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Medical Application Of Nuclear Physics In Pawie Hospital Metekel Zone Benishangul Gumuz Region North West, Ethiopia

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ABSTRACT

The purpose of this study is to give some remarkable guidance on the safety precautions when using radioactive sources and hazards of nuclear radiations. The main objectives of this study is to measure how much medical workers specifically Pawi General Hospital laboratory workers have the knowledge of application of physics in medicine and to improve the cooperation among physicists, physicians and radiologists in using radioactive sources. Therefore, the study leads the readers to get some information about uses of radioactive substanes in different fields including education, industry, agriculture, medicine, etc… and some techniques of using radioactive isotopes.

During the study all seven doctors of the hospital (two of them are the hospital manager and emergency room director) and four laboratory technicians were interviewed using structured and pre-tested questionnaires and all their response is recorded by the data collectors. Before the interview clear orientation was given to them by the researcher about the purpose of the interview and what they will be asked. After the data collection has been completed, analysis has been made according to the objective of the study. Finally, elementary statistical analysis were used to improve understanding on the development of nuclear diagnostic techniques, and to explains the peaceful use of nuclear facilities in Ethiopia among physicists, physicians and radiologists.

The result obtained from the study show that almost all of the doctors have a positive attitude to work with physicists; there is lack of available radioactive sources for laboratory rooms; majority of the laboratory workers did not use the safety precaution of radioisotopes; and the doctors know the application of nuclear physics in medicine. Based on the result obtained it is recommended that: the laboratory technicians must take care that safety measures needed when handling and using radioisotopes as well as they must keep them in a sealed container; when using radioactive source it should be handled with tongs or forceps, never with body parts and it should be kept at arms' length distance pointing away from the body.

KeyWords: *Application, Medical, Hospital, Nuclear Physics*

1. Introduction

1.1 Background of the Study

Everyone knows that radiation have many applications in different fields such as in industry, agriculture, medicine etc. For example, the medical applications of radiation is to treat cancer. It destroys the cancerous cells while treatment is designed to protect non–cancerous cells. For example the use of iodine-131, in the form of iodine chloride, which is used to treat thyroid cancer. When the patient takes the radioactive substances orally, the chemical travels to the thyroid and its radiation treats the disease.

Roentgen's discovery of X–rays in 1895 was quickly followed with their application to medical diagnosis. Because X–ray travel easily thorough soft body tissue but are strongly attenuated by bone, X-ray photographs can reveal the detailed structure of the human skeletal system and is of course in voluble in medical diagnostic procedures leading to the resetting of broken bones. Two disadvantages of X–ray photograph that limit its usefulness are it is not very effective in differentiating between different types of soft tissue and it produce a flat, two–

dimensional image even it reveals an abnormality.

In 1896 Becquerel, while he is studying the effect of X-rays on a fluorescent salt of uranium, found that the salt emitted the radiation even without being irradiated by X–rays.

1.1 Objectives of the Study

1.1.1 General Objectives

The general objectives of this study are:

- To improve the cooperation of physicists with physicians and radiologists on the development of nuclear diagnostic techniques, and
- To explains the peaceful use of nuclear facilities in Ethiopia.

1.1.2 Specific Objectives

The study have the following specific objectives:

- To identify the radiation which is most suitable for medical uses,
- To identify the attitudes of the doctors and lab technicians towards the application of nuclear physics in medicin, and
- To measure how much the doctors and laboratory technicians in Pawi General Hospital have the knowledge of radiation in cancer treatment and safety precaution when using radioactive sources.

1.2 Statement of the Problem

This study is designed to give some direction for those who are using the radioactive substances in hospitals and schools, especially in hospital, because radioactive sources, which are used in school, are usually very weak and they can only be used in the presence of an authorized teacher. Specifically, this study is done on Pawi General Hospital laboratory rooms by exchanging different information with the lab room workers. The research was done on the following formulated questions:

- What is radiation? And which is suitable for medical uses in hospital?
- How gamma emitting radioisotopes can produce an image of a specific area inside the body?
- What is the level of the doctors towards the use of X–rays in cancer treatment?
- What are expectations of doctors towards the techniques of using X–ray photographs?

1.3 Significance of the Study

We know that radiation has wide application indifferent fields. For example, cancer is often treated with some combination of radiation therapy. Therefore, this study significantly explains uses of radiation or techniques of using radioactive sources in our daily life specially in Hospitals which is used in treatment of humanbieng. It expected that, the study points out ways or directions for every individuals who use radioactive isotopes for treatments or other uses. It is known that, cancer is a dangerous disease in our world today and therefore this study also expected to enhance the use of radiation or radioactive isotopes, which destroys the cancerous cells, with treatment is designed to protect non–cancerous cells.

1.4 Scope of the Study

The study was delimited on the medical use of nuclear radiation in Pawie General Hospital. I was discussed with hospital workers specifically with the radiologist and laboratory technicians on different issues and we are tried to solve some listed problems under objective of the study as it is written under different topics in the body of the research proposal.

1.5 Limitation of the Study

The study has many limitations. These include:Shortage of time.

- Financial shortage
- Shortage of resources
- Location of the hospital from my working area
- Lack of available data

2. Review Of Related Literature

2.1 Medical Application of Physics

Medical physics examines and applies numerous aspects of nuclear science to medicine. Medical physicists rarely have a direct contact with patients, but are a part of many treatment teams. For example, medical physicists decide the numbers of radiation based cancer treatment to calculate precise dosages, maintain radiation equipment, and ensure that imaging devices such as Computed Tomography (CT) scanners and Magnetic Resonance Imaging (MRI) are properly functioning.

2.2 Uses of Radioactive Substance

Radioisotopes have wide applicants in different fields including:

1) **Education:** Different properties of α, β and γ-rays can easily be studied with the help of radioisotopes emitting a particular radiations. For example, the absorption coefficient of different substance for these different rays can easily be measured. Radioactive indicators have been used on the determination of the solubility of carefully soluble substances.

2) **Industry:** We know that X-rays can detect cracks and defective weldings etc. Similarly, γ-rays emitted from Cobalet-60 ($_{27}Co^{60}$) can also put to similar use.

3) **Agriculture:** Certain types of fertilizers are more suitable for particular types of soil. By using fertilizers mixed with radioisotopes or radio phosphorus it is possible to choose the most suitable fertilizer for a particular soil and crop. To protect the crops, a large number of male insects are bred in laboratory and sterilized with α-particles are released to the insect infected area.

4) **Medicine:** Radioisotopes used in diagnosis of disease where other conventional methods have failed. For example, the position and size of a tumor in the brain can easily be known by the following method. Tumor tissue absorbs more radioisotopes than normal tissue. So, small quantity of radioisotopes is injected into the body with organic dyes. After sometimes radioisotope will accumulate at the tumor, which can be detected by detectors. Similarly, the use of radioisotopes for the poroper functioning of thyroid gland is clear. Radiations from radioisotopes of Cobalet-60 ($_{27}Co^{60}$) are used for controlling the development and growth of some types of cancer cells. Leukemia can be treated by the radiation from radio isotope of phosphorus and iodine respectively.

2.3 Some Application of X-rays

2.3.1 Medical and Biological Use

X-rays shadow photographs are called Radiographs are used to detect: fractures of bones, location of foreign matter like nails, bullets etc, in human body, disease like tumors, tuberculosis and stones in kidney, gall bladder etc.

2.3.2 Scientific Uses

X-rays are used to investigate:

- Structure of crystals.
- Structure of atoms and molecules.

2.4 Some Techniques of Using Radioisotopes

The development of techniques in experimental nuclear physics has permitted parallel development in medical imaging, gamma ray cameras, specialized accelerators for producing medical isotopes, and remarkable techniques for obtaining images at specified depth within the body. This branch of research practitioners are often nuclear physicists who work in close association with physicians in developing and applying the techniques.

The gamma emitting radioisotopes can be used to produce images of specific area of the body. The very simple application of these techniques is the measurement of iodine uptake by the thyroid gland. Radioactive is orally ingested and a gamma ray counter placed near the neck measures the increase in activity with time as iodine is concentrated in the thyroid. Originally, Iodine–131 was used for this purpose, it is a fission period of hours with half life is far too long the activity lingers in the body and results in large radiation dose to the patient.

Kidney function is also studied a compound labeled with Iodine–131 (sodium iodohippurate) which is administered intravenously. A γ-detector views each kidney and comparisons of the rate of uptake of Iodine–131 by the two kidneys can reveal disorders. One of the most remarkable developments in imaging techniques has been the field of tomography, which is capable of imaging a particular 'slice' of the internal structure of the body either through externally incident X–rays or internally introduced radio–isotopes. The X–tube and the film are moved simultaneously in opposite directions so that a fixed point of a section trough the body maintains its images on the film.

2.5 Hazards of Nuclear Radiation

Radioactive sources need to be bundled with extreme care. Safety precautions must be taken when using them. Ionizing radiation can interact with human. There may be so much situation that cells die as a result of where there is less ionization, the molecules of Deoxyribonucleic Acid (DNA) in the cell may change slightly, which could cause the cells to have an increasing tendency to become cancerous. Because the radiations ionize at different extents, the hazard is also at different level. Ionizing radiation has sufficient energy to affect the atoms in living cells and thereby damage their genetic material (DNA). Fortunately, the cells in our bodies are extremely efficient at repairing this damage. However, if the damage is not repaired correctly, a cell may die or eventually become cancerous.

Exposure to very high levels of radiation, such as being close to an atomic blast, can cause acute health effects such as skin burns and acute radiation syndrome ("radiation sickness"). It can also result in long-term health effects such as cancer and cardiovascular disease. Exposure to low levels of radiation encountered in the environment does not cause immediate health effects, but is a minor contributor to our overall cancer risk. The hazards are summarized in the table below.

Types of radiations	Inside the body	Outside body
Alpha (α) radiation	Highly ionizing, very dangerous radiation, poisoning and a possible cancer causing	Absorbed by surface layer of dead skin cells-and has no danger.
Beta (β) radiation	Moderate ionization and danger should be minimized	ionization has danger hence close exposure should be minimized
Gamma (γ) radiation	Minimal ionization, cancer danger from long-term exposure.	Minimal ionization cancer danger from long-term exposure

Table 2.1 Hazards of radiation inside and outside of the body

3. Methodology

3.1 Sampling Method and Sampling Size

The hospital has 15 doctors and 45 nurses and 15 laboratory technicians. To conduct this study intiltled with medical application of nuclear physics seven medical doctors are randomly selected, who are expected to have a knowledge about radioactive sources specifically in Pawi General Hospital. Five close ended questions were included in the questionnaire. The questionnaire were provided for the selected medical doctors to answer and collected some relevant informations or data.

To get more important and relevant information about radiation or radioactive isotopes, in addition to seven doctors (two of them are the hospital manager and emergency room director) and four laboratory technicians were also chosen. The instruments that are implemented in this course of study are questioner, observation during treatments and interview**.**

3.2 Study Area

Ketena-2 Village-7 town is the capital of Pawi district of Benishangul Gummuz region is located 555 km North of West of Addis Ababa. The study was conducted on Pawi General Hospital which is located at the west of the town. The total population of Pawi hospital is 10 medical doctors 45 nurses, 15 laboratory technicians and 83 supporting stuffs. The town is bounded on East Pawi Agriculture Research Institute and Military Camp, on west Ketna 2 Vilage 114; on North Diga Dum and on South Dandur Kebele.

3.3 Study Period

The study was conducted from February 15, 2016 to June 20, 2016.

3.4 Study Design

A community based cross sectional study

3.5 Population

3.5.1. Source population

The total population of Pawi hospital is 15 doctors 45 nurses, 15 laboratory technicians and 83 supporting stuffs

3.5.2. Study population

A sample of 7 doctors of 4 laboratory technicians were chosen for the project

3.6 Ethical Consideration

Formal letter were written from Pawi Education and Capacity Building office to Pawi General Hospital in order to conduct the study and the objective of the study will be discussed with the hospital management bodies to obtain their cooperation, in addition; the member of the hospital were requested their willingness to give the necessary information during data collection.

4 Result and Discussion

The closed ended question provided to the seven medical doctors and their responses are presented or summarized as follows:

Question 1: What do you think about the application of nuclear physics? All selected hospital workers are asked and they give similar answers for the this uestion. The replied the application of nuclear physics includes: fission and fusion, power, radioactive dating, crystal structure determination, and so on. Everyone knows the common known application of nuclear physics such as nuclear power generation and nuclear weapons technology. They also said that related to our proffesion many of the methods and practices of nuclear physics have found a great applications in diagnosis and treatment of disease such as cancer. The said in our hospital we have lack of available radioactive sources and we are using some with care and proper way asmuch as possible.

Question 2: Can you list some types of radiation or radioactive sources, which are most suitable for medical uses and you are using for treatment? There are different types of radiation used for treatment such as …. but as we have mentioned in question one there is a lack of available radio active sources and laboratory rooms. We are using X-ray photograph which is used to reveal the detailed structure of the human skeletal system and the gamma emitting radio isotopes that can produce an image of the specific area of the body.

Question 3: Can you explain some types imaging techniques and their purpose outside human body?
The responses of this questions are summarized or explained in table as follows:

No	Techniques	Purpose
1	Scanning techniques	To produce an image of the brain
2	Computerizing tomography	To produce particular slice of the internal structure of the body
3	Positron-emission tomography	To show the density of tissue
4	Nuclear magnetic resonance	To enlarge static magnetic field and time varying measurement in radiofrequency

Table 4.1 Techniques of using radioactive sources

Question 4: What do you think about the disadvantages and hazards of radioactive substances? They said that even if there are application of nuclear physics in medicine, radioactive substances have disadvantages and hazards on the human body. For example radioactive materials emit penetrating, ionizing radiation that can injure living tissues or can interact with human cells. These ionization sometimes may results in cells to die and cuase cancer. Therefore, radioactive substance has hazards and need to be handled with extreme care.

And X-ray photography, has limitation as disadvantage, that is it is not very effective in differentiating between different types of soft tissue and they produce a flat, two dimensional image that even if it reveals in abnormality would not indicate the depth of that abnormality within the body.

Question 5: What do you expect from physicists in using radioactive sources? They replied that, since there are different applications of physics in medicine physicist are always expected to work in collaboration with physicians and medical experts to improve this application in treatment of patients. Mostly, techniques for obtaining images at specified depth within human the body is important in hospitals, for example using γ-detectors are some remarkable mechanism in the measurement of iodine uptake by the thyroid gland. Such techniques require knowledge of physics.. Therefore, it is important for physicians to cooperate with physicists specifically with nuclear physicists to develop and use the technology. Physicians always need different research product from physicists for the advancement of medical equipments as well asreduce the disadvantages of radioactive substances and to increase the effective use of nuclear physics in medicine. Hence physicists are expected to fill such gaps by doing researchs and helping medical experts.

5. Conclusion

Generally, the study is to improve the cooperation of physicists with physicians and to reduce the hazard of radioactive substances specifically on Pawi hospital.
Based on the response of the doctors I would like to conclude the study as follows:

- Almost all doctors and lab technicians have a positive attitude towards the application of nuclear physics and to work with physicists
- There is a lack of available radioactive sources for laboratory rooms.
- Majority of the laboratory workers did not use the safety precaution of radioisotopes.
- The doctors know the application of nuclear physics in medicine and are using radiation in disease treatments

Based on the response of health workers for question asked, I would like to recommend the following:

- The hospital should consider or work in focus in the application of nuclear physics in medicine today.
- The hospital should make available radioactive sources for laboratory rooms.
- Laboratory workers must use safety measures needed when handling and using radioisotopes and they must keep in a sealed container.
- When using radioactive source it should be:
    1. Handled with tongs or forceps, never with the body.
    2. Kept at arms' length distance pointing away from the body
    3. Always kept as far as possible from eyes.
    4. Hands must be washed after finished and definitely before eating.

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