Methods: A descriptive cross-sectional design was employed, targeting nurse and health care staff in diagnostic radiology, oncology, and nuclear medicine departments. A random sample of 105 participants (25 nurses and 80 technicians) was selected. Data were collected using a self-administered questionnaire to assess knowledge and an observation checklist to evaluate safety practices. Statistical analysis was performed using SPSS version 22, with significance set at $p < 0.05$. Results: The study revealed that 38.1% of participants were under 30 years old, with 51.4% having less than 10 years of experience. Despite the availability of personal protective equipment (PPE), only 5.7% of participants found it sufficient, and only 17.1% had attended training on PPE usage. Knowledge levels were predominantly poor, with over two-thirds of participants demonstrating inadequate safety practices. A significant correlation was found between knowledge and practice levels ($p < 0.05$). Participants with over 20 years of experience reported higher prevalence rates of occupational diseases, particularly blood disorders, with statistically significant associations between years of experience and disease occurrence. Conclusion: The study highlights gaps in knowledge and practice regarding radiation hazards among nurse and health care staff . Regular training programs, adequate provision of PPE, and enhanced educational efforts are recommended to improve safety practices and reduce occupational risks in radiation-related departments.

KEYWORDS: healthcare, radiation.

1. Introduction

Radiation refers to energy traveling through space and encompasses any process where energy emitted by one body traverses a medium or space to be absorbed by another body. Radioactivity is the property of certain atoms that spontaneously emit energy in the form of particles or rays. This process, known as ionizing radiation, occurs when radioactive atoms decay, emitting energy as electromagnetic radiation (gamma or X-rays) or particulate radiation (alpha or beta particles, or neutrons) (US EPA, 2018).

Ionizing radiation is widely used in medical practice, with approximately 20% of the global population exposed to it. The usage is expected to grow continuously worldwide. Annually, over 3.6 billion diagnostic radiology examinations, 37 million nuclear medicine procedures, and 7.5 million radiotherapy treatments are conducted globally (WHO, 2016). However, occupational exposure to ionizing radiation in diagnostic and therapeutic practices poses significant health risks to healthcare workers if proper safety measures are not followed (El-Feky et al., 2017).

Nuclear medicine, a branch of medical imaging, utilizes small amounts of radioactive material to diagnose, determine the severity of, or treat various diseases, including cancer, heart disease, and other abnormalities. Radioactive material, or radiotracer, is introduced into the body via injection, ingestion, or inhalation and accumulates in specific organs or tissues, emitting gamma rays that provide structural and functional insights (Kim et al., 2018).

Radiation can harm living tissues by altering cell structures and damaging DNA. The extent of the damage depends on the type, energy, and total absorbed dose of radiation. While most cellular damage is repaired, some cells may not recover completely, potentially leading to cancer. Radiation exposure may also kill cells, with acute exposure causing immediate symptoms, and chronic exposure contributing to long-term effects, such as genetic defects, cancer, skin changes, and congenital anomalies (US EPA, 2016).

Health hazards from radiation exposure can manifest immediately or have delayed effects. Chronic exposure can lead to systemic damage, including blood disorders, benign tumors, and radiation sickness (e.g., hemorrhaging, anemia, and infections) (Salih et al., 2017). Healthcare workers in radiation-related departments, such as technologists and nurses, face increased risks of radiation exposure. Studies indicate that insufficient knowledge about radiation safety among healthcare staff contributes to these risks. Proper education, training, and use of protective tools and equipment are essential to mitigate these hazards (Holmberg et al., 2016).

Nurses working in nuclear medicine departments (NMDs) play a crucial role in patient care during diagnostic and therapeutic procedures. Their responsibilities include preparing patients, administering medications, explaining procedures, and ensuring patient safety. These tasks increase their vulnerability to ionizing radiation’s harmful effects. However, adhering to radiation protection principles can minimize these risks (Alotaibi et al., 2015).This study aims to assess the knowledge of nurse and health care staff about radiations hazards

2. Subjects and Methods

A descriptive cross-sectional research design was employed in this study.The study was conducted within diagnostic radiology, oncology, and nuclear medicine departments in healthcare facilities.A random sampling technique was utilized using a simple number generator to select nurse and health care staff . The total population consisted of 210 individuals, comprising 50 nurses and 160 technicians. A sample size representing 50% of the population was selected, resulting in 105 participants: 25 nurses and 80 technicians.

Tools of the Study

Two tools were developed to gather data:

1. Self-Administrative Questionnaire Sheet

Designed by the researchers, this tool gathered information across two parts:

- Part 1: Personal characteristics of participants, including age, gender, marital status, occupation, education level, department, and years of experience.
- Part 2: Knowledge regarding radiation hazards and safety measures, covering definitions, types, causes, uses, effects on cells, health safety measures, personal protective equipment, occupational hazards, and the impact of radiation on health. This section also assessed knowledge of safety measures, such as periodic maintenance, training attendance, supervision, and consequences for not using personal safety measures.

Scoring System

Knowledge was assessed through 31 questions. Correct answers received a score of 1, while incorrect answers received 0. Scores were converted into percentages:

- Poor knowledge: <50%
- Fair knowledge: 50–70%
- Good knowledge: >70%

Reliability of the questionnaire was verified using Cronbach's alpha, with a reliability coefficient of 0.861.

2. Observation Checklist

Developed by the researchers, this checklist assessed the practical application of safety measures among nurse and health care staff . It included observations on wearing gloves, masks, gowns, aprons, and handwashing practices.

Scoring System

Practice was evaluated through 42 items. Each completed action scored 1, while uncompleted actions scored 0. Scores were categorized as:

- Poor practice: <50%

- Fair practice: 50–70%
- Good practice: >70%

Reliability for the checklist was confirmed with a Cronbach's alpha coefficient of 0.769.

Statistical Analysis

Data were reviewed, coded, and analyzed using SPSS version 22. Descriptive statistics, including percentages and mean values, were used. Chi-square tests were applied to compare frequency distributions among groups, with significance set at $p < 0.05$. Statistical tests identified relationships, associations, and interactions among study variables.

3. Results

The data showed that 38.1% of the studied nurse and health care staff were under 30 years old, followed by 33.3% who were over 40 years. Additionally, 60% of the participants were male. Regarding marital status, 75.2% were married, and 67.6% held a technical institute qualification. In terms of job experience, 51.4% had less than 10 years, while 24.8% had more than 20 years of experience. Notably, only 7.6% of the study participants had attended training courses related to radiation.

Findings revealed that 65.6% of the nurse and health care staff stated that lead walls and glass were present as safety measures in the radiation unit. Protective barriers and warning signs were mentioned by 46.7% and 35.6%, respectively. However, 26.7% were unaware of the safety measures in the radiation unit.

All of the study participants indicated the availability of personal protective equipment (PPE). However, only 5.7% reported that the equipment was sufficient. The vast majority (98.1%) stated that the protective tools were suitable for use, and 75.2% noted the presence of periodic maintenance. Regarding educational programs, 17.1% had attended training courses on using personal protective equipment, and only 1.9% mentioned that the department conducted seminars or lectures on radiation risks. Furthermore, 96.2% reported that supervision of PPE usage was in place, with 71.3% identifying the safety officer as responsible for this oversight.

The data highlighted statistically significant differences between the level of education and the periodic medical examination, frequency of examination, and occupational diseases resulting from working in the radiology department, with p-values of 0.000, 0.005, and 0.000, respectively.

There was a statistically significant difference between diseases caused by working in the radiology department and years of experience (p-value = 0.000). However, no significant difference was found between types of diseases and years of experience in radiation therapy, except for blood diseases (p-value = 0.053).

Table 1: Personal Characteristics of Nurse and health care staff

Variable	No. (105)	%
Age (years)		
< 30	40	38.1%
30 – 40	30	28.6%
> 40	35	33.3%
Mean ± SD (Range)		36.54 ± 11.75 (22.0–58.0)
Sex		
Male	63	60.0%
Female	42	40.0%
Marital Status		
Single	26	24.8%
Married	79	75.2%
Years of Marriage (N=79)		
< 10	33	41.8%
10 – 20	19	24.1%
> 20	27	34.2%
Mean ± SD (Range)		15.09 ± 10.46 (1.0–36.0)
Level of Education		
University Education	16	15.2%
Secondary Education	18	17.1%
Technical Institute of Health	71	67.6%
Workplace		
Diagnostic Radiation	80	76.2%
Nuclear Medicine and Oncology	25	23.8%
Occupation		
Nurses	25	23.8%
Technicians	80	76.2%
Years of Experience in Radiation Therapy		
< 10	54	51.4%
10 – 20	25	23.8%
> 20	26	24.8%
Mean ± SD (Range)		13.15 ± 10.85 (1.0–34.0)
Attending Training Courses About Radiation Therapy		
Yes	8	7.6%
No	97	92.4%

Table 2: Knowledge of Nurse and health care staff About Radiation Unit Safety Measures

Safety Measure	No. (105)	%
A warning sign	32	35.6%
The department is separate and ventilated	21	23.3%
The space must be sufficient	19	21.1%
The work surface is separated	28	31.1%
A wash basin in the room	9	10.0%
Lead walls and glass	59	65.6%
A protective barrier	42	46.7%
Special containers for radioactive materials	7	7.8%
Sewage system	11	12.2%
Monitoring devices	26	28.9%
Disposing of radioactive waste	21	23.3%
Not eating or drinking in the room	18	20.0%
Warning devices	28	31.1%
Don't know	24	26.7%

Table 3: Knowledge of Nurse and health care staff About Personal Protective Equipment

Variable	No. (105)	%
Personal Protective Equipment		
Present	105	100.0%
Not Present	0	0.0%
Criteria of Personal Protective Equipment		
Enough	6	5.7%
Suitable for use	103	98.1%
Periodic maintenance	79	75.2%
Person Responsible for Maintenance		
Physicist	45	57.0%
Maintenance Officer	7	8.9%
Safety Officer	14	17.7%
Nursing Supervisor	13	16.5%
Attending Educational Programs		
Attending training courses	18	17.1%
Seminars or lectures on radiation risk	2	1.9%
Supervision of PPE and Environmental Tools		
Yes	101	96.2%
No	4	3.8%
Person Responsible for Supervision (N=101)		
Safety Officer	72	71.3%
Head of Department	4	4.0%
One of my colleagues	15	14.9%
Physicist	34	33.7%
Infection Control Officer	22	21.8%
Punishment for Non-Use of PPE		
Exposed to punishment	45	42.9%
Not exposed to punishment	60	57.1%
Types of Punishment (N=45)		
Delay in upgrade	4	8.9%
Deducting a sum of money	44	97.8%
Deprivation of vacation	2	4.4%

4. Discussion

Radiation poses a health risk in both workplace and environmental settings. The level of risk depends on the dose and type of radiation exposure, which can lead to various health issues such as cancer, cataracts, infertility, blood disorders, genetically determined illnesses, developmental abnormalities, and degenerative diseases (Alzubaidi et al., 2017).

The current study found that approximately one-third of the nurse and health care staff were under 30 years old, with a mean age of 36.54 ± 11.75 years. This aligns with the findings of Rahimi et al. (2021), who assessed Malaysian nurses' knowledge of radiation protection and reported a similar age distribution.

In terms of gender, more than one-third of the participants were female. This contrasts with the findings of Shaban and Mostafa (2019), who investigated factors affecting compliance with radiation standard precaution measures and found that the majority of participants were female. This discrepancy could be attributed to the

increasing number of males entering nursing and technical professions, particularly in high-risk and physically demanding roles.

Regarding education, most participants in this study had a technical education background. This finding is consistent with the report from the Central Agency for Public Mobilization and Statistics (2019), which indicated that the majority of workers in high-risk jobs had secondary or technical education. However, it contrasts with Salah Eldeen and Farouk (2020), who found that most healthcare workers in radiation environments held bachelor's degrees.

In terms of work experience, nearly half of the participants had less than 10 years of experience, with most working as technicians in diagnostic radiation units. This is in line with Ahmed et al. (2016), who reported that most healthcare workers in diagnostic radiology were technicians with less experience, rather than nurses. The higher risk associated with less experienced workers could explain these findings.

The study also found that only a small percentage of participants had attended training courses on radiation safety, which agrees with Abdellah et al. (2015), who evaluated healthcare workers' knowledge, attitudes, and practices regarding radiation safety and found limited participation in training programs. This may be due to a lack of departmental initiatives to provide such training.

Regarding knowledge of radiation unit safety measures, participants noted the presence of lead walls, glass barriers, warning signs, and monitoring devices. These findings are consistent with Durduran et al. (2018), who highlighted the importance of barriers and shielding in reducing radiation exposure. However, the lack of training courses may contribute to gaps in knowledge about these safety measures.

The study observed that all participants had access to personal protective equipment (PPE), which they deemed suitable but insufficient. Few participants had received training on proper PPE use, and supervision was mainly conducted by safety officers. These findings are similar to Fayed et al. (2016), who emphasized that inadequate supplies and training hinder compliance with protective measures.

A statistically significant relationship was found between the level of education and the frequency of periodic medical examinations, as well as occupational diseases resulting from radiology work (p-values = 0.000, 0.005, and 0.000, respectively). This supports the findings of Mohammed et al. (2018), who reported a similar relationship and noted that technicians faced higher exposure risks due to inadequate medical examinations.

Additionally, there were significant correlations between years of experience and radiation-related diseases (p-value = 0.000) and between exposure and blood disorders (p-value = 0.05). This aligns with Reagan (2017), who reported that adherence to safety practices improved with experience, and Mohammed et al. (2018), who found a high prevalence of blood disorders, such as anemia, among technicians and nurses exposed to radiation. Prolonged work in radiation therapy may increase the risk of occupational diseases.

The study also found that the majority of participants had poor knowledge scores regarding radiation hazards, consistent with Esfahani et al. (2020), who demonstrated

the importance of training programs in improving radiation safety knowledge.

Similarly, over two-thirds of participants had poor practice levels regarding radiation safety measures, mirroring Hirvonen et al. (2019), who emphasized the critical role of education in promoting safe medical radiation practices. The lack of preventive equipment in departments may partly explain these findings.

Finally, a positive correlation was observed between knowledge and practices related to radiation safety measures ($p = 0.000$), consistent with studies by Fayed et al. (2016) and Ahmed et al. (2016). However, this contrasts with Yousef et al. (2021), who found no significant correlation between knowledge and practices in his study.

5. Conclusion

The study revealed that the majority of nurse and health care staff demonstrated poor knowledge regarding radiation hazards, with over two-thirds exhibiting poor practice levels. A positive and significant correlation was found between knowledge and practice among the participants concerning radiation safety measures.

Regarding education levels, only a small number of participants, particularly technicians, underwent regular medical examinations. Participants with over 20 years of work experience reported a higher prevalence of occupational diseases, with a statistically significant association identified between years of experience and the occurrence of blood disorders.

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