



Assessment of the Knowledge and Attitude to Radiation Safety Standards of the Radiological Staff in Damaturu, Yobe State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by authors SDY, AIB, IU and MMI. The first draft of the manuscript was written by author AIB, reviewed and re-drafted by author SDY and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Radiation protection and safety has been a major concern of many national and international bodies because of the potential hazardous effects associated with ionizing radiation if not properly controlled. However, no much research has been done on the compliance of Radiographers to radiation safety standards in Nigeria. In this study, we access and evaluate the level of compliance of the radiological staff in Damaturu, Yobe State using a self-structured questionnaire. The simple random sampling technique was used to collect 25 valid responses from radiographers, radiologist, technicians and other staff, corresponding to 92.86% response rate. Results show that even though the radiographers show high compliance rate to radiation safety standards, majority of the workers do not have thyroid shields and monitoring devices and since the total number of exposures given during radiography is usually not recorded, it means they are over exposing themselves as well as

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the patients to radiation which is not a good safety measure. However, hospital management should focus attention on providing continuous professional development programs and quality assurance programs so as to maintain good processing of X-ray films for good quality radiographs as this will reduce repeated exposures. Provision of monitoring devices and thyroid shields are of great importance.

Keywords: Radiation protection; radiation safety; radiation safety standards; compliance; attitude and knowledge, radiographers.

1. INTRODUCTION

The increasing use of radiation for medical and other purposes has stimulated a concern for potential harmful radiation effects [1]. According to Shika [2], the complexity of radiography procedures, lack of quality control programme and specific training on radiation protection may result in an occurrence of deterministic effects. The potential for increased stochastic effects is a major public safety concern.

Nowadays, there is a rapid development with regards to radiation safety measures that radiographers are expected to comply with [3]. Radiographers are challenged to keep abreast with these developments. The Nigerian Nuclear Regulatory Authority (NNRA) and International Atomic Energy Agency (IAEA) are enforcing compulsory continuing professional development for radiographers ensuring that they are updated with new developments in their profession to remain competent [4].

Radiation can be described as the energy or particles from a source that travel through space or other mediums [5]. Radiation can broadly be defined as the entire spectrum of electromagnetic waves including radio waves, microwaves, infrared, visible light, ultraviolet, X-rays and atomic particles [6]. According to Thormod [7], radiation can be classified into two main categories ionizing or non-ionizing depending on its ability to ionize matter. According to Dance et al. [6] radiation and radioactive substances are used for diagnosis, treatments, therapy and research, but the major source of human exposure is the medical utilization of diagnostic and therapeutic radiography. X-rays for instance pass through muscles and other soft tissues of the body but are stopped by dense materials (such as a tumour, bone, or a metal fragment) which enable doctors to locate fractured bones and to locate cancers that might be growing in the body [6]. Iżewska [5] explained that certain diseases are also located by injecting a radioactive substance

and monitoring the radiation given off as the substance moves through the body. However, radiation used for cancer treatment is called ionizing radiation because it forms ions in the cells of the tissues it passes through as it dislodges electrons from the atoms [6,7]. According to Homer [8], over exposure to ionizing radiation could cause a potentially serious occupational health hazard. X-radiation for example is dangerous and yet it is used extensively in medicine, hence it is regulated and monitored to protect staff, patients and general public from the dangers associated with its application [9]. Dance et al. [6] had pointed out that, at high doses it is carcinogenic, mutagenic and teratogenic, but the effects at low doses are much less certain. According to Moritz et al. [10], the severity of the effects appears in most circumstances to be no greater than a linear relationship to dose with no threshold value. The effects of radiation are classified into stochastic and non-stochastic effects [5]. According to Dewey et al. [11], stochastic effects occur where a cell exposed to radiation is modified and over a long period may develop into cancer or genetic mutations. Non stochastic effects occur when a tissue is exposed to high dose of radiation within a short period of time resulting in death of a cell and delayed cell division, for example skin changes, and gonadal cell damage leading to infertility [11].

Radiation safety is the protection of personnel against harmful effects of radiation by taking steps to ensure that people will not receive excessive doses of radiation and by monitoring all sources of radiation to which they may be exposed as well as measures taken when working with radioactive substances [12]. Radiation safety also provides more effective diagnosis and treatment, improves patient and personnel safety and reduces radiation exposure risk [1]. According to Dance et al. [6], radiation safety rules must be strictly adhered to otherwise it would result in so many hazards including environmental contamination, increasing cancer risk and damaging of living organs to both

personnel and patients. Radiations Safety Standards are the standards, regulations, rules and codes of practice established to protect people and the environment against ionizing radiation and to minimize danger to life and property [12]. The goal of the standards is not only to give lowest dose but to provide the correct dose to enable personnel to make beneficial diagnosis and avoid exposures that could cause deterministic effect from noncompliance to safety standard [13]. Shika [2] pointed out that, maintaining the safety standard reduces the harmful effects associated with radiation exposure and increases the safety of patients, staffs and the environment. The danger of not maintaining standards with the increasing use of radiation has stimulated a concern for potential harmful radiation effects [7]. Lack of maintaining standards may result in closure of radiology centre, revocation of licenses and some legal penalties until standards are fully implemented [3].

In the case of Nigerian health industry, there is an indication that some Radiology departments in some hospitals and Radio-diagnostic centres in Nigeria are not complying with radiation safety standards. According to a recent report from the visit to some hospitals in Nigeria by a team of radiation control inspector's, NNRA [4] has confirmed that some hospitals do not comply with the licensing conditions of X-ray equipment. As a result of this, a number of radiology departments received warning notices and some X-ray machines were sealed until they can comply with the licensing conditions. NNRA [14] had emphasized on the availability of adequate protective clothing such as lead aprons, thyroid collars, lead gloves, gonad shields, written protocols and quality assurance which were also concern points. The aim of this study is to access and evaluate the current status of compliance to radiation safety and standards and the challenges faced by Radiographers and radiation workers in the implementation of such standards at public hospitals in Damaturu, Yobe State, Nigeria, as stipulated in the national and international agencies publications.

This study seek to help hospitals to understand the level of compliance to radiation safety and standards and some challenges faced by the radiographers in complying with such standards so as to assist the management in taking vital decisions that will help in moving the hospital forward and creating the right policies and actions that could minimize the risk of

occupational radiation exposure of these radiographers and other radiological staff in public Hospitals.

2. METHODOLOGY

A qualitative descriptive survey research design is used for this study as this approach provides standardized information in form of quality assurance and will assist in making analysis and measuring compliance to radiation safety standards. Radiation safety for this study will relate to availability and use of lead protective clothing and radiation monitoring, implementation of quality assurance program and proper management of radiation records. This will show how the radiographers conduct themselves in the workplace, their perceptions and performance. The research employed the use of simple percentages and frequencies in the analysis of data.

2.1 Study Area

This study is conducted in Damaturu, Yobe State. Yobe is one of the 36 states in Nigeria, with a population of about 3.1 million people [15]. It shares borders with Borno, Bauchi, Jigawa, Gombe and Adamawa states and international border with Niger Republic. The capital city of Yobe is Damaturu which has 3 public hospitals with Radiation facility and in addition, 3 private hospitals and diagnostic centres. Yobe state have a number of primary health care facility, specialist hospitals and 2 tertiary health facilities in Damaturu and Nguru towns. X-ray facilities are found in all the two tertiary health facility and specialist hospitals in Damaturu, Gashua, Geidam and Potiskum.

2.2 Population of the Study

The population of this study includes all the hospitals that have radiology department in Damaturu Local Government. That is all the staff of the radiology departments of Yobe State University Teaching Hospital, Yobe State Specialists Hospital and Maryam Abacha Hospital all in Damaturu. The total population is 52 staff comprising of 15 radiographers, 13 radiologist, 14 technicians, and 10 other staff.

2.3 Sample Size and Sampling Technique

Yobe State University Teaching Hospital was selected for the study after a simple random sampling selection, using "My Random" software.

The sample size of the study consist of 28 personnel (respondents) as it covers all the medical staff of the radiology department of Yobe state university teaching hospital Damaturu, which consist of 10(35.71%) radiographers, 6(21.43%) radiologist, 2(7.15%) technicians and 10(35.71%) other staff. The sample of the study is shown in Table 1.

Table 1. Sample size of the study

Personnel	Frequency	Percentage
Radiographers	10	35.71
Radiologist	6	21.43
Technicians	2	07.15
Others staff	10	35.71
Total	28	100.00

2.4 Experimental Design

The self-structured questionnaire was developed in English. There are three (3) Sections; section A comprised of questions regarding demographic, section B comprised of questions about radiation safety standards and section C is the questions on the challenges faced by radiographers in the implementation of radiation safety standard. The questionnaire uses close ended question where the respondent is to choose from a list of options. The Research tool was validated by two senior lecturers at Nasarawa State University (NSUK) and the chief Radiographer at State Specialist Hospital (SSH), Maiduguri. This was done to improve the face validity and content validity of the instrument. A pilot survey with five (5) subjects randomly sampled from different levels (radiographers and technicians) in a hospital was conducted for the reliability test. This was followed by the main survey conducted in the radiology department of Yobe State University Teaching Hospital Damaturu using face-to-face interviews led by research assistants who were adequately instructed on what to do.

3. RESULTS

3.1 Data Collection

Table 2 represents the data for this study obtained through the survey using radiographers and all medical staff (Radiologist and technicians) of the radiology department of Yobe State University Teaching Hospital Damaturu. These are people who directly have access to the source of radiation. We provided some incentives to ensure the active involvement of participants in the survey. Of the 28 questionnaires distributed, a total of 26 responses were received, corresponding to an initial response rate of 92.86%. After discarding invalid responses, we had 25 responses remaining, of which 68% responses were from males and 32% from females. The other questionnaire was invalid because it was not fully filled.

The age of respondents ranges from 20 – 50 years, with 60% in the age range 20 – 30 years, 28% 31 – 40 years, and 12% 41 – 50 years. For the entire sample, there was low percentage of the respondents educated at National Diploma level (12%), and similarly Master Degree (12%). The majority of respondents have a university education (48%), followed by others with either primary or professional training in colleges, or technical training centers (28%).

3.2 Compliance to Radiation Standards

Result on the compliance to the implementation of radiation safety standard includes questions on the protective equipment or devices available, the principles of radiation protection and safety employed, and the radiation safety technique used in the hospital. Table 3 shows a list of the available protective equipment’s in us in the study hospital.

Table 2. Demographics of respondents

Categories	Percentage	Categories	Percentage
Gender		Qualifications	
Male	68	MSc. (Radiography)	12
Female	32	BSc. Medical Radiography	48
Age range (20-50 yrs)		National Diploma	12
20-30	60	Others	28
31-40	28		
41-50	12		

Table 3. Protective equipment available or in use

Protection device	Yes (%)	No (%)
Do you use Lead Aprons full front and back	100	0
Do you use Gonad Shield	100	0
Do you use Waist Apron	100	0
Do you use Lead Gloves	64	36
Do you use Thyroid Shield	40	60

Radiographers have the ethical responsibility to make sure that lead protective garments are available and are used at all times to protect patients and public from primary radiation, especially sensitive parts of the body such as reproductive organs, thyroid glands and hands. From Table 3, the result of the availability and use of protective equipment reveals that, the respondents indicates high level of the availability of protective equipment with 100% lead aprons full front and back, gonad shields and waist apron, followed by lead gloves (64%) but very low availability of thyroid shield (40%). The principle and practice of radiation protection used in the hospital are shown in Table 4.

Radiation safety principles such as ALARA, Ten day rule, Inverse square law, Justification and optimization are recommended by ICRP in publications 26 and 60. From Table 4 of the principle of radiation protection used reveals that, the respondents indicated high level usage of radiation protection principles with 100% Justification and Optimization (ALARA) principles and 88% Dose limitation. In addition, it was noticed that the total number of exposures given during radiography is usually not recorded (10%) and the hospital has failed to implement the quality assurance programme (08%).

3.3 Challenges of Radiographers

Some challenges faced by the radiographers in the implementation of radiation safety standards, includes amongst other having a practicing licenses, use of monitoring devices and continuous professional developments as shown in Table 5.

From Table 5 the result of the challenges faced by radiographers reveals that, the respondents indicated that majority of the radiographers have current practicing license (80%). Whereas majority (60%) of the radiographers does not have radiation monitoring devices and only few personnel are with continuous professional development programs certificate (48%).

4. DISCUSSION

4.1 Theoretical Implications

Findings have revealed that even though most of the protective equipment's such as Lead Aprons, Gonad shields, waist Apron, and Lead gloves are readily availability which can provide protection to an extent they are still deficient in the availability and use of thyroid shields which could expose them to thyroid cancer. Since majority of the workers do not have monitoring devices they may be over exposing themselves to radiation which is not a good safety measure. Compliance to safety standard must be in totality not partial as it may lead to violation of the safety rules and regulations. This finding is similar with the findings of Doolan et al. [16] where availability and use of gonad shielding were inadequate in a hospital in Dublin and also to the findings of Dewey et al. [11] where lead gloves and thyroid collars were often omitted and orthopedic surgeons developed thyroid cancer due to exposure to radiation. Though based on the radiation principles in use, findings on compliance and noncompliance to safety standard in certain elements of the Radiation Safety standards in the hospital have shown high

Table 4. Principle of radiation protection used

Principle	Yes (%)	No (%)
Do you use the justification principle	100	0
Do you use optimization (ALARA) principle	100	0
Do you use the dose limitation principle	88	12
Do you record the total number of exposures during radiography	10	90
Do your hospital implement quality assurance programme regularly	08	92

Table 5. Challenges faced by radiographers

Challenges	Yes (%)	No (%)
Do you have current practicing licenses	80	20
Do you have monitoring devices	40	60
Do you have continuous professional development certificate	48	52

rate of literacy and compliance of personnel to radiation safety standards as stipulated by the Nigerian Nuclear Regulatory Authority and International Atomic Energy Agency. However, it was noticed that the total number of exposures given during radiography is usually not recorded; this can also lead to over exposure of the patients. Prescribed dose must be delivered accurately and precisely to maximize the Tumour Control Probability (TCP) and to minimize the Normal Tissue Complication Probability (NTCP). This finding is in line with Izevska [5]. The hospital has also failed to implement the quality assurance programme. In general poor implementation of quality assurance program results in poor processing conditions of X-ray films which may result to poor quality radiographs that may lead to repeated exposures and since the total number of exposures given during radiography is usually not recorded, it means they are over exposing the patients. This is in line with the findings of Horner [8].

4.2 Managerial Implication

From the results obtained some managerial implications are drawn. The high level of literacy (qualifications) among the dispensers of radiation results is in compliance to safety and adherence to standards. However, the hospital management should note that rather than a friendly smile to this, they should consider to place more emphasis on providing continuous professional development programs and monitoring devices (which is the basis of safety). Efforts should be made to implement quality assurance programs regularly to enhance quality processing of X-ray films that will result to good quality radiographs for reduce repeat exposures that could lead to over exposure of the patients, in line with the findings of Horner [8], and Izevska [5]. Provision of thyroid shields and monitoring devices is of utmost important to ensure full compliance to the safety standards.

5. CONCLUSION

It is obvious that the benefit of high level of radiation protection is adherence to radiation safety standards. The goal of this paper is to

evaluate the radiographer’s compliance and noncompliance to radiation safety standard. As a foundation for policy making, this research also looks into the challenges faced by the radiographers in adhering to the radiation safety standards. To maintain high level of radiation protection, hospital management should pay attention to continues training programs that will help in their personal development. However, compliance to safety standards is with regards to the availability of personnel protection and safety equipment, principles and techniques employed. Though the radiation protection devices present in the hospital was impressive indicating employer’s willingness to abide by radiation safety and standards. However, relative to other safety devices, provision of thyroid shields and monitoring devices should be the priority of the hospital management. However, we did not take into consideration other safety measures as the research was focused only on basic safety tools and equipment and authorized standards. Also, due to limited time and other factors beyond control of the research we only considered one hospital. Such small sample size may not fully represent the actual situation of the whole Hospitals in Yobe State. Therefore, we recommend that further research including all the Hospitals in Yobe State that have X-ray facilities will reveal more information and implications for better policy making.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard written ethical approval has been collected and preserved by the author(s).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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