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Assessment of radiation knowledge and awareness among nursing staff working in a nuclear medicine department

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RESEARCH

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ABSTRACT

Background
Nuclear medicine (NM) involves the use of radioisotopes (radiopharmaceuticals) for either diagnostic or therapeutic purposes which emit ionizing radiation used for image formation. Despite patient benefit from medical radiation, the nursing staff caring for patients administered with radioisotopes may be exposed due to limited knowledge of radiation protection principles since they do not undergo formal training. Exposure my raise the risk of cancer induction among nurses.

Aims
This study aimed at evaluating radiation knowledge and awareness among nurses working in a NM department (NMD).

Methods
A cross-sectional study, using a validated questionnaire, demographic information (age, gender, work experience), radiation knowledge and related training as well as awareness were measured among a group of consenting nurses.

Results
A total of 5 nurses participated in the study mean with age 45 and age range 20 – 60 years. Eighty percent (4/5) nurses showed limited knowledge of radiation and awareness of radiation protection principles irrespective of years of service. All nurses expressed fear of radiation exposure from patients.

Conclusion
Efficient execution of nursing duties in a NMD may be compromised by lack of formal training in radiation protection. Conducting work on radiation protection and providing nurses with self-study material can boost their moral and improve their efficiency while caring for patients in radioactive environments such as a NMD.

Key Words
Nurses, nuclear medicine, radiopharmaceuticals, ionizing radiation, radiation safety, radiation awareness, knowledge

What this study adds:

1. What is known about this subject?
Working in radiation environments with limited knowledge on radiation protection and lack of awareness leads to exposure and raises the risk of cancer induction.

2. What new information is offered in this study?
Nurses working in radiation environments such as NMD have limited knowledge of radiation protection principles.

3. What are the implications for research, policy, or practice?
There is need of introducing radiation protection curriculum for continued professional development for nurses working in radiation environments such as NMD.

Background

Medical Radiation

The use of radiation in medicine can be traced as far back as 1895 when Roentgen invented X-rays. Today, the use of radiation in medicine has become routine in the fields of radiology, nuclear medicine and radiation therapy.[1] However, despite the medical benefits of radiation, there are concerns that it can damage living tissue inflicting injury to the deoxyribonucleic acid (DNA). In some instances the cells may repair. The degree of injury is dependent on the type of radiation as well as the quantity of radiation absorbed.[2] Epidemiological studies on survivors of the atomic bombs at Hiroshima and Nagasaki in Japan have elucidated the deleterious effects of radiation.[3] Although small quantities of medical radiation there are no levels of radiation that can be considered as

safe.[1] However, the NM modality contributes less radiation compared to radiology.

Nuclear Medicine

The NM modality plays a significant role in diagnosis and treatment of various ailments.[4] For diagnostic purposes, small quantities of radiopharmaceuticals that target specific body parts (organs) or tissue are administered into the human body.[4,5] The scintigraphy and tomography (single photon emission computed tomography (SPECT) and positron emission tomography (PET) techniques are used to acquire the images of the distribution of the administered radiopharmaceuticals. [5]

Nuclear medicine imaging techniques

The commonly performed scintigraphy (planar imaging) procedures included imaging of salivary glands, lungs, thyroid and the brain. The most common SPECT procedures include suspected brain death, acute stroke and epilepsy.[2] Both techniques acquire images using a gamma camera.[1] The PET technique is well-known for oncology studies which include diagnosis and staging of cancer, as well as evaluation of inflammation and brain diseases.[5]

Radiopharmaceuticals

A radiopharmaceutical is a pharmaceutical preparation with a radionuclide as one of its components. The other component is a chemical moiety that may or may not carry an active biomolecule such as Iodine-131 (^{131}I) and Thalium-201 ($^{201}Tl^{+}$) which are supplied in form of salts.[6] The chemical property of the radiopharmaceutical determines its physiological behaviour and distribution in the body organs and tissue. Nearly 95% of radiopharmaceuticals are used for therapy while the remaining 5% are used for therapy.[7]

Characteristics of radiation emitted by diagnostic radiopharmaceuticals

Diagnostic radiopharmaceuticals decay by gamma emission or positron emission. It is important that these should never emit alpha and beta particles.[7] Technetium-99m (^{99m}Tc) labelled radiopharmaceuticals are mainly used in conventional nuclear medicine imaging due to the easy availability and affordability of ^{99m}Tc from the moleydenum-99m/technetium-99m generator and available variety of kits required for final preparation of radiopharmaceuticals.[6]

Upon reaching its end of distribution in the targeted tissue or organ, the ^{99m}Tc component of the radiopharmaceuticals decays emitting gamma photons that are detected by a gamma camera permitting evaluation of the physiological structure of the organ or tissue.[6] ^{99m}Tc has proven to be an ideal radioisotope because it emits energy of radiation 140 keV and has a half-life of about 6 hours.[1] The most commonly used radiopharmaceutical in PET imaging is fluorine -18 fluorodeoxyglucose (F-18 FDG). The F-18 decays emitting a positron that travels a small distance within the tissue before coming to a halt upon encountering the electron in the tissue (absorber material) resulting in collision and complete annihilation of both resulting in formation two photons of energy 511 keV that move 180^0 apart.[4]

Characteristics of radiation emitted by diagnostic radiopharmaceuticals

Radiopharmaceuticals used for therapy should emit particulate radiation in form of either alpha or beta particles.[4,7] The intended effect of the two particles is to damage diseased cells.[7] An alpha particle is a helium, due to its heavy mass it travels a very short range in tissue depositing most of its energy over a small area. However, their current used is limited to research. Beta particle are mainly are mainly used for treatment of thyroid diseases and their range in matter is 40 -100 µm depending on their energy.[6]

Concerns of radiation from radiopharmaceuticals

The radiations emitted by radiopharmaceuticals are classified as ionizing radiation.[8] Of concern is that this type of radiation has ability to cause deoxyribonucleic acid (DNA). The damage inflicted to the DNA may result in chromosome breakages resulting in possible mutations when cells replicate raising the risks of cancer induction and possible hereditary effects that could manifest in future offspring years post exposure.[9] In order to minimize exposures, radiation workers undergo radiation protection courses. However, the nurses despite working in radiation environments such as NM are not considered as radiation workers and thus do not do any such courses.

Exposure of nurses working in Nuclear Medicine facilities

A review of literature reveals that majority of nursing staff working in NM departments (NMDs) do not have formal training on radiation protection and related courses. As a result, they have limited knowledge and awareness of radiation from radiopharmaceuticals and associated health effects.[10,11,12,13] This leaves them prone to exposure during their daily activities of caring for patients in the NMDs. Vijayakumar et al.,[12] publicized that an essential component of radiation protection is ionizing radiation knowledge and understanding of radiation sources including methods that can be used to limit radiation exposure. Bento et al.,[10] further observed that the knowledge gap among nurses contributed to fear of radiation consequently compromising effective execution to their routine duties.

Daily routine duties of nurses in a nuclear medicine

department

The nurses in a NMD duties are more clearly defined in European countries. These include administering radioactive and non-radioactive medications.[12] However, these have evolved with time varying from one country to the other. The nurses also care for patients undergoing diagnostic and therapeutic procedures. In addition, they comfort patients and ensure their safety throughout all imaging procedures.[10,11] In the process, they run a high risk of being exposed. Furthermore, by virtue of their working environment that deals with open radioactive sources, the nursing staff in NMDs are vulnerable to ionizing radiation.[10] In this light, nurses working in radiation environments should be equipped with adequate information on radiation risks and necessary skills required to prevent unnecessary exposure in order to protect themselves and also to pass on to patients correct information about radiation exposure practices.[13] This study aimed at evaluating practices and radiation awareness among nurses in a NMD at a tertiary hospital.

Method

A cross-sectional study involving consenting nurses working in a NMD. A validated questionnaire was implemented to gather demographic information (age, gender, work experience), measure radiation knowledge, awareness and related training among the nurses. Nurses were also observed over a period of a week as they carried their routine duties. Particular attention was also paid to radiation protection signs within the department.

Results

Demographics

A total of five nurses voluntarily participated in the study. Of the 5 nurses 4 were female while 1 was male. Twenty percent (20%) of the participants (i.e. 1 out of 5) were in the age group 20 – 30 years, 3 out of 5, sixty percent (60%) were in the age group 41 – 50 years, and the remaining twenty percent (20%) i.e. 1 out of 5 fell in the age group 50 – 60 years. The mean age was 45 years. All nurses had a certificate in nursing.

Working environment of nurses

An observation of the working environment revealed that the working stations in the NMD had clearly visible radiation warning signs displayed. The hot laboratory and the imaging rooms were clearly demarcated. Access was restricted to card holders. The details and contacts of the radiation protection officer were displayed on the NMD's notice board. All nurses were assigned individual radiation dosimeters. However, it was established that they were not regularly worn.

The duties of the nursing staff included taking care of patients who underwent diagnostic and therapeutic procedures. Furthermore, the nurses assisted technologists who administered radiopharmaceuticals to patients. They also comforted children while undergoing nuclear medicine studies. Within the Positron Emission Tomography/ Computed tomography (PET/CT) the nurses monitored the blood glucose levels and possible adverse reactions of patients to iodine contrasts.

In the radiation isolation ward, nurses cared for patients after treatment with radioiodine capsule (Iodine-131). However, the nurses did not administer radioactive medicines as was observed by Brown,[8] in other countries.

All the five nurses voluntarily answered the questionnaire. Among them non attended any formal training in radiation protection or safety. This explains why most of the nurses did not always wear their TLD badges. It was further established that all the nurses were well aware of their limited knowledge on radiation.

Discussion

The nursing staff working in a nuclear medicine department are generally thought to be exposed to doses that are less than the prescribed dose limits for radiation workers.[11] As a result, nurses in general do not receive any training on radiation safety. Furthermore, little if any attention is given on the awareness of the nursing staff on radiation protection principles despite some NMDs having services of medical physicists who provide radiation support. However, nurses in other countries do undergo radiation protection training.[14,15] The nurses in Pomeranian Medical University in Szczecin, Poland are trained in all manual hot-laboratory activities. In Australia, the nursing unit managers provide basic radiation training on request, but the training is not compulsory since medical physicists provide radiation support.[14]

Bawdy et al,[14] observed that lack of awareness of radiation safety and protection principles on the part of the nursing staff working in the NMDs puts them under immense fear of radiation exposure. As a result, fear of radiation may compromise the quality of their nursing duties. Nurses therefore need to be aware of radiation safety principles in order to protect themselves and also to perform their duties efficiently without fear of radiation. Fear of radiation was also established in this study among the nursing staff.

The survey results established a deficit of knowledge on radiation protection among nurses. It was even surprising that none of the nurses were acquainted with the acronym

"ALARA". It was also surprising that all the nurses were aware of the primary risks of occupational exposures. However, the portrayed knowledge deficit was not unique to the nurses in this study. Similar findings were confirmed in other studies.[8,12,14,16] Lack of knowledge and awareness of radiation among the nursing staff in this study was found to cause unnecessary anxiety over radiation as they were not sure whether they were safe from radiation and whether they needed protection while performing their duties. However, such fears according to Badaway et al,.[14] could be overcome by affording nurses an opportunity to undergo basic radiation safety training. Attendance to radiation safety courses would according to Badaway et al,.[14] would enable nurses to protect themselves from exposure and also to take good care of their patients without fear of radiation.

Cases have been reported where nurses have been so fearful of attending patients treated with radioiodine. However, nurses with the knowledge of "ALARA" principle and the ten-day rule would certainly respond differently.[14] Ionizing radiation knowledge deficit have been overcome in Australia, through providing nurses with basic radiation safety training.[17] In Guatemala and Saudi Arabia, where there was shortage of professional radiographers, nurses underwent radiography training, a course that equipped them with basic radiation safety principles and improved their care of patients in NMDs.[15]

Conclusion

Knowledge of radiation is very important to nurses who care for patients in the NMDs. Patients become radioactive by virtue of being administered with radioisotopes. In order to effectively care for these patients, nurses need specialized training in radiation protection safety principles. Lack of knowledge on ionizing radiation and limited knowledge on basic safety principles contributes to fear of radiation among the nursing staff. In order to overcome fear, formal training on radiation safety is recommended. In the event formal training is not possible, nurses may be given pamphlets on radiation protection principles for self-study.

References

1. Donya M, Radford M, ElGuindy A, et al. Radiation in medicine: Origins, risks and aspirations, Global Cardiology Science and Practice 2014:57 http://dx.doi.org/10.5339/gcsp.2014.57
2. Kleiman NJ, Macvittie TJ, Aleman BM, et al. ICRP publication 118: ICRP statement on tissue reactions and early and late effects of radiation in normal tissues and organs: Threshold doses for tissue reactions in a radiation protection context. Am. IRCP. 2012;41(1-2):1–322
3. Hendry JH. Radiation biology and radiation protection. Am. IRCP. 2012;41(3-4):64–71.
4. Mettler FA, Guiberteau MJ. Essentials of Nuclear Medicine Imaging. 5th ed. Philadelphia, Pennsylvania. Saunders Elservier. 2006.
5. Zuckier LS. Principles of Nuclear Medicine Imaging. Global Publishing; 2008 p. 63-98.
6. Gano L, Paulo A. Conventional Nuclear Medicne Radiopharmaceuticals.
7. Fartad B. The Radiopharmacy. A Technologist's guide. European Assosciation of Nuclear Medicine. p. 6.
8. Brown CD. Improving patient care in the diagnostic imaging department: The role of the nurse navigator. J Radiol Nurs 2012;31(3): 97-100.
9. University Hospital if Leicester. Radiation – Medical exposure. Available from: https//www.Leicesterhospitals.nhs.uk.
10. Bento J, Teles P, Neves M, et al. Study of nuclear medicine practices in Portugal from an internal dosimetry perspective. Radiation Protection Dosimetry 2012;149(4): 438-443.
11. Urushizaka M, Not Y, Ogura N, et al. Changes in Nurses' impression of radiation after attending educational seminars on radiation. Radiation Emer Med 2012;2(2): 35-42.
12. Vijayakumar V, Briscose E, Vijayakumar S, et al. Role of nurses in Nuclear Medicine. Inter J Nuclear Med 2006;3(2): pp.1-4.
13. Makanjee C.R., Berg A, Hoffmann W.A. "So you are running between"- A qualitative study of nurses' involvement with diagnostic imaging in South Africa. J Radio Nurs 2014; 33(3): pp105-115.
14. Badawy MK, Mong KS, Lykhun P, et al. An assessment of nursing staffs' knowledge of radiation protection and practice. J Radiol Prot 2016; 36 (1). doi:10.1088/0952-4746/36/1/178
15. Piwowarska-Bilska H, Supinska A, Listewnik MH, et al. Radiation doses of employees of nuclear medicine department after implementation of more rigorous radiation protection methods. Radiation Protection Dosimetry 2013; pp.1–4.
16. Alotaibi M, Saeed R. Radiology nurses' awareness of radiation. J Radiol Nurs 2006; 25: pp.7-12.
17. Alaamer AS. Radiography education and training in Saudi Arabia. Open J Radio. 2012; 2(4): 134-140.

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CONFLICTS OF INTEREST

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