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Knowledge and awareness of radiation exposure and safety practice among patients undergoing medical imaging in 3 selected hospitals in Bauchi

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Abstract
The study investigates Knowledge and Awareness of Radiation Exposure and Safety Practice among Patients Undergoing Medical Imaging in 3 Selected Hospitals in Bauchi. The objective of the research was to examine the Knowledge and Awareness of Radiation Exposure and Safety Practice among Patients Undergoing Medical Imaging in 3 Selected Hospitals in Bauchi.
Methodology: A total population of 172 patients was used for the purposes of the research. Research questionnaire was used as instrument for collecting data and statistical techniques such as frequency, mean and standard deviation were used for analyzing the data.
Result: It was discovered that the patients have basic knowledge on ionizing radiations. Such knowledge include them knowing that Ionizing radiations are used in the hospitals to ascertain the body parts of patients before surgeries are performed on patients. They also revealed that the patients are aware of some side effects of ionizing radiations. They opined that ionizing radiations cause mutation, skin cancer and related infections, irritations on the skin, killing of vital cells in the body. They were of the opinion that the side effects of these radiations can reduce the life span of an individual.
Recommendations: Enlightenment and seminars should be organized for patients going for radiotherapy in hospitals, adequate radiotherapy protective equipment should be made available in the hospitals for the patients to use, and the staff in the Radiology Department and patients going for radiotherapy should endeavor to always wear protective equipment when carrying out radiations.

Keywords: Radiation exposure, safety, patients, medical imaging, hospitals

Introduction
As Good Clinical Practice needs good knowledge, attitude, and practice (KAP) and as they are practically interdependent, several factors such as sex, education practice age and hospital type, geographical region might affect good clinical practice. In general, 80% of exposure to ionizing radiation comes from natural sources of which radon gas is highest, while the rest comes from man-made sources, primarily medical X-rays (Leyton *et al.*, 2014). Radiological examinations is a necessity in managing a patient as most of critical decisions are based solely on their interpretation despite biological adverse effects which vary based on dose and duration of exposure (Rehani, 2007) [20].
The potential risks of radiation (cataract, skin erythema, foetal anomalies, genetic mutations, cancers) comprises of stochastic effect where probability of disease increases with dose and deterministic effect where severity of disease increases with dose (Paolicchi *et al.*, 2016). Thus the patients undergoing radiation should be in the knowledge to follow "As Low as Reasonably Achievable" (ALARA) concept in radiotherapy. A key part of managing radiation safety on the parts of the patients coming for radiotherapy is through orientation and enlightenment. Every person involved must know what and how to handle radiation, safety precautions and issues relating to dose optimisation, to protect oneself and patient from unnecessary exposure, because the number of diagnostic radiology procedures performed in a hospital is growing exponentially with time (Alavi *et al.*, 2016) [1].
The research focused on the assessment of Knowledge and Awareness of Radiation Exposure and Safety Practice among Patients Undergoing Medical Imaging in 3 Selected Hospitals in Bauchi State. The research covers only three health facilities: 261 Nigerian Air

Force Reference Hospital Bauchi, Abubakar Tafawa Balewa University Teaching Hospital Bauchi and State Specialist Hospital Bauchi due to financial constraint. This research work will be of vital importance to patients going for radiation procedures in health facilities not just in the 3 selected hospitals used for the research but also hospitals in Bauchi State and Nigeria at large. Proper education on the dangers of radiation and safety measures to be put in place as contained in this research will help in enlightening patients and non-patients alike on issues relating to ionizing radiations and safety best practice.

Historical perspective of radiation

The invention of the x-ray by Wilhem Roentgen in 1895 was a transformative moment in the history of medicine, for the first time making the inner workings of the body visible without a need to cut into the flesh (Goodman, 2005) [10]. Roentgen, a Professor of Physics in Würzburg in Germany, was at the time experimenting with electrical currents through cathode ray tubes. Although the glass tube he was using was covered in thick black cardboard, and the room was completely dark, Roentgen noticed that a nearby screen, covered in barium platinocyanide (a fluorescent material), became illuminated. He quickly realized that this was due to radiation being emitted from his experimental apparatus. Furthermore, a number of different objects could be penetrated by this radiation, and a projected image of his hand on the screen showed a contrast between opaque bones and translucent flesh. One week after his initial discovery, Roentgen replaced the screen with a photographic plate, and x-ray imaging was born (Glasser, 2005) [9].

Roentgen began lecturing on his invention in January 1896, and a few weeks later an X-ray was used in Canada to find a bullet in a patient's leg. Within a year, the world's first Radiology Department was set up at Glasgow Royal Infirmary, and quickly produced images of kidney stones and of a penny lodged in a child's throat. Shortly after, an American physiologist used a similar system to actively trace food going through the digestive system. During the 20 years following Roentgen's discovery, x-rays gained increasing popularity, both as a fairground curiosity and as a powerful diagnostic tool in the medical setting. Their use in the treatment of wounded soldiers in the Boer War (1899-1902) and World War 1 (1914-18) cemented the use of X-rays at the heart of medical diagnostic practice. Roentgen was awarded the very first Nobel Prize for Physics for his discovery in 1901 (Glasser, 2005) [9].

Around the same time as Roentgen's work, scientists like Henri Becquerel and Marie and Pierre Curie were among the first to discover natural radiation, whilst investigating the properties of fluorescent minerals. When storing some such minerals (a uranium compound) in a drawer with photographic plates, Becquerel noticed that the latter became exposed, and concluded that this must be due to a type of highly penetrative radiation being given off by the mineral itself.4 As scientists began to look at this phenomenon more closely, they discovered that radioactive atoms are naturally unstable, and that in order to become stable, they emit particles and/or energy, in a process known as radioactive decay. Polonium and radium were discovered by the Curies over this period. Radium would become particularly important as a source for gamma rays, first extensively used in industrial radiography during the US Navy's ship-building program in World War 2. By 1946, Cobalt and iridium were developed as man-made sources of gamma radiation for industry. Since these were cheaper to produce and more powerful than radium, they quickly replaced it in all industrial applications (Dutreix, 2006) [8]

Understanding Radiation Risks

Radiation can damage living tissue by changing cellular structure and damaging an organism's DNA. The amount of damage depends on a number of variables, including the type and quantity of radiation absorbed and its energy (Kleiman, Macvittie, Aleman, Edgar, Mabuchi, Murihead, Shore, &Wallace, 2012). Because radiation damage is done at cellular level, the effect of minor or even moderate exposure may be difficult to detect, and often can be successfully repaired by the body. However, certain types of cells are more sensitive to radiation damage than others, and with greater exposures, cellular recovery might be less successful and turn cancerous. Radiation can kill cells outright, as well as damaging their DNA. This obviously creates a hazard, but also opportunities for medical intervention, if cellular death can be precisely targeted (e.g. in radiation therapy for cancer) (Hendry, 2012) [12].

Much knowledge of the risks of radiation is based on studies of survivors from the atomic bombs at Hiroshima and Nagasaki in Japan at the end of the Second World War. Other studies of radiation industry workers and of people receiving high doses of medical radiation have added greatly to the understanding of radiation. Radiation ranks among the most thoroughly investigated causes of disease, and more is known about the mechanisms of radiation at the molecular, cellular and organ system levels than for almost any other health stressor. This has allowed health physicists to determine ‘safe’ levels of radiation to be used for medical, scientific and industrial purposes to ensure that relative risk does not exceed that associated with other commonly used technologies (Barendson, Walter, Fowler &Bewly, 2003) [4].

Measurement of radiation

There are 4 separate but inter-related units for measuring radiation;

1. Radioactivity, which refers to the amount of ionizing radiation released by a material.
2. Exposure, which measures the amount of radioactivity travelling through the air.
3. Absorbed dose, which describes the amount of radiation absorbed by an object or person.
4. Effective dose, which combines the absorbed dose and the medical effects for that type of radiation.

The absorbed dose can be calculated on the basis of total radiation energy absorbed (Joules) per unit of mass (kg) in an affected area of tissue or organ. The most common unit of measure for this is the Gray (Gy), where one Gray is equivalent to one Joule per kilogram. With beta and gamma radiation, the Effective Dose (expressed in Sievert, or Sv) is equivalent to the absorbed dose. For alpha radiation however, which is more damaging to the body, the Effective Dose is greater (Huda & Vance, 2001) [14].

Classifications of the effects of radiation

The biological effects observed in irradiated persons fall into one of two categories: Deterministic, due largely to a “kill” effect on cells, and Stochastic, related to mutations which may result in effects over time, such as cancer or hereditary mutations.

a. **Deterministic effects:** In this situation, skin necrosis and cataract, have a practical threshold dose below which effects are negligible or not evident, but as a general rule, severity of the effects increases with the radiation dose. The threshold dose is not an absolute number, but can vary between individuals.
b. **Stochastic effects:** This includes cancers and hereditary mutations, where the relationship between dosage and severity of effect is much weaker. Stochastic injuries occur when there is injury to the DNA backbone that fails to heal adequately (Wakano & Iwasa, 2013) [23]. A single X-ray photon may cause this effect, however the risk of acquiring such injury increases with dose/exposure (linear no-threshold hypothesis). Stochastic risk is particularly challenging to address given its delayed and cumulative effect, lack of a “safe” threshold dose, and absence of a reliable biomarker.

Sources of radiation

Lifetime exposure to radiation comes from a variety of sources, both natural and man-made.

Naturally occurring radiation

Almost half of the radiation one is exposed to come from the environment around us. Many elements found in the earth's crust emit radioactivity, including uranium, radium, polonium, thorium and potassium. Levels of exposure will depend on the make-up of the local soil and rocks. Another natural source is cosmic radiation. Earth is constantly exposed to radiation created by processes occurring in the sun, other stars and throughout the Universe. Perhaps the most damaging source of natural radiation is radon, a tasteless, colorless, odorless gas produced by the decay of radium, an element present in nearly all rocks and soils. Radon gas seeps into buildings from cracks and other openings in floors and walls. Since radon gas emits alpha particles, accumulated radon within buildings can pose a serious health hazard via inhalation. Radon causes an estimated 20,000 cases of lung cancer per year, and is second only to smoking as a cause of lung cancer death. Smokers living in a home with high radon levels are particularly at risk (JAMA, 2008) [15].

Radiation in medicine

In countries with a developed clinical sector, up to a further 50% of the radiation exposure can be attributed to medical sources. Most of this comes from the use of standard x-ray and CT scan technology to diagnose injuries and disease. Other procedures such as radiation therapy also use radiation to treat patients (Hricak, Brenner, Adelstein, Frush, &Hall, 2011) [13].

General principles for minimizing radiation risk in medical use

The most effective way to reduce patient risk in radiological examinations is through appropriate test performance and through the optimization of radiological protection for the patient. These are primarily the responsibility of the radiologist, the nuclear medicine clinician and the health physicist. The basic principle of patient protection requires that procedures should seek to achieve diagnostic information of satisfactory clinical quality using the lowest reasonably achievable dose. Evidence obtained from a number of countries indicates a significant variability in entrance doses routinely administered to patients (i.e. doses measured at the body surface, at the site where the x-ray beam is entering), varying by a factor of 100 in some cases. As most doses in these studies tend to cluster at the lower end of the distribution, it is clear that entrance doses at the higher end (say above the 70th or 80th centile) are difficult to justify as adhering to an optimal risk/benefit ratio (Dorr, 2010) [7].

A beneficial first step towards radiation risk-reduction for patients is therefore the development of an agreed protocol of diagnostic reference tables of appropriate radiation for different procedures and patient types (e.g. children vs. adult), at an institutional, regional or national level, based on observed international best practice. An initiative of this kind provides not only a valuable learning or guidance tool, but it can also assist with quality control, helping to quickly identify institutions or equipment requiring corrective action in order to reduce patient risk. Measures that strengthen communication, transparency and implementation between radiologists, health physicists and audit teams can also help to significantly impact on radiation dose reduction for patients, whilst at the same time improving effectiveness of diagnosis (Gray, Archer, & Butler, 2005; McCollough, Branham, & Herlihy, 2011) [11, 18].

In parallel, the use of fluoroscopically-guided interventional procedures has increased dramatically over the past two decades. The number and spectrum of such procedures continue to expand across different specialties. Patients are generally subjected to significantly higher radiation dosages compared to diagnostic studies; averaging 15 mSv for a simple coronary intervention and 50 mSv for a complex electrophysiological procedures, equivalent to 750 and 2500 posteroanterior chest X-rays respectively. The direct benefits of these procedures usually outweigh the potential hazards associated with such high doses of radiation. However, even with this favorable risk/benefit ratio, efforts to minimize risk must apply. Quality assurance and improvement programs focusing on minimizing exposure to patients and staff, continuous education, dose monitoring, proper use of equipment and protective garments/shields, and adherence to radiation safety guidelines issued by various professional societies, cannot be overemphasized (John, 2010) [16].

Radiation risks and children

Radiation control is a concern both in the case adults and children. However, with regard to children and fetuses, three unique considerations apply, which must inform actions:

1. Children are considerably more sensitive to radiation, as demonstrated in numerous epidemiological studies of exposed populations.
2. Children have a longer life expectancy than adults, resulting in a longer window of opportunity for radiation damage to be expressed.
3. Children may receive a higher dose of radiation than necessary, if equipment settings and dosages are not adjusted for their smaller body size.

Radiation-induced malformations or intellectual impairment, either in the developing fetus or children, are extremely unlikely through normal diagnostic radiology or nuclear medicine procedures. However, a small but significant risk of cancer induction does exist, and must be borne in mind even at typical diagnostic levels of radiation (<50mGy). The risk of developing radiation related cancers can be several times higher for a young child, compared to an adult undergoing similar diagnostic or interventional procedure.

Radiation dose reduction must therefore be a priority goal particularly for procedures carried out on children, or in pregnancy. In pediatric use, dose reduction is achieved in practice principally through technical factors specific to children. In nuclear medicine, the smaller size of children means that acceptable images can be achieved using smaller administered doses than for adults, whilst in diagnostic radiology, particular care must be exercised in ensuring that radiation is focused as narrowly as possible on the specific area of interest (Paolicchi, Faggioni, Bastiani, Molinaro, Puglioli, Caramella, &Bartolozzi, 2014) [19].

Radiation risk and CT (Computed Tomography) use in pediatrics

CT can be a life-saving tool for diagnosing illness and injury in children. Between 5 and 9 million CT examinations are performed on children annually in the United States alone, and use of this procedure is increasing steadily, both due to its utility in common diseases and because of technical innovation. Yet despite its many clear advantages, CT also poses a major disadvantage in terms of significant radiation exposure. Despite accounting for only 12% of diagnostic radiological procedures in the USA, CT scans deliver around 49% of the US population's collective radiation absorption from medical procedures as a whole (Andrade, Borras, Kkoury&Dias, 2012) [2].

The first study to directly assess the risk of childhood cancer following CT scans found a clear dose-response relationship for both leukemia and brain tumors, with risk growing alongside increased cumulative radiation absorption. A cumulative dose of around 50-60mGy to the head was found to increase the likelihood of brain tumors threefold in children. Likewise, exposing bone marrow to a similar dose of radiation was found to increase the risk of leukemia by the same amount. For both findings, comparison was made with a control group having cumulative radiation absorption of less than 5mGy to the relevant regions of the body. These findings mirrored estimates from studies after the atomic bomb explosions in Japan (Brenner, Elliston, Hall, Berden, 2001) [6].

The number of CT scans required to reach a cumulative threshold of 50-60mGy depends on the equipment used, the age and size of the patient, and the scanner settings themselves. On typical current settings for pediatric CT, two to three head scans are sufficient to expose the brain to this level of cumulative radiation. In the case of bone marrow, this threshold is reached at between 5 and 10 procedures. The above is based on accepted US scanner settings for the < 15 age group.

Despite these findings, it is important to stress that the absolute cancer risks associated with CT scans are small. The absolute lifetime risk, as estimated in the literature, is about 1 case of cancer per 1000 CT scans performed, with a maximum incidence of 1 in 500 patients scanned. Strong justification exists for the continued use of CT scanning in pediatrics. However, once again, a careful assessment of the risk/benefit equation remains paramount, as does a commitment to reducing patient exposure to medical radiation to the minimum necessary to obtain results (Brady, Frush, Huda, Bront, 2007) [5].

Where CT is used in pediatric settings, several immediate steps and long term strategies can be put in place to help safeguard patient safety. From a process perspective, specialists should:

1. Minimize use of ionizing radiation based procedures like CT on children, opting for non-ionizing options such as ultrasound or magnetic resonance imaging (MRI) whenever possible.
2. Adjust exposure parameters for pediatric CT based on development of size/weight based protocols, and on the limitation of radiation to the smallest necessary area.
3. Adjust settings for pediatric CT to reflect the area being scanned - lower mA and/or kVp settings should be considered for skeletal, lung and some angiographic and follow up scans.
4. Limit scan resolution to ‘adequate for diagnoses. The highest definition images are not always necessary, but expose patients to more radiation.
5. Limit the use of multiple scans-usually taken at different phases of contrast enhancement, these are rarely necessary for diagnosis, but considerably increase the radiation dose and risk.

Magnetic resonance imaging (MRI)

An alternative form of imaging that has been developed over the last 40 years is that of magnetic resonance imaging (MRI). This uses radio frequency radiation from the far left hand end of the electromagnetic spectrum displayed earlier. This radiation is low energy and cannot directly damage tissue or DNA. It should be noted, however, that if enough of this radiation is introduced to the body then it can cause tissue heating that could then cause damage and MRI scanners have strict limits on the quantity of radio frequency radiation in order to avoid this.

For the vast majority of MRI the radiofrequency magnetic field is used to excite the hydrogen nuclei that then emit a signal that decays away in the timescale of tens of milliseconds. The signals on MR images depend firstly on the density of hydrogen nuclei or protons in the water or fat based tissues and then on many other factors including so called relaxation times, flow and diffusion. The weighting of the numerous other factors can be altered by modifying the so called MRI sequence and this gives great potential to MRI for characterizing different soft tissues or measuring blood flow for example. Cardiovascular MR sequences have been developed for a wide range of applications including cine imaging for measurement of cardiac function, various methods of characterizing the myocardium and identifying damaged tissues therein, measurement of myocardial perfusion, measurement of bulk blood flow and flow patterns in the heart and blood vessels and angiographic imaging of the vasculature.

Potentially, one of the most important applications is the ability of MR to image and characterize disease in the vessel wall, as this could enable detection of cardiovascular disease at a much earlier stage than at present. Imaging the vessel wall is challenging particularly in the coronary arteries which move not only during the cardiac but also the respiratory cycle. This is now possible, however, by using motion tracking techniques such as described by Scott *et al.* (2011) [21].

Methodology

The research design used is a survey research design, this is because the survey design allowed investigation of possible relationships between variables. In this way the survey design was more appropriate for the study because it enabled data collection from broader category as well as comparisons between variables. Questionnaire will be used as the instrument for collecting data for this study.

The research participants were patients drawn from radiotherapy services in three government-owned hospitals in Bauchi State. These health facilities are: 261 Nigerian Air Force Reference Hospital Bauchi, Abubakar Tafawa Balewa University Teaching Hospital Bauchi and State Specialist Hospital Bauchi.

Table 1: Population of the Study

S/N	Hospitals	Average patients' monthly visits to radiology department
1.	261 Nigerian Air Force Reference Hospital Bauchi	58
2.	Abubakar Tafawa Balewa University Teaching Hospital Bauchi	60
3.	State Specialist Hospital Bauchi	54
	Total	172

Inclusion criteria

All patients that go for radiation procedures in 261 Nigerian Air Force Reference Hospital Bauchi, Abubakar Tafawa Balewa University Teaching Hospital Bauchi and State Specialist Hospital Bauchi, Bauchi State.

Exclusion criteria

All medical personnel working in the Radiology Department of the three hospitals

Ethical clearance: Ethical clearance was obtained from the ethics committee of Bauchi state Ministry of Health, Bauchi State

Result

Simple percentage, mean and standard deviation were used in analyzing the data. The Statistical Package for the Social Sciences (SPSS) was used to run the analysis of the data.

Demographic Information of the Respondents

The demographic information of patients undergoing medical imaging in Bauchi metropolis is presented below.

Table 2: Patients' Demographics

S/N	Variables	Categories	Frequency	Percentage
1	Gender	Male	117	68.02
		Female	55	31.98
		Total	172	100
2	Age	1-15 years	59	34.30
		16-25 years	56	32.56
		26-35 years	31	18.02
		36-50 years	17	09.88
		51 years and above	9	05.24
		Total	172	100
3	Educational Qualifications	Non-formal	15	08.72
		FSLC	32	18.61
		O' Level	67	38.95
		ND/NCE	35	20.35
		HND/BSC	20	11.63
		MSC	3	01.74
		Total	172	100

Table 2 shows the demographic of the respondents contacted for the study. 68.02% of them are male while 31.98% are female. 34.30% of them are in the range of 1-15 years, 32.56% in the range of 16-25 years, 18.02% in the range of 26-35 years, 9.88% in the range of 36-50 years and 5.24% in the range of 51 years and above. 8.72% of the responds have non-formal education, 18.61% of them have first school leaving certificate, 38.95% are O' Level certificate (WAEC/NECO) holders, 20.35% of the respondents are holders of ND/NCE while 11.63% of them are holders of HND/BSC and 1.74% of them are Master's Degree Holders.

Research question one

What is the knowledge level of the patients on basic ionizing radiations?

Table 3: Knowledge level of the patients on basic ionizing radiations

	Items	SA	A	N	D	SD	Mean	Std. Dev
1	Ionizing radiations are used in the hospitals to ascertain the body parts of patients	120 (69.8%)	48 (27.9%)	2 (1.7%)	1 (0.6%)	0 (0.0%)	4.67	0.541
2	Ionizing radiations have penetrative abilities	130 (75.6%)	40 (23.3%)	1 (0.6%)	1 (0.6%)	0 (0.0%)	4.74	0.491
3	Ionizing radiations are electromagnetic radiations that do not require material media for their transportation	99 (57.6%)	63 (36.6%)	6 (3.0%)	4 (2.3%)	0 (0.0%)	4.49	0.680
4	Some ionizing radiations are naturally occurring in the universe	140 (81.4%)	27 (15.7%)	3 (1.7%)	1 (0.6%)	1 (0.6%)	4.77	0.566
5	Ionizing radiations can be produced in the laboratory	125 (72.7%)	40 (23.3%)	1 (0.6%)	4 (2.3%)	2 (1.2%)	4.64	0.724

Table 3 indicates that 97.7% of the respondents agreed that Ionizing radiations are used in the hospitals to ascertain the body parts of patients while 0.6% disagreed with the statement of the questionnaire and 1.7% was indecisive concerning the item of the questionnaire. Concerning the second item of the questionnaire, 98.9% of the respondents agreed that Ionizing radiations have penetrative abilities while 0.6% of them disagreed with the statement. 0.6% did not make any choice concerning the statement of the questionnaire. The third item of the questionnaire was answered thus: 94.2% of the respondents agreed that Ionizing radiations are electromagnetic radiations that do not require material media for their transportation while 2.3% of them disagreed with the statement and 3% of them were indecisive. The fourth item was responded to in such a way that 97.1% of the respondents agreed that Some ionizing radiations are naturally occurring in the universe while 1.2% of the respondents disagreed with the statement and 1.7% of them were undecided. The last item of the questionnaire for this research question was answered in such a way that 96% of the respondents agreed that Ionizing radiations can be produced in the laboratory while 3.5% of the respondents disagreed with the statement and 0.6% of them were indecisive.

Research question two

To what extents are patients aware of the risks involving radiations in the hospitals?

Table 4: Patients' awareness of the risks involved in radiations in the hospitals

	ITEMS	SA	A	N	D	SD	Mean	Std. Dev
6.	Ionizing radiations cause change in gene arrangement (mutation)	110 (64.0%)	51 (29.7%)	4 (2.3%)	5 (2.9%)	2 (1.2%)	4.52	0.783
7.	Ionizing radiations can cause skin cancer and other skin-related diseases	160 (93.0%)	12 (7.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	4.93	0.256
8.	Ionizing radiations can reduce the lifespan of an individual	96 (55.8%)	63 (36.6%)	4 (2.3%)	4 (2.3%)	5 (2.9%)	4.40	0.883
9.	Ionizing radiations are hazardous to soft spots in the human body such as the eyes	135 (78.5%)	32 (18.6%)	3 (1.7%)	1 (0.6%)	1 (0.6%)	4.74	0.579
10.	Improper application of ionizing radiations in the course of treatment can bring about complications	141 (82.0%)	22 (12.8%)	4 (2.3%)	2 (1.2%)	3 (1.7%)	4.72	0.728

Table 4 shows that 93.7% of the respondents agreed that Ionizing radiations cause change in gene arrangement (mutation) while 4.1% of them disagreed with the statement and 2.3% of them were undecided. Concerning the second item in the table, 100% of the respondents agreed that Ionizing radiations can cause skin cancer and other skin-related diseases. Concerning the third item in the table, 92.4% of the respondents agreed that Ionizing radiations can reduce the lifespan of an individual while 5.2% of them disagreed with the statement and 2.3% of the respondents did not make any choice in this regard. The fourth item in the table was answered thus: 97.1% of the respondents agreed that Ionizing radiations are hazardous to soft spots in the human body such as the eyes while 1.2% of them disagreed with the statement and 1.7% did not make any choice on that. The last item on the table was answered in such a way that 94.8% of the respondents agreed that Improper application of ionizing radiations in the course of treatment can bring about complications while 2.9% of the respondents disagreed with the statement and 2.3% did not make any choice in this regard.

Research question three

To what extents are patients aware of the safety measures to be considered when using radiations?

Table 5: Extent to which patients are aware of the safety measures to be considered when using radiations

	ITEMS	SA	A	N	D	SD	Mean	Std. Dev
11.	Radiation rooms are only open to authorized persons only in the hospital	100 (58.1%)	63 (36.6%)	3 (1.7%)	4 (2.3%)	2 (1.2%)	4.48	0.753
12.	Personal Protective Equipment for the art of radiography are available in the radiology of the hospital	120 (69.8%)	46 (26.7%)	2 (1.2%)	3 (1.7%)	1 (0.6%)	4.63	0.658
13.	Safety signs and warnings present in the radiography wards pass adequate information concerning radiations safety	130 (75.6%)	40 (23.3%)	0 (0.0%)	1 (0.6%)	1 (0.6%)	4.73	0.552
14.	Safety inscriptions in the hospitals are written in various languages	136 (79.1%)	35 (20.3%)	1 (0.6%)	0 (0.0%)	0 (0.0%)	4.78	0.426
15.	The staff of the radiology department seldom give orientation to the patients on radiation safety	150 (87.2%)	19 (11.0%)	2 (1.2%)	0 (0.0%)	1 (0.6%)	4.84	0.476

Table 5 indicates that 94.7% of the respondents responded that Radiation rooms are only open to authorized persons only in the hospital while 3.5% of them disagreed with the statement and 1.7% were indecisive. The second item in the table was answered in such a way that 96.5% of the respondents agreed that Personal Protective Equipment for the art of radiography are available in the radiology of the hospital while 1.2% of them out rightly disagreed with the statement and 1.2% of them did not make any choice. The third item was responded to in such a way that 98.9% of the respondents agreed that Safety signs and warnings present in the radiography wards pass adequate information concerning radiations safety while 1.2% of them disagreed with the statement and all respondents did make a choice in this regard. The fourth item in the table was answered in such a way that 99.4% of the respondents agreed Safety inscriptions in the hospitals are written in various languages while 0.6% of them were indecisive. The last item of the table was answered thus: 98.2% of the respondents agreed that the staff of the radiology department seldom give orientation to the patients on radiation safety while 0.6% of them disagreed with the statement and 1.2% did not make any choice in this regard.

Major Findings

The patients have basic knowledge on ionizing radiations. Such knowledge include them knowing that Ionizing radiations are used in the hospitals to ascertain the body parts of patients before surgeries are performed on patients. They also know that Ionizing radiations are electromagnetic radiations that do not require material media for their transportation and some ionizing radiations are naturally occurring in the universe.

a. The respondents opined that they are aware of some side effects of ionizing radiations. They are aware that ionizing radiations cause mutation, skin cancer and related infections, irritations on the skin, killing of vital cells in the body. They were of the opinion that the side effects of these radiations can reduce the life span of an individual.
b. The patients are aware of the safety measures put in place in the hospital to avoid excessive exposure to radiation. They are aware that radiation rooms are only open to authorized persons only in the hospital, Personal Protective Equipment for the process of radiography are available in the radiology of the hospital, safety signs and warnings present in the radiography wards pass adequate information concerning radiations safety and safety inscriptions in the hospitals are written in various languages.

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