

# Radiation Protection and Safety Measurements in Nuclear Medicine Departments: Students Perspective

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**Abstract:** Due to the introduction of new ionizing radiation related diagnostic and therapeutic practices, usage of ionizing radiation in medicine is growing. Radiation protection education is important in developing safety culture among the radiation workers. Also, it is vital to make sure the workers are well educated, trained and knowledgeable. Beside the well recognized working procedures, availability & utilization of relevant protective equipment, and an effective monitoring program are indispensable factors in making sure that radiation workers in nuclear medicine department are satisfactorily protected. Hence, the purpose of this work was to study the availability of necessary tools and compliance of radiation protection and safety rules by the staff working in nuclear medicine departments in Malaysia through student's observation. A questionnaire was distributed to 65 students those spent more than two months of clinical practice at the nuclear medicine department. It is concluded from the results that the overall proper implementation of radiation protection and safety was followed by the staff of nuclear medicine departments. With the improvement in radiation protection program, it is expected that more workers can comply the radiation protection and safety rules.

**Keywords:** Radiation Protection, Nuclear Medicine, Technologist, Radio-pharmacist, Dosimeter, Shielding.

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## I. INTRODUCTION

According to [1] medical specialties contributing to the annual radiation doses to the radiation workers are diagnostic radiology, radiotherapy and nuclear medicine and collectively termed as three medical radiation sciences (3MRS). Complex interventional radiological procedures and nuclear medicine examinations are due to the advancement in technology. However, harmful effects to the living systems of radiations used in the 3MRS are well studied. Therefore it is extremely important to understand and implement the well established radiation protection and safety rules to limit the radiation exposure to the radiation workers. Thus to minimize the radiation induced health problems. Although radiation protection modules are compulsory and part of education curriculum related to courses on application of radiation. The survey of literature on radiation protection shows that some of the radiation workers do not apply the acquired knowledge on radiation safety at their work which leads to insufficient protection from radiation either to patient or themselves. Furthermore, it is mentioned in National Council on Radiation Protection and Measurements report no. 158 that some individuals forget to wear or purposely not wear their dosimeters [2].

When it comes to radiation protection, it involves how to reduce the exposure both to staff and patient. In nuclear medicine imaging departments, radiation protection program should follow, well planned activities, acceptable and latest working procedures, use of new sophisticated equipment, seek the help from well educated and experienced persons and the cooperation among the staff and other institutions [3].

This study aims to know the knowledge of the students on radiation protection, availability of relevant equipment and tools, working methods, and compliance of radiation protection rules in the nuclear medicine departments of only two institutions.

## II. MATERIALS AND METHOD

### 2.1 Sampling:

The reference population in this study was the sixty five final year students of two local universities studying nuclear science course in Malaysia. Students were selected as the respondents for this study those who spent more than two months of clinical practice at the nuclear medicine department.

### 2.2 Questionnaire:

The structured survey using questionnaire was conducted in the format of a closed-ended question to assess the awareness and perspective of students. It tested the students' knowledge regarding radiation protection. In addition, it includes questions on rules, equipment related to radiation protection and materials. The questions also asked the viewpoints towards the nuclear medicine department and the staff based on their observation during their clinical practice at the hospitals that they were assigned.

In order to get high response rate, respondents were contacted directly by using social media. By choosing this kind of method, the respondents were reached easier and answered the questionnaire and submitted on time rather than distribution of the questionnaire using mail/post which could have taken more time. The questionnaire was written in English. The questionnaire was divided into two sections of close-ended questions. The sub-sections in the questionnaire covered the information such as:

- a. Safety, rules and regulation of radiation protection in the nuclear medicine department.
- b. Equipment and tools relevant to radiation protection.
- c. Materials used for radiation protection when handling radioactive sources at the workplace.

### 2.3 Ethical consideration:

For ethical consideration, the information of the data collected from the respondents was kept confidential. Since this research was based on the respondents' observation and awareness and did not involve any clinical examination or experiment. Therefore, need of consent form, formal letter and research ethics application form were not compulsory.

## III. RESULTS AND DISCUSSION

According to [4] patients and the community need to understand the safe use of radiation, and to become more active participants in their own healthcare. The level of radiation exposure differ significantly between different roles and types of work as reported by [5] conducted a survey with the purpose of evaluating the different roles, exposures and radiation protection conditions of workers in PET facilities in Japan. Management should provide an appropriate level of resources, such as staff, facilities and equipment to ensure that radiation dose is adequately controlled. In any nuclear medicine department personal radiation dose monitors are provided to all employees who work with the ionizing radiation.

### 3.1 Students perspective:

It is well established that ionizing radiation has many adverse effects on biological systems. Thus, it is imperative for radiation workers to take all necessary precautions to avoid the unnecessary exposures at work. In order to achieve this, knowledge, experience, responsibilities of the relevant staff at the department and availability of all relevant sources and tools are important. In this survey, students of nuclear science course of two universities were involved to study their basic knowledge about the radiation protection and share their observations on radiation protection facilities, tools and compliance of radiation protection and safety rules by the staff involved in dealing with the radioactive materials and patients in nuclear medicine departments.

Table 1 show that most of the respondents have the knowledge and studied subjects on radiation protection. Out of all respondents 91.4% participated in programs related to radiation safety in order to strengthen their knowledge on the radiation protection rules and regulations. Few of them, 8.6 % could not join the program. Overall, based on questionnaire results, students' awareness of the radiation protection policy was adequate and their observation show that the staff at the department also provided enough information pertaining to the safety, rules and regulation at work.

Results show that this information is well understood by the respondents as they were aware of the dose limits, with 85.7 % of the respondents were aware of the dose limits to radiation workers while 14.3 % of them were not aware.

RPO is responsible for the implementation of the Radiation Protection Program (RPP). According to Malaysian Radiation Protection (Basic Safety Standards) Regulation 1988, the RPO should have the necessary knowledge, skills and training for enabling effective radiation protection of individuals. As per results 50 % of the respondents were aware of the RPO in the nuclear medicine department that was assigned during their clinical practice.

Based on the result, respondents knew the different types of personal monitoring devices and their use, 74.3 % of the respondents knew how to use the different types of personal monitoring devices while another 25.7 % were not unaware.

**Table.1: show the % response of students relating to their knowledge on radiation protection.**

<b>Section 1: Student's Perspective</b>		<b>Yes (%)</b>	<b>No (%)</b>
<b>Statement</b>			
<b>A. Safety Rules and Regulations</b>			
1.	Have you ever had any education on radiation protection?	100	-
2.	Did you participate in any program/seminar related to radiation protection?	91.4	8.6
3.	Are you aware about dose limits to radiation workers?	85.7	14.3
4.	Do you know any Malaysian organization or agency that relates to radiation protection and safety in nuclear medicine? If yes, please list the names.	100	-
5.	Did you know the Radiation Protection Officer (RPO) at the department?	50	50
<b>B. Equipment Relating to Radiation Protection</b>			
1.	Do you know about the personal monitoring devices?	100	-
2.	Are you aware of the types of personal monitoring devices used?	100	-
3.	Do you know how to use the different personal monitoring devices?	74.3	25.7
4.	Are you aware of the importance of dose record keeping?	100	-
<b>C. Radiation Protection Materials</b>			
1.	Did you notice the areas/rooms/materials labeled with warning signs?	94.3	5.7
2.	Do you know what types of materials are used for shielding inside the nuclear medicine department?	100	-
3.	Were you satisfied with radiation protection rules and regulation that practiced by the staff?	82.9	17.1

Warning signs and posts of areas and rooms respondents showed 94.3 % were pasted and labeled. The rest 5.7 % disagreed.

With the information on safety precaution provided in the department, the staff also followed and implemented good radiation protection rules while working in the nuclear medicine department. Based on the result, 82.9 % of the respondents were satisfied with the radiation protection rules and regulation practiced by the staff and only 17.1 % of them were not satisfied, which resulted from poor implementation of radiation protection rules by the staff such as not wearing personal monitoring devices and not monitoring the workplace.

### **3.2 Observation on Department and Staff:**

In order to strengthen the implementation and awareness of the radiation protection measures in the nuclear medicine department, it requires a lot of encouragement, motivation and interest from the department as well as the workers themselves.

Table 2 shows that all respondents agreed about the briefing given by the staff of nuclear medicine on radiation protection measurements. The results reflect that the information about RPO available at departments, 77.1 % of the respondents answered that they saw the details of the RPO, while the other 22.9 % answered no. It is important that any person including the students during their clinical practice in the nuclear medicine department must know about the RPO so that in case of radiation accident (contamination/exposure) and any other urgent matter can be reported immediately.

All respondents found that the information was available relating to the dose limits/rules/safety precautions at departments.

Regarding the availability of radiation protection related equipment and tools, based on the observation of the respondents towards the staff and department, the personal monitoring devices provided were sufficient and functional. Only 11.5 % of the respondents answered the devices provided at the nuclear medicine department that they were assigned for clinical practice were not enough and some of the devices were non-functional.

The staff also wears their personal monitoring devices at all times in the department which contributed 80 % from the result. Some staff also forgot to wear the dosimeter either purposely or not. This can be proved by the result of the 20 % of the staff did not wear their devices all the time during working. According to National Council on Radiation Protection and Measurements, these actions result in an incorrect value of dose received and make it impossible to determine the user's true occupational risk [2].

Thus, it is important and crucial to have accurate monitoring of personnel exposure as it will demonstrate regulatory compliance. In other word, personal monitoring programs help tracking exposures to specific tasks in order to identify

steps that may be useful for dose reduction initiatives. The survey shows that 85.7 % of the staff get their dosimeters checked.

All records relevant to radiation protection shall be kept and maintained in an appropriate manner to facilitate their effective retrievability and utilization. Records like medical records of the radiation workers must be kept for licensing authority. For other records such as monitoring or material related records must be kept for safety assessment and verification or for other necessary purposes. Such records include: medical examination records of workers, radiation dose of workers, register of radiation sources, date of area monitoring, records of waste disposal, reports of abnormalities and accidents. Personnel dosimetry programs must preserve firm standards and guarantee the accuracy of monitoring data and be implemented in a manner that the radiation workers' exposures are assessed. 100% respondents agreed that reports and records of personal dose were kept and maintained properly.

Based on the result, the design of the nuclear medicine departments comply the international standards as according to the respondents' observation during their clinical practice at respective nuclear medicine departments.

The patients become a source of radiation after administering radioactive materials. Thus, the patients need to be placed in a single room with toilet. In order to control contamination, areas like laboratories need to be monitored. This can be done by using a survey meter on a systematic basis. The result showed that 60 % of the staff monitored the workplace regularly but the 40 % of them disagreed. Both Geiger-Muller type survey meters and ionization chamber-type survey meters are used for monitoring the working areas [3].

Relating to the use of proper shielding equipment for syringe, bench and dispensing station shielding by the staff of nuclear medicine department, 94.3 % agreed, the rest 5.7 % did not.

In nuclear medicine department, source of exposures come from ingested or inhaled radionuclides, patients and also from the source itself. 68.6 % of the respondents answered that the staff protect themselves from the radiation emanated from the patient but 31.4 % answered that the staff did not take precautions.

Shielding requirements were followed by departments as well as the staff in terms off the radiation emanated from patients and radioactive sources. Respondents answered that 82.9 % staff applied the personal shielding while another 17.1 % did not when working with the radioactive sources.

**Table.2: show the response of students on the staff observing the radiation protection and safety measures in the department.**

<b>Section 2: Observation on Department and Staff</b>			
<b>Statement</b>		<b>Yes (%)</b>	<b>No (%)</b>
<b>A. Safety Rules and Regulations</b>			
1. Were you briefed about radiation protection measures in nuclear medicine department?		100	-
2. Did you see the details, e.g., name, contact number of the Radiation Protection Officer (RPO) in the nuclear medicine department?		77.1	22.9
3. Did you find any relevant information about the dose limit/ rules/ safety precaution at the department?		100	-
4. Did you find all staff practicing radiation protection and safety rules?		68.6	31.4
<b>B. Equipment Relating to Radiation Protection</b>			
1. Were the personal monitoring devices at the department sufficient and functioning?		88.5	11.5
2. Did you find the workers wearing approved personnel monitoring devices all the time in the department?		80	20
3. Did the staff check the personal radiation exposure regularly, using radiation badges or dosimeters?		85.7	14.3
4. Did they report and keep records of personal doses?		100	-
<b>C. Radiation Protection Materials</b>			
1. In your opinion, did the design of department comply with the international standards?		100	-
2. Did the staff monitor radiation regularly at the workplace?		60	40
3. Did the staff used proper shielding equipment for syringe, bench and dispensing station?		94.3	5.7
4. Did the staff protect themselves from the radiation emanated by the patients?		68.6	31.4
5. Did the staff apply the personal shielding for protection when working with the radioactive sources? (e.g., lead apron, goggle)		82.9	17.1

As for the respondents' awareness towards the radiation protection safety measures, most of them have sufficient knowledge about the safety precaution in the nuclear medicine department. They also knew how to effectively use the personal monitoring devices of different types as well as being aware of the shielding equipment, design of the department and radiation protection rules that are practiced by the staff.

Moreover, from this study, it was found that the nuclear medicine departments and the staff followed and implemented the radiation protection and safety. However, some of them did not follow the proper radiation protection policy, but the percentage was low. Overall, the department and the staff practiced good protection measures when handling the radioactive sources and also shielded themselves from the unnecessary radiation dose.

#### **IV. CONCLUSION**

It is concluded that, students have sufficient knowledge, skills in understanding and observing the radiation protection and safety rules. A positive feedback was obtained from study relating to the proper implementation of radiation protection and safety by staff, which ensure the awareness about the rules and regulation pertaining to radiation protection and safety at nuclear medicine department. The findings of this study cannot be generalized because only two institutions were involved.

Moreover, by improving the radiation protection program, participation of more workers is possible to increase their awareness in implementing radiation protection and safety measures to protect themselves from harmful effects of radiation.

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