

# Occupational radiation exposure monitoring among radiation workers in Nepal

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**Abstract.** Nepal was accepted as a member of the IAEA in 2007. Nepal is one of the world's least developed countries and is defined in Health Level IV. The population counted 26.4 millions in 2007. The health care sector increases with new hospitals and clinics, however, Nepal has no radiation protection authority or radiation protection regulation in the country until now. The radiation producing equipment in the health sector includes conventional x-ray and dental x-ray equipment, fluoroscopes, mammography, CT, catheterization laboratory equipment, nuclear medicine facilities, a few linear accelerators, Co<sup>60</sup> teletherapy and High Dose Rate brachytherapy sources. The situation regarding dosimetry service for radiation workers is unclear. A survey has been carried out to give an overview of the situation. The data collection of the survey was performed by phone call interviews with responsible staff at the different hospitals and clinics. Data about different occupationally exposed staff, use of personal radiation monitoring and type of dosimetry system were collected. In addition, it was asked if dosimetry reports were compiled in files or databases for further follow-up of staff, if needed. The survey shows that less of 25% of the procedures performed on the surveyed hospitals and clinics are performed by staff with personnel radiation monitoring. Radiation monitoring service for exposed staff is not compulsory or standardized, since there is no radiation protection authority. Nepal has taken a step forward regarding radiation protection, with the IAEA membership, although there are still major problems that have to be solved. An evaluation of the existing practice of staff dosimetry can be the first helpful step for further work in building a national radiation protection authority.

**KEYWORDS:** *monitoring; radiation exposure; developing country, Health Level IV, dosimetry, occupational exposure*

## 1. Introduction

Ionizing radiation is being used extensively in medical practices and there are 2.3 million medical radiation workers worldwide [1]. Any kind of radiation exposure incurred due to work is regarded as occupational exposure, and in practice, it is customary for all those who are occupationally exposed to external radiation to be individually monitored with personal dosimeters. The routine monitoring of occupational exposures is performed to verify and demonstrate compliance with the regulatory dose limits, recognize new exposure pathways or risks, and demonstrate a suitable level of radiation protection [2].

Nepal is a developing country in Health-Care level IV, located in the South Asia between China in the North and India in the South, East and West. There are 32 different ethnicities and even more spoken languages [3]. The population counted 26.4 million in 2007, and geographically the country is administered under 14 zones and 75 districts. The healthcare system in Nepal is both public and private. The public sector health service run by the government is based on a decentralized system, where most of the zones have so-called zonal hospitals which serve as a referral center for that zone. Similarly, there are district hospitals at the district level which serve as referral centers for health posts and sub health posts of rural areas. In 2005 there were a total of 89 hospitals, with 6796 beds, 699 health posts and 3131 sub health posts [4]. Everyone has access to both public and private healthcare

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systems if they can pay, but distance travelling from remote places and a limited number of hospital beds are in practice a big impediment [5].

The resources for health care are unduly low, and most of the radiology and radiotherapy resources are located in a few major cities. Health expenditures per capita in Nepal, at average exchange rate, were only \$12 in 2006, as compared with \$4976 of a developed country like Norway [6]. More rural hospitals are often in shortage of both equipment and qualified staff [7]. The number of qualified health professionals is small, and they are mainly employed in the bigger hospitals in Katmandu Valley [8]. There are different categories of qualified radiographers in Nepal but most of the radiographic examinations are performed by assistant radiographer or dark room assistants (professionals without any formal education in radiography and radiation protection) in small clinics and most of the small hospitals.

Nepal became a member of the IAEA in 2007. However, Nepal has no radiation protection authority and there is no radiation protection regulation, although a National Nuclear Policy has been formulated recently in 2007 [9]. General data about the health care system and particularly the radiology, nuclear medicine and radiotherapy service are limited and the situation regarding shielding and personnel dosimetry is unclear [1]. The aim of the study is to reveal the existing practice of staff dosimetry in Nepal.

## **2. Material and method**

A survey has been carried out, with the aim to reveal the situation regarding personnel dosimetry for occupationally exposed staff in the Nepalese health care enterprises (HCEs). A list of HCEs was collected from the Nepalese Ministry of Health and Population and the hospital telephone numbers were collected from Nepal Yellow pages hospital list. The list represented the largest radiological facilities in Nepal, comprising eight hospitals with radiation therapy and radiology departments in teaching hospitals and cancer hospitals, and a private run nuclear medicine department. In addition, Nepal has a large number of smaller clinics using radiology equipment. From these, 27 HCEs were randomly chosen from the group of regional hospitals, zonal hospitals, district hospitals, private nursing homes and x-ray clinics. In all, 35 different sites were included in the study.

A questionnaire consisting of closed and open-ended set of questions was prepared, focusing on the availability of equipment, different type of staff and competence, workloads, personal dosimetry service and the staffs' view about radiation protection. In addition it was asked if dosimetry reports were compiled in files or databases for further follow-up of staff, if needed. The data collection for the survey was performed by phone call interviews with responsible staff at the different HCEs, during a two weeks period. Additional contacts were made with Nepal Radiological Society and Nepal Radiologists Association for updated information about the number of different professionals in Nepal.

## **3. Results**

The response rate was 100% and the respondents consisted of 21 (60%) radiographers, 5 (14%) assistant radiographers, 5 (14%) dark room assistants, 2 (6%) radiologists and 2 (6%) medical physicists. Most of the respondents (91%) were employed in radiology departments and the other 9% in radiotherapy departments. The study showed that radiology was used in all 35 HCEs interviewed. Twelve HCEs used radiation in operating theatres, 5 in radiotherapy departments and 1 in nuclear medicine department. One HCE offered only CT examinations. The activity in the radiological departments varied from 360 to 126 000 procedures per year (2007), with an average of 28 884 and a median of 16 200. The activity in the radiological departments comprised catheterization procedures, CT, intestinal barium procedures, skeleton and thorax (plain) x-rays (summarized in Table 1).

**Table 1:** Different type of radiological procedures performed at the different HCEs. One HCE performed only CT examinations.

Type of procedure	No. of HCEs
Angiography/catheterization	6 (17%)
CT	13 (37%)
Intestinal barium procedures	20 (57%)
Skeleton x-ray	34 (97%)
Thorax x-ray	34 (97%)

The total number of staff, using radiation in all HCEs was 393 and 344 of them worked in radiological departments, 46 in radiotherapy departments and 3 in nuclear medicine department (Table 2).

**Table 2:** Occupationally exposed staff in all HCEs and in the different departments.

	No. of occupationally exposed staff in the HCEs			
	All HCEs	Radiology dpt.	Radiotherapy dpt.	Nuclear Medicine dpt.
Average No. of staff	11	10	9	-
Median	6	5	6	-
Range	1-50	1-50	4-23	-
Total No. of staff	393	344	46	3

Six (17%) of the HCEs stated that they monitored the staff with personal dosimeters, and the total number of monitored staff were 149. The personal radiation monitoring had existed for 4-9 years and all six HCEs used TLD badges supplied by Bhabha Atomic Research Center, Mumbai, India. The wearing period was three months and all dose data were kept in hospital records. Five of the 6 departments performing catheterization procedures and 16 out of 20 departments performing fluoroscopic gastro-intestinal and other procedures did not have any dosimetry service for the staff. The only participating HCE with nuclear medicine had personal radiation monitoring service, but 2 out of 5 hospitals with radiotherapy departments lacked the service. In one of the radiotherapy departments monitoring service was available from 1983 to 2006, but no monitoring are performed today.

Altogether the 35 HCEs performed totally 929 940 radiological procedures in 2007, and the 6 HCEs with personal radiation monitoring service performed a fraction of 226 640 procedures, which is less than 25% of the total. Four of the 6 respondents being monitored, stated they wore the badges over the lead aprons. Among the respondents from radiology departments 28 (80%) of them said that they have sufficient number of lead aprons for the staff and 26 (74%) of respondents were satisfied with the quality of lead aprons available. It was found to be 100 radiologists, 9 radiation oncologists, 10 medical physicists and 250 radiographers in Nepal (Table 3) [10-11].

**Table 3:** The total number of different health professions working with radiation, and the number of professions per million inhabitants.

Profession	Total no. in Nepal	No. per million inhabitants
Radiologists	100	3.46
Radiation Oncologists	9	0.31
Medical physicists	10	0.35
Radiographers	250	8.65 <sup>a)</sup>

a) Includes radiological technologists and radiographers.

#### 4. Discussion

Personnel monitoring of exposed staff is not mandatory in Nepal, resulting in more than 75% of all radiological procedures in Nepal are performed by non-monitored staff. Most of the staff performing the procedures doesn't have any formal education in radiation protection, and they will be exposed to an unknown amount of radiation. The radiation exposure to staff is much dependent on the frequency and type of procedures performed. A great number of the facilities performing X-ray are probably restricted to low dose procedures like plain thorax and skeleton x-ray, due to limitations of the equipment. Those procedures are maybe acceptable to perform without personnel dosimetry monitoring, if functional equipment, shielding devices and competence could be ensured. This is however normally not the case in Nepal, especially in the smaller hospitals and clinics, due to lack of qualified health staff in radiography. The survey showed i.e. that there are only 10 medical physicists' and about 100 radiologists in a population of 26.4 million inhabitants. Of the 250 radiographers, only a small fraction has a B.Sc degree. However, a strategic plan for human resources for health; 2003-2017, has set an ambitious plan to increase the supply of radiographers by 1338% until 2017 [12]). This has shown to be a very challenging path ahead for the planners of the health and education sector.

The most exposed group is the staff working with catheterization procedures, where only 1 of 6 departments had monitoring service. In catheterization procedures, there are on a general basis, significant higher risk of receiving high staff doses, since the staff often have to stand near the patient during the exposures [13-15]. Other groups with potential high staff doses are personnel working with radiological intestinal barium procedures and fluoroscopic supervision during procedures in operation theatres. More studies are necessary to assess the magnitude of staff doses in those areas. This can, however, be a problem since the lack of medical physicists' competence in Nepal is substantial. An immediate action can be to prepare short basic lectures in radiation protection, suitable for internal education in the department. This can be a task for the professional organizations in Nepal.

There were 6 HCEs performing personnel monitoring of exposed staff, and fulfilled the IAEA requirement to have records on each employee's exposure dosage [16]. An individual cumulative dose will be possible to estimate for those who are monitored, but there are no regulatory dose limits to compare with. Personal dose readings can also be an important tool for evaluation and optimizing radiation protection and working technique during e.g. catheterization procedures.

The main standard regarding radiation protection of occupationally exposed staff is the Basic Safety Standard (BSS) from the IAEA [17]. According to the BSS shall occupational exposures be limited, as specified by the recommended dose limits of the International Commission on Radiological Protection (ICRP) [18]. Other detailed requirements are also given in BSS regarding e.g. training in radiation protection, health surveillance of workers, pregnant workers and individual monitoring, amongst other factors. The BSS also state that a full and proper implementation of the BSS requires that a regulatory authority is established by the government, with the aim to regulate the introduction and conduct of any practice involving sources of radiation. Beside the limited health care and educational resources in Nepal, the lack of a regulatory authority for radiation protection is a problem. The country has neither

any radiation protection regulation and there are no requirements for dose monitoring or dose limits for exposed staff. However, a work in radiation protection has been initiated and is formulated in a National Nuclear Policy [9].

## 5. Conclusions

There are few health workers in Nepal being monitored with personal dosimetry. The staff doses to those involved in catheterization procedures is unknown, and they also lack an important tool for evaluation and optimization of radiation protection. Studies with assessments of staff doses are desirable to carry out, but probably practically complicated due to the lack of competent staff and equipment. An immediate action can be to prepare basic educational material in radiation protection and disseminate the information to the concerned. One of the most urgent needs is, however, the establishment of a radiation protection regulatory body, which can regulate, guide and carry out inspections in radiological practices in the country. Nepal has newly become a member of the IAEA, and the membership will hopefully highlight radiation protection issues and bring expertise in to the country through IAEA and increased international collaboration.

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