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Investigation of the Effects of Diagnostic Radiology Using Patients' Doses in Argungu General Hospital, Kebbi State, Nigeria

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Abstract

Thermoluminescent dosemeters (TLDs) have been used to measure the entrance surface doses(ESDs) of patients undergoing pelvis, abdomen and lumbar spine diagnostic X-ray examinations. Entrance surface dosefrom the investigationthe effect of diagnostic radiology by using patient doses undergoing in Argungu General Hospital. The air kerma for each patient was measured using thermoluminescent dosimeter chips (TLD). The air kerma for each patient was then multiplied by a back scatter factor to obtain the Entrance surface dose. Generally doses obtained in this study were found to be higher than those in published works and International Atomic Energy Agency recommended limits for chest examination. The doses obtained for skull PA/AP, skull lateral, lumber spine lateral, lumber spine AP, hip AP, chest PA, chest lateral and abdomen AP examination were found to be within acceptable International Atomic Energy Agency recommended limit.All the results were discussed using patients' data, machine-specific data and the technical parameters used for the examinations. Comparison with published values showed that the doses reported in this work were generally lower than the International Atomic Energy Agency (IAEA) dose reference levels due to the regulatory activities in these centres, thereby making their examination better optimized.

INTRODUCTION

Radiology is a branch of medicine using radiation for the diagnosis and treatment of disease. Radiology originally involved the use of x-rays in the diagnosis of disease and the use of x-rays, gamma rays, and other forms of ionizing radiation in the treatment of disease [1]. X-rays are a form of energy, similar to light and radio waves. X-rays are also called radiation. Unlike light waves, x-rays have enough energy to pass through your body. The process can be used to diagnose a number of problems, such as broken bones, blood clots, and heart conditions; moreover, even gastrointestinal conditions can be diagnosed with this method. This method is effective to diagnose severe diseases such as breast cancer. The radiologist is a specially trained physician who can examine these images on a monitor [2,3]. The monitor is like a computer display. It allows the radiologist to see very fine detail of the structures in your body [4].

The first ultrasound allowing physicians to visualize a fetus in utero was performed in 1958. Imaging techniques that are now routine were developed more recently. The first computed tomography (CT) machine was used commercially in 1971 followed by the first magnetic resonance imaging (MRI) in 1979. The first positron emission tomography (PET/CT) scan was performed in 1998 with acceptable levels recommended by the ICRP [5]

According to [4], the minimum energy required to ionize an atom, i.e. to remove an electron, is known as the ionization potential. For elements, its magnitude ranges from a few electron volts for alkali metals to 24.5 eV for helium. For water, it is 12.6 eV. Electromagnetic radiation of frequency higher than the near-ultraviolet region of the electromagnetic spectrum is ionizing, whereas electromagnetic radiation with energy below the far-ultraviolet region (e.g. visible light, infrared and radiofrequency) is non-ionizing. This research is aimed at investigating the patients' doses from radiological examinations in Argungu General Hospital, radiology department and the specific objectives are: to investigate the risk of diagnostic radiology, in order to estimate the absorbed doses of the patient, to determine the effect of diagnostic radiology in patient doses at Argungu General Hospital, to study the diagnostic patient radiological doses in Argungu General Hospital and to measure the patient's doses in order to practice as an aid to the optimization of patient protection.

MATERIALS AND METHOD

Materials

In this research, the materials to be used are shown below in table 3.1;

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Table 2.1. Materials and their uses

Materials	Uses
Thermoluminescent Dosimeter (TLD)	Used to measure the entrance the entrance surface dose
Shielding/Apron	Used to protect myself from radiation
X-ray Mobile Machine	Used, to take the picture of Hand, Skull etc.
Chest X-ray Machine	Used in taking the imaging of the Chest

Method

The effect of diagnostic radiology using patient doses in Argungu General Hospital will be investigated. In this case, x-ray machine will be used for Hand X-Ray, Chest X-ray, Abdominal X-ray, Skull X-ray, Pelvis X-ray, Cervical Spine X-Ray, Thoracic Spine X-Ray, Lumber Spine X-Ray, Dental x-rays and Dislocation of the bone respectively.

Thermo luminescence dosimeter chips will be placed at positions within the X-ray room chosen because of their importance in determining dose to patients, workers and public.

The TLD chips will be attached on the changing gowns of the sample patient, on the area of interest for the investigation with a cello tape. Several cases will be examined under eight projections, including abdomen, chest, cervical spines, thoracic lumbar spines, hip joints, skull and pelvis. All the patients were of the average build, 30 to 35cm chest width, 60 to 70 kg weight, between 20 and 40 years of age. After the exposure, the TLD chips were taken to the Centre of Energy Research and Training for reading.

Plate 2.1 shows an x-ray machine detecting the effect of diagnostic radiation doses using the patient doses.

Plate 3.1. Mobile X-ray Machine

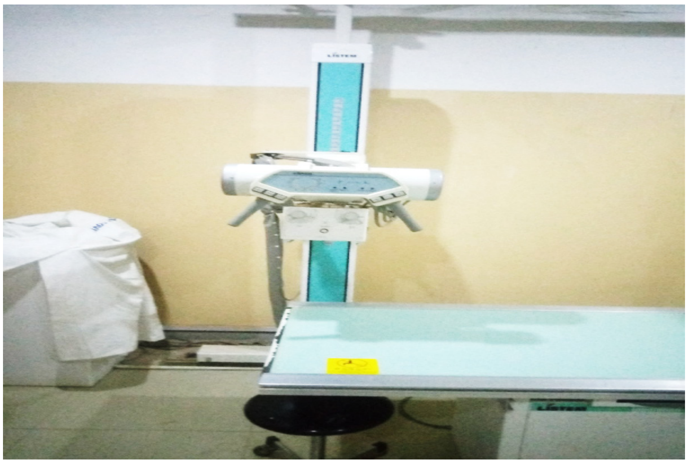

Plate 3.2. The Static/Stationary X-ray MachinePlate

Plate 3.3. Chest X-ray Machine

RESULT AND DISCUSSION

Results

Table 3.1. Comparison of measured ESD with reference level

Routine examination	Measured (mSv)	IEAE reference level
Abdomen-AP	8.30	10
Chest-PA	0.15	0.4
Chest –lateral	0.55	1.5
Hip-AP	13.50	10
L. S-AP	5.65	10
L. S-lateral	15.00	30
Skull-AP/PA	1.38	5
Skull-lateral	3.30	3

Table 3.1 shows the results of the experiment performed to obtain the entrance dose using parameters specific to the machines and operating condition at General Hospital Argungu.

From the result in table 4.1 the lumbosacral spine lateral projection has the highest entrance surface dose to the patients having 15.00 mSv, it is below the IAEA guidance level for lumber spine lateral of 30mSv, and the reason for the high value may be as a result of high tube charge (mAs) use for lumber spine lateral x-rays. The entrance dose of Hip AP is 13.50 mSv, which it is slightly higher than the IAEA 10mSv for the Hip AP. The Chest PA has the entrance dose has the lowest value of 0.15mSv where the IAEA level has the value level of 0.4.

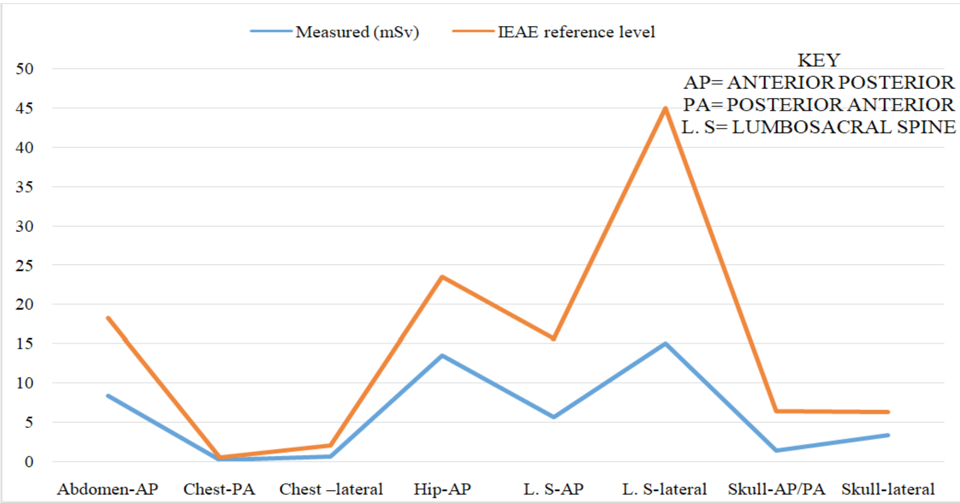

Figure 3.1. Graph of the Comparison of measure ESD with reference level

Table 3.2. Comparison of Calculated ESD with IAEA reference level

Routine examination	Calculated ESD	IEAE reference level
Abdomen-AP	10.05	10
Chest-PA	0.50	0.4
Chest –lateral	3.00	1.5
Hip-AP	13.40	10
L. S-AP	18.00	10
L. S-lateral	14.60	30
Skull-AP/PA	8.35	5
Skull-lateral	12.00	3

Table 3.2: shows the results of the experiment performed to obtain the entrance dose using parameters specific to the machines and operating condition at General Hospital Argungu.

From the table above shows that the L. spine AP has the highest value having 18.00 mSv where IEAE has less value of 10 mSv.

Also the L. spine Lateral has the value of 14.60 mSv where the IEAE has the highest value of 30 mSv. Hip AP has the value of 13.40 and the IEAE level of 10. The skull lateral has the value of 12.00mSv where the IEAE level is 3.00 and the Skull-AP is 8.35 and reference level of 5.00. The Abdomen AP has the value of 10.05 mSv and the reference level of 10. The chest lateral has the high value than that of chest PA of 3.00 and the IEAE reference level of 1.5 where chest PA has the lowest value of 0.50mSv and its IEAE reference level of 0.40

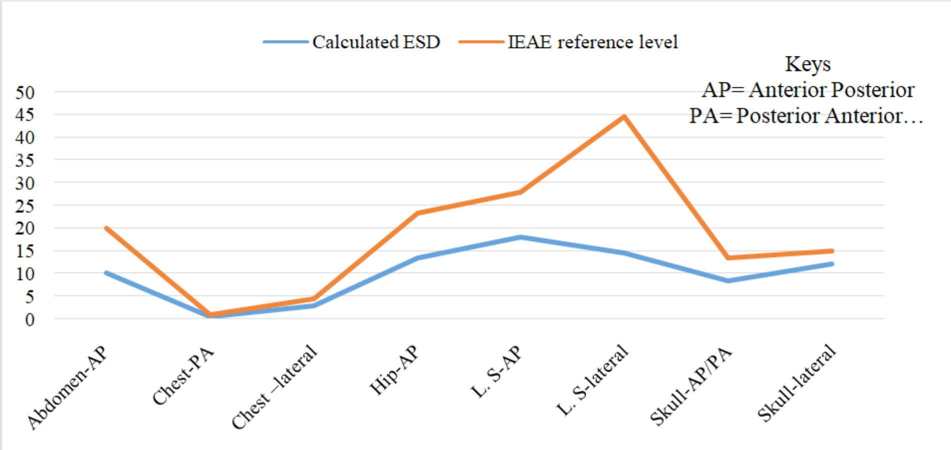

Figure 3.2. Graph of the Comparison of measure ESD with reference level

Scattered Dose to the Environment

The measured equivalent dose at various positions of interest are shown in table 4.3 and displayed in the values shown in table 3.3 include the background which had been estimated to be 0.034 mSv in Argungu.

Table 3.3. Scattered radiation in x-ray room of General Hospital Argungu

Position	Measured Dose (mSv)	Measured Dose (mSv)	Measured Dose (mSv)	Measured Dose (mSv)
1	0.04	0.20	0.90	0.36
2	1.05	0.76	0.80	0.80
3	0.50	0.45	1.00	0.65
4	0.12	0.06	0.13	0.10
5	0.06	0.05	0.21	0.09

In table 3.3 the measured scattered doses in the X-ray room are higher than the estimated background radiation of 0.036 mSv. In General Hospital Argungu. The scattered dose in the changing cubicles is 0.39 mSv and is higher than the background radiation.

The radiographer working in the control console will receive 0.80 mSv which is much higher the background radiation. Around the window, the scattered dose is 0.65 mSv.

This is eighteen (18) times higher than the background radiation. So anybody passing near the window of the x-ray machine will receive about eighteen times the background radiation. The left side of chest stand has 0.1 mSv which is the lowest scattered dose in the very dangerous room, this is about three (3) times the background radiation.

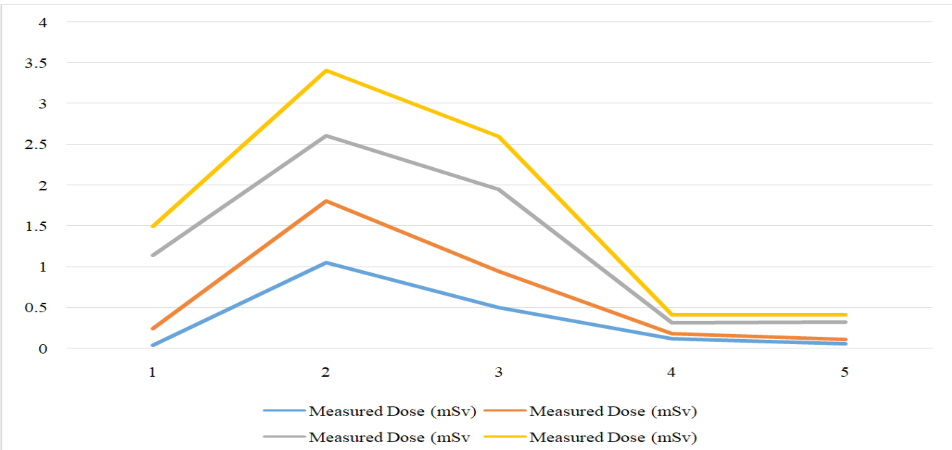

Figure 3.3. Graph of the Comparison of measure ESD with reference level

Discussion

The entrance surface doses of selected routine examinations conducted in General Hospital Argungu showed these vales and impressions for patient dose.

Abdominal X-ray: anterior- posterior projection's measured entrance of surface does 8.30 Gy which is below the IAEA reference level of 10 Gy. While the calculated does from Kumar's formula gave 10.26 Gy, this value is higher than the IAEA reference level. The exposure factors selected for abdomen. This is as a result of the age of the machine and its constant breakdowns. The entrance surface doses for hip x-ray is 13.50 mSv using TLDs for AP. The AP projection has IAEA reference dose for 10 mSv.The entrance surface doses for lumber spine x-rays are 5.65 mSv for AP. These values are higher than the reference levels. This may be due to high mAs used for lateral and AP projections and also the age of the machine.The entrance surface doses to patients for skull AP are 1.38 mSv for AP and 1.38 mSv for PA. These values are below the IAEA reference doses of 5 mSv respectively. But the calculated doses are 8.45 mSv for AP and 11.25 mSv for lateral. These values are much higher than the IAEA reference doses.The entrance surface dose for skull is 1.38mSv for AP and 3.30 mSv for lateral projections. These values are below the IAEA reference doses of 3mSv and 15mSv respectively. This may be as a result of increased mAs for the examination, and reduced current to the machine.The results obtained in this study are consistent with findings in [6,7,8,9], which show that patient doses can exceed recommended reference levels due to high exposure factors (mAs) and aging or poorly maintained X-ray equipment. However, some measured doses that fall within standard limits also agree with established studies indicating that proper optimization of imaging parameters can significantly reduce patient radiation exposure.

CONCLUSION

Radiations dose delivered to patients from the routine examinations measured are generally less than the IAEA references doses for the routine examinations indicated. The doses delivered per square area of the routine examination are not within the IAEA reference doses indicated for the routine examination investigated except for pelvic examination which has more dose per square area than the reference dose.The doses to workers at the control console are three times higher than the background radiation.

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