Available Online at https://www.nepjol.info/index.php/IJOSH
International Journal of Occupational Safety and Health, Vol. 12 No. 1 (2022), 45 – 53

# Occupational radiation safety studies in Nepal – A review

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## ABSTRACT

Occupational radiation safety and health is one of the neglected aspect in the health sector in Nepal. Gross negligence in occupational safety and health is a common phenomenon in Nepal. This paper is a review of previously published articles on occupational radiation safety and health in Nepal. Keywords such as Nepal, occupational safety, radiation safety, radiation risk, and health were used to search for relevant articles in PUBMED and Google Scholar.

A total of 15 articles were reviewed, which dealt with different forms of occupational radiation risks and exposure, regulatory works and consequently its knowledge and awareness among the professionals. The reviewed articles are basically of 3 types: analytical or progress reports, knowledge or awareness assessment, and measurement-based research articles.

The overall status of occupational radiation safety and health was not satisfactory. Occupational radiation safety and health is an important issue at an individual, socialietal as well as at the national level. It involves various sectors such as medicine, agricultural or industrial and yet it is fair to say that it has not received adequate attention. This is evident by the minimal number of literature available on the status of occupational radiation safety and health in Nepal. Standard work situations and criteria have to be set up and evaluated and regular radiation monitoring should be done to ensure the maintenance of quality work. In addition, workshops, seminars, symposiums, training courses should be organized regularly to raise the level of radiation awareness in the profession as well as to the public. The state agencies need to develop and update respective national laws, policy and programs for occupational radiation safety and health. There is an utmost need for extensive researches to be performed covering overall radiation health and other services of the professionals in Nepal where radiation is being used extensively.

**Key words:** Occupation, Radiation, Regulation, Risk, Safety, Workplace.

## INTRODUCTION

Occupational Safety and Health (OSH) is a cross-disciplinary area, concerned with protecting the safety, health and welfare of workers or employed. The goal of occupational safety and health programs is to promote a safe work environment. The Government of Nepal has enforced concepts of OSH through its Labor Act 1992[1]. Yet, the Ministry of Health and Population has not drawn its attention to occupational health issues let alone occupational radiation safety and health. There has been no health programs in Nepal that address the prevention and control of occupation-related diseases and health conditions. A New Labor Act 2017 has been passed for provisions for the rights, interests, facilities and safety of workers and employees working in the enterprise of various sectors. As per the New Labor Act 2017, the entity should formulate the safety and

**DOI:** https://doi.org/10.3126/ijosh.v12i1.41037

Conflicts of interest: None
Supporting agencies: None

Date of submission: 03.06.2021
Date of acceptance: 20.09.2021
Date of publication: 01.01.2022

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health policy as per the Regulation or Directive.[2] Such policy, which should be registered with Labor Office, states that “the employer shall constitute a safety and health committee, having the representation of workers, where 20 or more workers are engaged in work in an entity”. Even so, we do not have any legal document that describes the identification, diagnosis, and management of occupational diseases. The New Labor Law does not mention radiation-affected work as a separate field hence it is less prioritized in the government policy. The lack of adequate and skilled human force in occupational radiation safety and health is also a concern. Although occupational radiation safety and health is an important issue at an individual, socialetial and the national level and it concerns with various fields such as industry, agriculture and medicine, its importance has not been perceived in Nepal so far. This is evident by the minimal number of literature available on the status of occupational radiation safety and health in Nepal. This study is carried out to get a general outline of the status of occupational radiation safety and health in Nepal.

## METHODS

This review paper has tried to summarize all the original research articles on occupational radiation safety and health in Nepal, previously published in national and international scientific journals. The author did not happen to come across any review articles concerning occupational radiation safety and health studies in Nepal. Keywords such as “Nepal, Safety, Occupational Safety, Radiation Safety, Radiation Risk, and Health” were used to search for relevant articles in PUBMED and Google Scholar. Other review articles, editorials, comments, letters were excluded in this review. The main purpose of the review was to have an overall picture of occupational radiation health and safety in Nepal.

This review initially included 17 articles to be reviewed. Two articles were excluded as one being a detailed background of cancer care in Nepal without any implications for occupational safety or health and the other being a similar conference paper to the one reviewed with just a superficial description of regulatory structure in Nepal. This review includes 15 original research articles describing occupational radiation safety, risk, and hazard in Nepal from 2007 to 2020. The study was conducted in April/May of 2021.

## RESULTS

The 15 articles focused on the radiation use in the medical field, knowledge of the radiation workers, its subsequent occupational radiation health and safety, their probable effects on the health of the worker and the regulatory aspects in radiation use and occupational safety.

Giri et al. in 2007 conducted a radiation survey at different diagnostic and therapeutic rooms of 16 different hospitals in Kathmandu.[3] Measurements of fall-out radiation were done subsequently after the exposure at 4 corners of the room with background radiation measured before the radiation-emanating machine was switched on. The radiation-exposure levels ranged from 2.63 to 5.13 mSv/yr. They had also done a radiation survey in the fluoroscopy section of 2 hospitals where they found a mean dose of 301 mSv/yr and 446 mSv/yr. For the CT-scan unit of the hospitals, they found a mean dose of 2773 mSv/yr and concluded that the employees are at greater risk of exposure to high radiation doses. The article had raised the necessity of adequate and appropriate radiation protection at all the hospitals surveyed citing the excess doses surveyed at the centers.

Adhikari et al. in 2007, a medical physicist in Bir Hospital carried out a radiation survey in 20 regional and zonal hospitals across the country.[4] A total of 67 radiation workers were asked to fill the “Radiation Personnel Assessment Form” with questions seeking information regarding professional responsibility, protection training, personal dose monitoring, institutional and self-motivation towards radiation safety, and others. Among 67 radiation workers were Radiologists, Radiation Safety Officer/Medical Physicists, Radiation Oncologists, Radiographers, Dark Room Assistants, Radio-technicians, MD Residents, B.Sc. (RT) students. Similarly, 175 patients and the public were also asked about their general knowledge about radio diagnosis and radiotherapy. Six specific locations were selected to measure the radiation level. The equivalent dose rate in the air at different locations at the specified reference points was measured during the study. The article found that most of the general diagnostic radiology, CT, and Radiotherapy working areas were almost safe but emphasized the requirement of some additional radiation protections in the patients entering the door and in the control console area. The article also found exceeding permissible doses in the Fluoroscopy. The paper cited the unavailability of personal monitoring as a big problem with over 95% of medical radiation workers as they had never been monitored for their occupational radiation exposure.

Similarly, Adhikari et al. in 2012, published an article describing the overall radiation protection status of different hospitals in Nepal.[5] The study was focused on assessing whether weekly equivalent doses received by the radiation workers are within the dose limits recommended by ICRP (International Commission on Radiological Protection).[6] Knowledge of radiation protection and the possible radiation health hazard among the radiation workers were also assessed. Consequently, an inventory of the availability of equipment of the surveyed hospitals was made. From the questionnaires, the study found that most of the radiation workers have quite good knowledge about the radiation hazard, dose limits, radiation risk to the patients in different clinical cases. The study from the questionnaire emphasized the need for protective items (lead apron, lead glass, etc.) and legal regulations to bind the institutions for providing appropriate protective suites or items. The study also pointed to the unavailability of radiation protection experts and the lack of radiation protection trainings in institutions across Nepal. The study was done in 28 hospitals and 5 radiotherapy centers, 2 catheterization laboratories; in total 44 X-ray equipment, 10 CT scans, 2 Mammogram units, 2 catheterization laboratories, and 3 Cobalt-60 machines. The study found that Automatic Exposure Control (AEC) was not used in most of the hospitals' diagnostic X-ray services and no quality control programs existed in most of the hospitals for the diagnostic radiology equipment. The maximum calculated equivalent radiation level ($H_W$) was 0.006 mSv/week, which was within the safe limit of ICRP.[6] Radiation dose level measurement was also done at the patient waiting area and inside the darkroom and leakage radiation test was done by closing the collimators and reading was taken at a 1-meter distance from the tube. There was leakage in almost all units which was not good given the protection of the patients and the average reading was 0.0075 mSv/week. Dose levels at different reference points around the CT unit showed a maximum value of 0.057 mSv/week at door near the control console. A radiation survey around the mammogram unit showed that all the area was very safe and built according to protection criteria. The survey was done for Cobalt-60 and Brachytherapy in beam off position at 6 different points, 1 m away from the source, at 50 cm from the source head, at the corridor. For linac, measurements were taken with the largest field size and with different energies at the door, control console and behind the primary wall. The study found only the staff working in radiotherapy centers were regularly monitored for radiation exposure using Thermoluminescent dosimeter (*TLD*) where as 65% of the radiation workers in other sites were not monitored for radiation exposures. In conclusion, the article pointed out the insufficient protections for the radiation workers and lack of qualified professionals in some hospitals.[5]

In the same year, Bhatt et al. published a paper on a cross-sectional study carried out in 2008 in selected health care facilities.[7] Thirty-five (35) health care facilities with radiological and nuclear medicine services were selected including radiation therapy services. The information was collected by telephone conversations and personal interviews with the relevant radiation workers. Data about different types and number of procedures performed, the number of different types of personnel involved in clinical radiation services, workload and availability of personal dosimetry service were collected. Among the interviewee were radiographers, assistant radiographers, darkroom assistants, radiologists and medical physicists. The study found that out of 35 health care facilities, 6 provided staffs with personal dosimetry service therefore occupational exposure of the other health care facilities was not known. Hence, the study pointed to a lack of evaluation and optimization of radiation protection in most of the health care facilities. The study found a gross disparity between the number of medical radiation personnel and inhabitants in Nepal. The study concluded that the qualified radiological workforce and equipment were limited resulting in radiological services being provided by unqualified personnel. Similarly, the article concluded an urgent need to establish a national radiation protection authority overseeing issues of radiation use and protection.[7]

Adhikari et al. produced another article in 2013 about the radiation level and evaluation of doses to the medical staff at a catheterization laboratory in Kathmandu.[8] In this study, the authors investigated the status of radiation safety mechanisms, procedures and practices in the catheterization laboratory. The personnel radiation dose of the working staff was evaluated during the investigation and ensured proper working condition of the fixed C-arm Unit in the catheterization laboratory.

The laboratory had not provided personal dosemeters for the staff for occupational radiation monitoring hence for the investigation period of 2 months the author provided the personnel dosemeter for the required. The TLD dosimeters worn by the laboratory staff during angiography procedures were measured to be within the limits. The study found that there was no excess radiation in the control console area and outside of the catheterization laboratory. The dosemeter put outside of the lead apron in the catheterization laboratory staff (as close as possible to the right eye) showed the exposure doses were within the limit. Values usually low and sometimes less than 1 mSv were reported which the author suggested inappropriate use of dosemeters under an apron or not used at all. The author also measured radiation at different points in and around the laboratory which resulted in acceptable dose values except at position under the table which was corrected with the installation of adequate protection. The author cited the study limitations as no extremity doses or eye doses were measured and the TLD dosemeter was kept on 1 side of the shoulder and the monitoring was only for the short period of the investigation.[8]

Subedi KS in 2013 published a detailed article on the status of radiation safety and the emerging challenges in Radiology in Nepal.[9] The author, a radiologist in a regional hospital, knows very well the challenges in radiology in Nepal. The author was quick to point out the enormous shortage of adequate and qualified workforce in radiology where demand exceeds supply. Because of this, the author pointed out that many unqualified workforces were in radiology services with little or no experience and knowledge in X-ray procedure and radiation safety, hence disregarding radiation protection of any aspect. The author raised poor maintenance facilities for radiological equipment as a major problem in radiology in Nepal. Despite significant advancements in modern diagnostic and radiotherapy facilities in Nepal, the author presented the bitter truth of the absence of the quality assurance and radiation protection part in most of the centers.[9]

Subedi et al. in 2014 raised a significant question if Nepalese radiologists are following the advancement and relevance in radiation hazards and protection.[10] The study was conducted during a radiology continuing medical education (CME) program among the radiology residents and practicing radiologists in Kathmandu in 2012 through a questionnaire survey. Topics such as radiation protection, radiation dose limit, effective dose, biological effect, and ionizing radiation were included in the questionnaire. The level of knowledge in the post-test survey was significantly higher than the pretest, even in the group scoring less than 50% in the pretest survey. The authors recognized that limitation of their study as the questionnaire included a comparison of radiation dose among various investigations rather than an exact estimation of the radiation dose for individual investigation.

A descriptive cross-sectional study was conducted on technical and non-technical staff in selected hospitals in the eastern part of Nepal in 2014 by Jha et al.[11] 113 medical professionals from private, district and zonal hospitals, involved directly or indirectly in the radiology department and had some sort of medical training were involved in the study. A set of self-structured questionnaires and observations were used for data collection during the study. The study showed, where required, 75.4% used lead apron during the exposure followed by 35.4% thyroid shield, 30.8% lead glass, 30.8 % lead gloves, 12.3% gonad shield and 12.3 % were using other protective material like a lead barrier, etc. The study showed only 78.4% of the total respondent “strongly” thought that they were at risk of radiation hazard showing the majority distrust in occupational radiation protection in their facilities. A critical point to be undertaken is that among the entire participant, 5.3% of them did not have any knowledge of possible radiation hazards and they did not practice radiation protection as well. The study showed that Zonal Hospitals were ignorant in radiation protection as only 64.3% of the technical staff used protective measures.

Likewise, Gyawali et al. conducted a similar study among clinicians who were actively working with radiation.[12] Regional cross-sectional hospital-based study was conducted in 3 hospitals in 2015. The survey was divided into 3 sections: socio-demographic characteristics (age, gender, academic qualification, specialization, work experience and attendance of training course on radiation protection), the current practice of radiodiagnosis, and knowledge regarding radiation protection. The study found that the clinicians have not updated their knowledge regarding radiation protection, did not undertake the radiation dose delivered to the patient; in addition, they were also less conscious about the importance of radiological investigation for proper treatment and management strategies. Their study also showed that clinicians have not updated themselves on advancements in imaging modalities and are ignorant about radiosensitivity and its hazard towards organs.

Maharjan et al. in 2017 conducted a questionnaire survey among radiographers and radiography students in an annual meeting of the radiological society held in 2016 where 102 participated in the study.[13] The study estimated from their result that many radiation protection aspects were neglected by the radiographers including protection of pregnant women and the fetus during radiation exposure as indicated by the level of knowledge of the radiographers in the questionnaires.

In 2018, an interesting paper was presented in a symposium on International safeguard in IAEA by Gaire KP on Regulatory infrastructure of Nepal.[14] It was an article showing the preparedness in Nepal for the radiation protection efforts, among many things related to regulating all the medical, industrial and agriculture-related work concerningthe use of radiation. The Ministry of Education, Science and Technology is the main body in Nepal responsible to utilize and promote, control and regulate nuclear technology; to implement and regulating policy, law and standards relating to atomic energy; and dealing with the treaty, agreement, protocol, liaison and coordination with international organizations related to the ministry. Gaire KP was Joint Secretary of the Ministry and was representative person of the country in the symposium. It was reported 48 organizations possessed radioactive sources. It was reported in the paper that a draft bill for a Nuclear Safety Act was in progress during that time. The act was expected to make the necessary legal provisions for the beneficial, safe and peaceful uses of nuclear technologies and ionizing radiation; and for the protection of people, and the environment against possible detrimental effects of ionizing radiation. The ministry planned to focus on enactment of the Act as soon as possible along with establishment of the authorities as prescribed by the Act; develop skilled technical workforce; and enhance capacity building of the existing regulatory infrastructure through training and workshops.

Sharma et al. performed a questionnaire survey to provide a snapshot of knowledge and awareness of radiation dose and risks associated with medical imaging among radiology professionals' radiographers/technologists in a Western city of Nepal.[15] The study was conducted for the period of three months from September to November 2018 at various hospitals and diagnostic centers in the city with 103 respondents. The study observed that protection equipment was either unavailable or they were not being used due to negligence. In the study, 100% of the participants knew the options to reduce radiation exposure to the patient, like time of exposure, distance from the course and shielding while 91.3% knew about ALARA. Their study, however, showed that only 8.7% of radiographers/radio technologists use dosimeters for exposure procedures for their occupational radiation monitoring purposes. Another problematic point is that 33% of the respondents were unaware of the occupational annual whole-body dose limit of 20 mSv averaged for 5 consecutive years as recommended by ICRP.[6] For the question regarding frequency of equipment calibration, only 13.6% marked periodically, 42.7% marked in the case of necessity, 37.9% marked that they do not have an idea about it and 5.8% marked never.

Occupational radiation protection in dentistry is one of the ignored aspects which may be the case as radiation doses emitted in dentistry are relatively low as compared to other medical radiology. Joshi et al. conducted a cross-sectional study among dental practitioners and interns of a teaching hospital from July to October 2020.[16] In that study, lead apron and thyroid collar were rarely used on regular basis as only 31% of the respondents replied on using them citing unavailability in the working area as the reason for such. The study showed 43% offered protection to their patients from radiation during exposure. Knowledge about radiation protection and safety was seen to be 'adequate' among 89% of participants while 11% of participants had 'inadequate' knowledge. The study emphasized regular workshops facilitated at both the institutional and national levels for motivating the respective personnel towards maintaining radiation safety protocol and radiation protection culture.

Maharjan et al. in 2020, performed a questionnaire survey at the Department of Radio-Diagnosis & Medical Imaging of a hospital in a western city of Nepal to obtain a snapshot of knowledge of radiation protection among 35 radiology professionals (radiologist, medical physicist, medical imaging faculty, technologist, and radiographers), residents and students.[17] All of the participants had previous formal education (lecture or training course) related to radiation protection. 17.14% of the participants had inadequate knowledge about the risk of radiation and radiation safety. The study showed adequate radiation awareness among the participants.

Furthermore, the level of knowledge of students was higher than the non-students, which implied a lack of updates of radiation protection courses among working staff.

A recent publication from Acharya et al. took a different approach to study occupational radiation exposure at different hospitals in Nepal. The study aimed to picture the existing practice of personal dosimetry in Nepal and to focus on the necessity of personnel monitoring in hospitals throughout Nepal. 8 hospitals spread across Nepal were selected which have facilities like CT scan, general X-ray, catheterization laboratory, mammography, C-arm, Fluoroscopy. 35 personnel were monitored for their radiation exposure. The TLDs were monitored for 3 to 10 months. It was found that all the radiation exposure of the hospitals was under the permissible limits for the occupational exposure of 20 mSv per annum as implicated by ICRP[6]**.** The exposure of an individual was found in the range of (2.21-16.17) ± 0.01 mSv per year. The publication emphasized on establishment of the National Radiation Protection Authority as well as a medical physicist in each hospital to regulate and to ensure safe radiation practices.[18]

## DISCUSSION

This is a review of all the previously published articles focused on the status of occupational radiation safety in Nepal. It was found there were very little researches concerning this area. Some of the research papers were deviating in their field coverage.

Among 15 articles selected, 2 are reports or analytical articles regarding radiation safety, hazard, challenges, and progress on the establishment of a nuclear act and implication of subsequent regulations.[9,14] All the other 13 articles are research articles where half of them are on evaluating knowledge and awareness of radiographers, technicians, clinicians, dentists,

**Table 1:** List of articles included in the review.

| S.N. | Author | Publication Year | Title |
|---|---|---|---|
| 1 | Giri et al[3] | 2007 | Radiation Measurement at X-Ray Centers of a few Hospitals in Kathmandu City, Nepal. |
| 2 | Adhikari et al[4] | 2007 | Radiation survey at different public and private hospitals in Kathmandu valley and different parts of Nepal. |
| 3 | Adhikari et al[5] | 2012 | Status of radiation protection in different hospitals in Nepal. |
| 4 | Bhatt et al [7] | 2012 | Occupational Radiation Exposure in Health Care Facilities. |
| 5 | Adhikari et al[8] | 2013 | First Data about Radiation Level & Evaluation of doses to Medical Staff working at the Catheterization Laboratory at Katmandu, Nepal. |
| 6 | Subedi et al[9] | 2013 | Status of Radiation Safety and Emerging Challenges in Radiology in Nepal Calling for Strong Safety Measures. |
| 7 | Subedi et al[10] | 2014 | Radiation Hazards and Protection: Are Nepalese Radiologists Up to Date? |
| 8 | Jha et al[11] | 2016 | Knowledge, Attitude and Practice of radiation risk among employees in selected hospitals of Nepal. |
| 9 | Gyawali J et al[12] | 2017 | Awareness regarding radiation knowledge among clinicians practicing in Bharatpur, Nepal. |
| 10 | Maharjan S[13] | 2017 | Radiation knowledge among radiographers and radiography students. |
| 11 | Gaire KP[14] | 2018 | Regulatory Infrastructure in Nepal. |
| 12 | Sharma BR et al[15] | 2019 | Knowledge of Radiation Exposure and it Risk among Radiographers and Radio Technologists. |
| 13 | Joshi U et al[16] | 2020 | Knowledge and Awareness of Dentists Working at Tertiary Care Hospital Towards Radiation Protection and Safety. |
| 14 | Maharjan S et al[17] | 2020 | Knowledge of radiation protection among radiology professionals and students: A medical college-based study. |
| 15 | Acharya P et al[18] | 2020 | Study on Occupational Radiation Exposure at Different Hospitals in Nepal using Thermoluminescence Dosimetry. |

students, medical physicists, or staff working in the field where radiation is used on regular basis and they are prone to be exposed as a part of their work.[10-13,15-17] The remaining 6 research articles conducted real measurement of the radiation level in or out of the radiation prone area and/or monitor the radiation workers which thereby analyze the radiation data to evaluate the occupational radiation exposure of the workers in addition to conducting questionnaires regarding aspects of radiation protection, hazards, risk and health.[3-5,7,8,18]

The analytical and progress articles have skillfully put forward a real scenario of occupational radiation safety and health in Nepal. The articles have excellently put forward the shortage of adequate and qualified workforce in radiology and other radiation-prone areas for proper radiation protection of the workers. The national occupational safety policy for radiation professionals does not exist in Nepal. The authors have stressed on the Government of Nepal about not giving a serious focus on radiation activities and safety measures, nor in the establishment of a national radiation protection commission authority responsible for permitting and control of radiation activities, and monitor radiation safety measures to be formulated in the country. With the enactment of National Nuclear Policy 2064 (2007) and Radioactive Substances (Utilization and Regulation) Act 2077 (2020) there has been a hope for a systematic and organizational approach to occupational radiation safety and health of the workers involved.[19,20]

The knowledge and awareness evaluation articles bring us an insight of the radiation safety and health, the risk from radiation directly from the professionals and students in this field.[10-13,15-17] Many of these studies were conducted in the premise of a hospital with few respondents which makes it difficult to generalize to the whole country. Subedi et al. concluded radiation protection of radiography professionals being a much neglected issue to date in Nepal.[10] Joshi et al. have done praise-worthy research about radiation safety in the field of dentistry which tends to be neglected in the radiation protection aspect citing its low exposure dose.[16]

Radiation measurement-based research articles raised the occupational radiation safety aspects in the academic field which seems absent for the last 8 years. Acharya et al. reignited this trend with measurement of the TLDs worn by the professionals exposed to radiation dose in their course of work.[18] However, there are some points in his paper which is worth discussing. The paper failed to discuss how the sampling was done and the basis they were based on. It was indicated that the TLDs were provided through a dosimetry service provider in Nepal and the TLD cards were well annealed and calibrated before being sent to respective hospitals for them to be worn by the professionals. They failed to clarify if the Co-60 source used for calibration is traceable to Secondary Standard Dosimetry Laboratory or Primary Standard Dosimetry Laboratory. The paper is not clear in presenting whether resulting compensation factors were used while reading the personnel dosimeters or just a calibrating factor was used for the final readout. It was stated that the TLD cards were read for a period ranging from 3 to 10 months. They did not clarify if all the hospital TLDs were used for 10 months or 3 months. If the period is not the same then it is a faulty comparison between hospital exposures. The study found that personals who work in fluoroscopy and interventional procedures received comparatively higher doses than general X-ray and CT scan except at one hospital where the general diagnostic X-ray personnel received higher doses. The hospital should be asked to check the reason for such a high dose even in TLDs worn by personnel in general X-ray service. The reasons for higher doses were “guessed” as probable cause whereas being the dosimetry service provider, they should have done a full investigation.

Adhikari et al. conducted considerable measurement-based researches in catheterization laboratory[8] and different hospitals across Nepal.[4,5,8] All 3 studies were done in 2 ways: by measuring radiation doses at different points outside the room usually occupied by the professionals and measuring the TLDs worn by the professionals. However, all of the articles pointed out the lack of personal monitoring for the radiation workers and lack of any national regulations to regulate the use of radiation. A similar approach was done by Bhatt et al. in 2008 where 35 health care facilities were studied for their use of radiation and subsequent occupational radiation safety which he concluded that qualified radiological workforce and equipment were limited and the gross disparity between the number of medical radiation personnel and inhabitants in Nepal, the situation being still relevant.[7] The 2007 measurement-based article from Giri K et al. has some faults in the basic principality in deciding the measured dose values for occupational or for public radiation exposure.[3] The paper had concluded that the radiation fall-out measured in the X-ray rooms at X-ray departments were beyond the prescribed level of 1 mSv/yr and thus has health risk to the public, employees, technicians and other attending staff. They tried to correlate the exposure inside the room right after any exposure to public exposure which is erroneous. However, there is an impending risk to the technicians but the exposure value is way lower than the occupational exposure limit. The occupational exposure can also be reduced by delaying entry to the X-ray room right after exposure. The article did not clarify if the health personnel used appropriate shielding during their procedure in fluoroscopy or not. If not, it is a serious concern. There were no uncertainties introduced except for calculation in mean dose. The measurements were done inside the exposure room where neither the employees nor public access and did not consider the workload or occupancy. Most of the articles have ignored the uncertainties that would have been encountered during measurement and simply put the mean readings as their result.

There are no articles with a real assessment of the health of the radiation workers. Health assessment of the radiation worker before being employed in this field and periodic assessment is required if the health of the radiation workers is to be taken seriously. There have not been any occupational accidents reported due to excess radiation exposure. It might not have been reported also because it was neglected, the workers had no way of knowing the excess exposure and also there are no guidelines or protocols established in case of excess exposure.

## CONCLUSION

It was observed that all the authors pointed the absence of any regulatory forms and authority in Nepal. They have emphasized regular Continuing Professional Education (CPE) programs for all the professionals working in radiation-prone areas in addition to the establishment of a national radiation regulation authority to regulate the use of radiation in Nepal. The state agencies need to develop and update national laws, frameworks, policies and programs for occupational safety and health which must include actions for providing occupational health services for all the people at work. There is an utmost need for extensive researches to be performed in radiation health and safety and other services covering all of Nepal where radiation is being used for their beneficial purposes.

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