Knowledge of radiation protection among radiology professionals and students: A medical college-based study

Surendra Maharjan a,+, Kalpana Parajuli b, Suraj Sah c, Upakar Poudel d

a Department of Radiological Sciences, Tokyo Metropolitan University, Tokyo, Japan
b Department of Biomedical Imaging, Abo Akademi University, Finland
c Department of Radiology and Imaging, Chirayu National Hospital and Medical Institute Pvt Ltd, Basundhara, Kathmandu, Nepal
d Department of Radio-diagnosis and Medical Imaging, Universal College of Medical Sciences, Bhairahawa, Lumbini, Nepal

HIGHLIGHTS

• The overall knowledge of radiation protection among radiology professional and students was adequate.
• The knowledge of radiation protection among diploma graduate was inadequate.
• Radiation protection law should be promulgated as soon as possible in Nepal.
• This is the first study to perform principal component analysis in the research study of its kind.

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ABSTRACT

BACKGROUND: Radiation protection is the core of radiography for safe radiation-based imaging practice. This study aims to determine the knowledge of radiation protection among radiology professionals and students in a medical college of Nepal.

MATERIAL AND METHODS: A questionnaire survey was carried out among 35 radiology staff and students at Universal College of Medical Sciences (UCMS), Bhairahawa, Nepal. The questionnaire survey consisted of sociodemographic variables and 17 questions, 3 questions were related to general information regarding training, knowledge, and experience and the remaining 14 multiple choice questions (MCQ) were related to radiation protection. Data were analyzed in SPSS Statistics software, version 27. The p-value was set at 5% level of significance. Nonparametric tests were applied since the data did not follow normal distribution. The knowledge score were categorized into lesser than 60 % inadequate, 60–80 % adequate and greater than or equal to 80 % excellent.

RESULTS: Out of total 35 participants, 28 were male and 7 were female with mean age 26.09 ± 7.18 years, range 18–54. The average radiation level of awareness was 9.6 (68.57 %), which was adequate, maximum 13 and minimum 4. There was not statistical significance of knowledge score by gender, age groups, work experience and studentship. Taking academic qualification, the level of knowledge of diploma graduates was inadequate 7.76 (55.42 %), and lower than other higher academic qualifications.

CONCLUSIONS: Adequate radiation protection course materials and training should be introduced for diploma graduates. Continuing professional education (CME) should be organized regularly. Moreover, radiation protection law is a must in Nepal now.

1. Introduction

Ever since the discovery of X-rays by Wilhelm Conrad Roentgen in 1895, the use of ionizing radiation in the field of medicine has been rapidly increasing, which is attributable to recent advancements in imaging technology, that are promising in solving wide array of clinical problems [1,2]. While the use of ionizing radiation has revolutionized the medical field, it is a double-edged sword since it is a potential source
of health hazard [3]. Radiation accidents have enabled the study of effects of high level of radiation, and linear-no-threshold (LNT) model for radiation risk assessment has been established, according to which radiation dose above zero poses risk to a certain extent [4]. Although some consider that concept of LNT based risk estimation is wrong attributing it to unnecessary fear among people and increased expenditure on safety measures, it is still the basis for radiation regulation [5,6]. Moreover, recent studies have shown carcinogenic potential of low dose ionizing radiation from medical imaging [7,8]. Thus, sensible and optimized use of radiation is of utmost importance [9]. Optimization of radiation in medical imaging is achieved through the collective effort of the referring physician, radiologist, radiologic technologist/radiographer, other staffs who are directly or indirectly involved in the imaging technique and the patient himself [10]. Referring physician should always ensure that the use of ionizing radiation is justified i.e. benefits of radiation should outweigh the risk [11]. It is also the duty of radiologist and radiographers to check whether the examination is obligatory [12]. Since they are formally educated, they are supposed to have thorough knowledge on safety measures and optimization techniques [10]. It is their responsibility to spread awareness regarding wise use of radiation not only among other staffs in radiology department but also among the patients and the public [10]. Therefore, radiation awareness is a must to ensure rational use of ionizing radiation in medicine [13].

The history of medical use of radiation in Nepal dates back to 1923 when the first X ray machine was installed [14]. New set ups are being established and radiation workers are constantly being produced through various academic programs. While the field of radiology in terms of academics is growing strong, there is still no radiation act in Nepal [14]. According to IAEA, it is essential for each nation to have radiation and nuclear safety authority in order to prevent repercussions arising from radiation safety issues from one country to other countries [15]. In the absence of radiation protection authority, Nepal is facing a huge challenge in terms of radiation protection [14]. Radiation awareness among radiation workers and public play even stronger role in conditions where there is no regulatory body. However, many studies done worldwide have shown that radiation protection knowledge in radiation workers does not meet the standard [16–19]. Very few studies have been done to assess radiation awareness among radiation workers of Nepal. These studies have shown that the level of knowledge is not adequate to ensure radiation safety, and radiation protection issue is still not taken into serious consideration [20,21].

The main aim of this survey-based study was to determine the knowledge of radiation protection among staffs and students in radiology department of one of the medical colleges of Nepal.

2. Methods

2.1. Questionnaire

A questionnaire survey was performed to obtain a snapshot of knowledge of radiation protection among radiology professionals (radiologist, medical physicist, medical imaging faculty, technologist, and radiographers), residents and students. The survey included demographic characteristics (age, gender, academic qualification, and work experience) and multiple choice questions (MCQ) related to radiation protection. 17 questions were administered to each participant, 3 questions were related to general information regarding training, knowledge, and experience of medical radiation imaging. The remaining 14 multiple choice questions (MCQ) measured the level of understanding of radiation protection. The questionnaire survey was conducted at the Department of Radio-Diagnosis & Medical Imaging, Universal College of Medical Sciences (UCMS), Bhairahawa, Nepal. UCMS is a pioneer institute in medicine, allied health sciences, nursing and dentistry, affiliated with Tribhuvan University (TU), recognized by Nepal Medical Council (NMC).

3. Data collection

All the staff and students of the Department of Radio-Diagnosis & Medical Imaging participated in the survey. The data were collected from 1st to 10th October 2015. The department comprises of Radiologist, Medical Physicist, Medical Imaging faculty, Radiologic Technologist, Radiographers, MD Radio-diagnosis residents and undergraduate students of medical imaging technology. Participants were handed out the hardcopy questionnaire survey by the principal investigator himself and were requested to complete in front of the investigator. Each correct answer was given “1” score and for negative answers, there was no negative markings.

4. Data analysis

Data were inserted into SPSS statistical software, version 27, IBM, Chicago, United States. A descriptive analysis and statistical tests were performed. The knowledge of radiation protection was categorized as inadequate <60 % adequate 60–80 % and excellent 80–100 %. The normality of the data was checked by using Shapiro-Wilk test. The equality of variance was assessed by Levene’s test. Non-parametric tests, namely Mann-Whitney U test and Kruskal-Wallis H test were used for statistical analysis since the data did not follow normal distribution. Pairwise post-hoc test with Bonferroni correction was applied for statistically significant findings obtained from Kruskal-Wallis H-test. The p-value<0.05 was considered as statistically significant.

Principal Component Analysis (PCA) was used to reduce the dimensionality of the 14-questionnaire responses into first two components. The first two components were visualized graphically using “ggbiplot” library. PCA was applied using prcomp() function in RStudio, an integrated development environment (IDE) for R programming language, Boston, Massachusetts, United States [22]. The results of the PCA analysis is enclosed as a supplementary file. To our best knowledge, this is the first study of its kind that used PCA analysis.

An ethical consent of approval was obtained from the local institutional review board (IRB) of Universal College of Medical Sciences, Bhairahawa, Nepal. A written informed consent form to participate was obtained from each participate, and the anonymity of the participants was completely ensured.

5. Results

Of 35 participants, 28 were male and 7 were female, with mean age 26.09 ± 7.18 years. 37.1 % (n = 13) were students and 62.9 % (n = 22) were included in this study. The demographic information of the participants is demonstrated in Table 1.

Out of 14 questions, the maximum and minimum scores obtained were 13 and 4 respectively. The average radiation awareness was 9.6 (68.57 %). Each participant stated that they had taken formal education (lecture or training course) related to the radiation protection. 6 participants (17.14 %) stated that they had inadequate knowledge about risk of radiation and radiation safety, whereas all the participants had clinical posting or job experience in x-ray related procedures. The correct response for each question is listed in Table 2.

Table 3 shows the distribution of the knowledge score by demographic information. Mann-Whitney U test resulted that the knowledge score was same across categories of gender, U = 75.50, p > 0.05. Kruskal-Wallis H test demonstrated that the knowledge score was same across age groups, χ2(3) = 7.35, p > 0.05. However, the knowledge score was statistically significant according to academic qualifications, χ2(5) = 16.43, p < 0.05. Pairwise post-hoc comparison test with Bonferroni correction showed that diploma graduates and MD radio-diagnosis residents have different knowledge score at p < 0.05. According to Table 3, the lowest average knowledge level was 7.76 (55.42 %) for diploma graduates, whereas the highest average knowledge level was 13.00 (92.85 %) for medical physicist. There was a same
Table 1
Demographic Characteristics.

| Demographic Characteristics | Frequency | Percentage (%) |
|-----------------------------|-----------|----------------|
| Gender                      |           |                |
| Male                        | 28        | 80.0           |
| Female                      | 7         | 20.0           |
| Age Groups (in years)       |           |                |
| ≤ 20                        | 11        | 31.4           |
| 20 – 25                     | 6         | 17.1           |
| 25 – 30                     | 11        | 31.4           |
| ≥ 30                        | 7         | 20.0           |
| Academic Qualification      |           |                |
| Diploma Graduate            | 17        | 48.6           |
| BSc MIT Student             | 5         | 14.3           |
| BSc MIT Graduate            | 2         | 5.7            |
| MDRD Resident               | 8         | 22.9           |
| MDRD Graduate               | 2         | 5.7            |
| Medical Physicist           | 1         | 2.9            |
| Work Experience             |           |                |
| Yes                         | 12        | 34.3           |
| No                          | 23        | 65.7           |
| Student                     |           |                |
| Yes                         | 13        | 37.1           |
| No                          | 22        | 62.9           |
country in the world, Nepal, having miniscule resources for radiation safety and dosimetry, the results showed adequate knowledge despite an obvious substandard quality of radiography education compared to developed countries. Subedi et al. [21] also highlighted radiation protection is a very much neglected issue in Nepal till date though x-rays have been in medical imaging use from nine decades ago. They also stressed an urgent need for quality assurance and safety for emerging immense hurdles. Adhikari et al. [14] also performed radiation survey and noticed that 65% of the radiation workers had never been monitored for radiation and the quality control tests were missing in all diagnostic hospitals. Though Nepal is a member of International Atomic Energy Agency (IAEA), still the government of Nepal and the authorized organizations have not taken appropriate steps to improve the present situation. It is pitty that Nepal has not enacted radiation protection and safety laws to the patients and radiation workers. Mounting adverse effects of radiation in Nepal and the present situation of COVID-19 pandemic has created a miserable situation. To uplift the present situation, it is high time that government of Nepal in collaboration with international monumental organizations, local stakeholders, radiological technology educators should take appropriate attention. Though regular training, workshop, seminar, and conference would firmly raise provide awareness on radiation protection, the authors expect the promulgation of legal laws of proper practice of radiation would prove to be a milestone for beginning this arduous task.

This may not be the first study performed regarding the awareness of radiation protection in Nepal, but we presume the study will play a crucial role in improving the situation of radiation protection in Nepal, considering the study was conducted in private institution. Though the results demonstrated adequate knowledge, the authors expect the improvement of knowledge of radiation protection among diploma graduates by inserting adequate radiation protection modules in diploma study curriculum.

6.1. Limitations of the study

This study was conducted in single institution with a small sample (n = 35) and therefore cannot be considered as representative of whole nation. A larger sample from different institutions could have enhanced the results. Future studies should be carried out among medical doctors, dentists, referral physicians, nurses and other workers to determine the total radiation protection knowledge level in a hospital who are directly or indirectly related to radiology field.

7. Conclusion

We recommend that radiation protection and safety training should be a part of mandatory training for radiology professionals, especially for diploma graduates. Ample radiation protection modules should be introduced in the curriculum of diploma level. Regular Continuing Professional Education (CPE) should be organized and implemented through collaboration between national and international organizations with the involvement of government representatives and hospital administration. Radiation protection, being a multi-sectoral field, every aspect should join hands to raise awareness about it. To sum up, radiation protection law is an uttermost importance in Nepal at present.

Authors Contribution

Surendra Maharjan has a contribution in research conceptualization, research design, data collection, data analysis, results interpretation, original draft writing, final draft writing, and revision of the manuscript.

Kalpana Parajuli has a contribution in research conceptualization, research design and initial draft writing.

Suraj Sah has a contribution in research conceptualization, and research design.

Upakar Poudel has a contribution in data collection.

Ethical statement

Hereby, I, Surendra Maharjan consciously assure that for the manuscript /insert title/ the following is fulfilled:

1) This material is the authors’ own original work, which has not been previously published elsewhere.
2) The paper is not currently being considered for publication elsewhere.
3) The paper reflects the authors’ own research and analysis in a truthful and complete manner.
4) The paper properly credits the meaningful contributions of co-authors and co-researchers.
5) The results are appropriately placed in the context of prior and existing research.
6) All sources used are properly disclosed (correct citation). Literally copying of text must be indicated as such by using quotation marks and giving proper reference.
7) All authors have been personally and actively involved in substantial work leading to the paper, and will take public responsibility for its content.

Financial competing interest

Nil.

Availability of data materials

The data and R programming codes will be provided upon reasonable request to the corresponding author.

Declaration of Competing Interest

Nil.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ejro.2020.100287.

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