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Assessment of Regulatory Requirements in Diagnostic X-Ray Facilities in Bangladesh

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ABSTRACT

X-ray is one of the very old yet powerful modalities of diagnostic imaging procedures. Bangladesh has a history of over 80 years of using X-ray for medical diagnostic purposes. But not many of the users were knowledgeable about the potential risks associated with an ionizing radiation like X-ray. To create awareness on radiation safety Bangladesh Government for the first time promulgated nuclear safety and radiation control (NSRC) act in 1993 and corresponding NSRC rules in 1997. The purpose of the current study is to evaluate shielding structure of some diagnostic x-ray facilities in Jessore district of Bangladesh with respect to regulatory standards. Radiation dose levels are also measured at different points in order to investigate the shielding adequacy of the facility. Estimated dose levels were found higher than the regulatory limit (0.5μSv/h) across the entrance door (ED) of 66% facilities. Secondary walls of the X-ray room were found adequately shielded with 10 inch brick wall. The shielding structure of control panel (CP) of the four facilities was not sufficient according to regulation and there were no shielding in the viewing window of CP of two facilities and the amount of lead shielding at the same points of two other facilities was found less than the regulatory requirements (2mm). Only 4 machine operators were found qualified diploma holder radiographer among 16 operators which could affect overall radiation safety features.

Keywords: NSRC rules, Dose levels, Shielding structure, Viewing window, Radiation safety

1. Introduction

In medical diagnostic procedure X-ray imaging is still playing very important role all over the world. The use of X-rays is getting more priority than the other imaging system particularly for its simple operational and decommissioning techniques. The rate of increase of X-ray facilities in Bangladesh is faster now than before as the economy is expanding and as the people is becoming more and more health conscious [1]. The application of X-rays may cause harm for the patients, occupational and the public if sufficient protection is not arranged in the facility [2]. Shielding design for X-ray facility is crucial to control the exposure for the concerned people. For shielding calculation of an X-ray room different methodologies (IAEA, NCRP etc.) are available [3, 4]. But in Bangladesh most of the facilities have been established without doing shielding calculation. Therefore, for obtaining license from regulatory authority a significant amount of structural change is needed to meet regulatory demand. To support the radiation users, NSRC rules and guides highlight some shielding aspects which are required to follow in order to operate an X-ray facility. According to International Commission on Radiological Protection (ICRP), the principles of radiation protection requirements lie on the

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main three basic pillars such as justification of practices, optimization of protection and safety, dose limitation. The concept of justification of practice reflects the use of radiation must offset the radiation harm that it might cause. The number of individuals exposed, the magnitude of individual doses and the likelihood of incurring exposures require assessing following ALARA principle in order to optimize protection and safety. On the other hand, by limiting occupational dose deterministic effects can be avoided. But still there is a potential for having stochastic effect from low exposure from the X-ray facility. The level of radiation dose to radiation workers, patients and the public depends on the quality of the machine, design of the facility, the procedures followed to take images, capability of persons running the practice and the overall management status of the X-ray facility. For controlling deterministic effects of radiation ICRP recommended annual effective dose limit for the occupational and public are 20 and 1mSv respectively [5]. Personnel monitoring badge (TLD) provides accumulated dose level for the radiation worker [6]. But due to lack of knowledge about radiation protection non trained radiation worker in the facilities do not use TLD badges during operation of the machine.

There is no quality control (QC) program for X-ray machines which is essential to assess the machine's performance hence to reduce the emission of leakage radiation level [7].

In the present study, the radiation safety condition of facilities mentioned above will be verified by evaluating the wall thickness, control panel barrier's thickness and he thickness and type of the shielding material used in entrance door. At the same time, experience of the operator for operating machine will also be assessed in this study.

2. Materials and methods

There were 9 diagnostic X-ray facilities randomly chosen in Jessore city for the study. For collection of data an investigation checklist was prepared. This checklist mainly includes machine inputs, model, manufacturer, aluminum filtration, room design, shielding parameters and radiation dose measurement at different location etc. The shielding condition of entrance door, control panel and surrounding walls were assessed. For radiation measurement two GM type dose rate meters were utilized. For precision of the findings, mean values were recorded. Before using the instruments were calibrated in secondary standard dosimetry laboratory at Atomic Energy Research Establishment (AERE), Savar, Dhaka. The calibrating source was a gamma emitting isotope (137 Cs) but radiation dose were measured for X-ray. Due to that discrepancy some deviation in the findings may occur. Same kind of two radiation dose rate meters were utilized for the dose measurements for precision of the reading. Dose rate was measured for chest X-ray, lumbar spine, KUB, thoracic spine, skull, knee and PNS. For the experiment tube potential from 55 to 125 kVp, current 20 to 300 mA and time 0.5 to 5 secs were selected. Radiation dose were measured across entrance door, control panel, primary and secondary walls. Among the different studies chest X-rays were preferred for the dose measurements of the primary wall because the direction of the tube remains towards the wall during chest X-ray. Dose rate was measured across the entrance door because public waiting place was located near the door of the facilities. Staff sitting room was found near primary wall in the 05 five facilities. The staffs were not involved in radiological activities. Therefore, this location across the primary wall was also one of the points of dose rate measurement. For occupational exposure assessment, dose rate was measured behind the control panel barrier. During investigation of X-ray room, room size and shape were also assessed. Information about academic/training qualification and experience of X-ray radiographer were also evaluated in this study.

3. Regulatory requirements

There are three standards available for controlling radiation related activities in Bangladesh. Among them Bangladesh Atomic Energy Regulatory (BAER) Act in 2012, Nuclear Safety and Radiation Control (NSRC) Rules in 1997 and regulatory guide on radiation protection in medical diagnostic x-rays in 2002 were established [8, 9, 10]. According to these standards the dose limits for occupational 20 mSv and for public 1 mSv per year. Regarding the facility structure, 10-inch brick wall or equivalent amount of concrete wall and 2 mm lead or 3 mm mild or stainless steel are recommended for shielding of doors/windows for the diagnostic x-ray facilities. According to the guide lines of Atomic Energy Regulatory Board (AERB) of India, 20 cm or 8-inch brick wall is required for the shielding of an x-ray room and 1.5 mm lead required for door shielding for general radiographic room. In Bangladesh, there are various categories of bricks are available. Their density varies significantly. For this reason, little higher thickness of brick is recommended than AERB for developing a barrier of brick for radiation protection. The qualification of radiation worker has been mentioned in the standard is diploma in radiography after completion of secondary education. Appointment of a radiation control officer (RCO) is another requirement for the operation of an x-ray facility [11].

4. Results and conclusion

4.1 Estimation of radiation levels

Fig.1 shows that occupational are receiving doses more than their limit 10µSv/h in the 3 facilities out of the 8 facilities. In other words, 40 % of the total facilities don't comply with regulatory requirements with regards to dose limit for the occupational worker. In 66% facilities, the amount of radiation penetrate through the entrance door (ED) is more than the permissible limit (0.5 µSv/h) for the public. The area outside the x-room is identified as supervised area where public dose limit is applicable. In most of the facilities radiation is not protected adequately at ED's due to insufficient amount of shielding. Primary and most of the secondary walls of the x-ray room have been established based on the standards. X-ray rooms are structured with 10-inch brick wall which is the requirement of the standards. As a result, radiation doses hardly penetrate through the walls of the facilities [3].

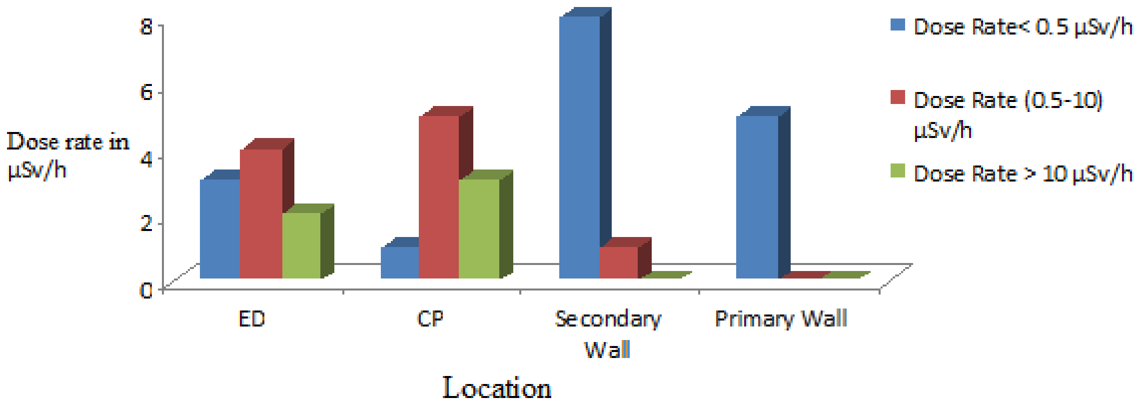

Fig.1 *Measurement of radiation dose rate across shielding materials*

4.2 Assessment of shielding materials

Wood, lead, thaiglass and bricks are found mostly as the shielding materials of the x-ray room. According to standard, wood and thaiglass are not recommended as shielding materials for x-ray room because these materials do not provide any shielding for x-ray radiation. But in some facilities (3) these materials are being used as shielding materials at entrance door of the x-ray room. Therefore, radiation is coming out through the entrance door and public is being exposed to unwanted radiation.

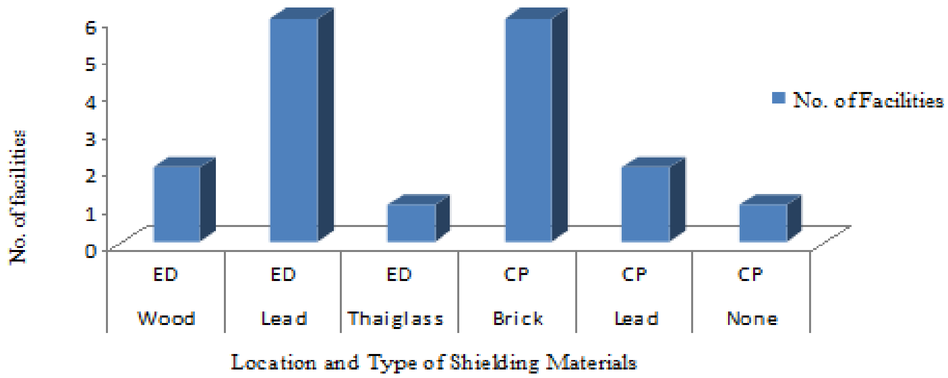

Fig.2 *Description of shielding materials used in x-ray facilities*

4.3 Selection of machine ratings

In the present study, it has been observed that for the same type of patient study by the same kind of machines for the same type of body's structure different kVp, mA and exposure time selected by the operators in different facilities. Even for the same patient different operator select different input parameters for the exposure. Fig.3 shows variations of kVp, mA and exposure time for lumbar spine (LS) study. Maximum value of mA was selected 200 and minimum was 60. In case of kVp, maximum 125 and minimum 55 were set up for the patient exposure. The time of exposure varied from 0.1 sec to 4 sec. This type of dissimilarities in selecting machine's parameters may happen due to the unqualified radiographer and lack of awareness on radiation safety of the operator.

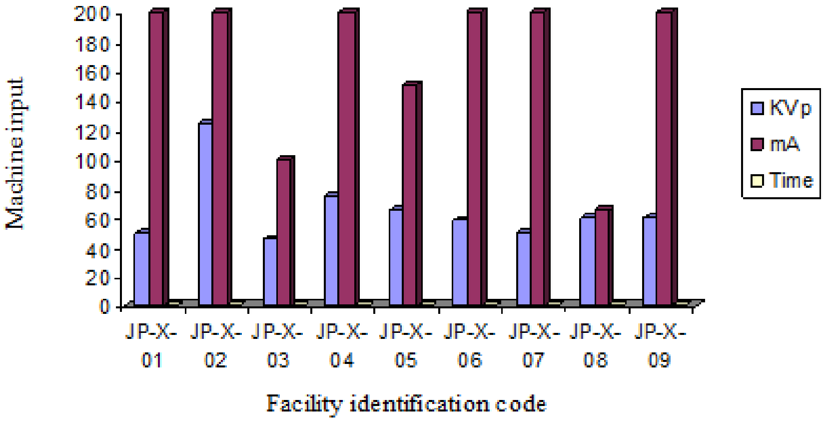

Fig.3 *Assessment of machine input settings*

5. Conclusion

Shielding structure of control panel barrier and entrance door of the diagnostic X-ray facilities is not up to the standard. Many facilities were established without following regulatory guidelines. In most of the diagnostic X-ray facilities the owner of the facility started working on the shielding structure after installation of an X-ray machine which is unrealistic and increases the shielding cost as well. As a result, more radiation dose is being received by the occupational worker and the public. The radiation safety condition is getting worse in the facilities due to the poor condition of shielding structure and lack of qualified operator for operating the machines. Therefore, stringent regulatory control and cooperation from the radiation users can only improve the present radiation safety situation in Bangladesh.

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References

[1] NSRC Publication .“ Main Report on Regulatory Survey-Inspection of Diagnostic X-ray Machines in Bangladesh”. Regulatory Publication I/II(15-20). Departmental Publication , (2001).

[2] Haider.Md. Mofazzal, Hannan. Abdul, Akramuzzaman. Mir. “Radiation safety aspects in diagnostix x-ray facilities in Bangladesh’. Nucl.Med. 13 109-113 (2010).

[3] NCRP Publication 49. “Structural Shielding Design and Evaluation of Medical Diagnostic x-rays and Gamma –rays of Energies up to 10 MeV.” NCRP Rep.49, 1976, Bethesda, MD, 20814.

[4] NCRP Publication 147. “Structural Shielding Design for Medical use of x-rays Imaging Facilities.” NCRP Rep. 147, 2004, Bethesda, MD, 20814.

[5] Safety Series No. 115. " International Basic Safety Standards for Protection Against Ionizing Radiation and for the Safety of Radiation Sources". International Atomic Energy Agency, VIENNA, (1996).

[6] Cember Herman. "Introduction to Health Physics." McGraw-Hill Professional (2008).

[7] Adhikari P. Kanchan, Jha. L.N., Galan P. Montenegro. " Status of radiation protection at different hospitals in Nepal." J Med Phys. 37. 240-244 (2012).

[8] BAER Act 2012. Bangladesh Atomic Energy Regulatory Act for controlling radiation and nuclear related activities. Law no. 19, (2012).

[9] NSRC Rules 1997. "Requirements of radiation shielding according to Nuclear Safety and Radiation Control Rules. Bangladesh Government Gazette, SRO No. 205, (1997).

[10] NSRC publication 2002. "Regulatory guide on radiation protection in medical diagnostic x-ray". NSRC-XR-G-01, ISBN 984-32-0671-1 (2002).

[11] Oluwafisoye, P.A., Obed, I.R., Bisi-Johnson, M.A., Olowookere, C.J., Popoola, A.O., Efunwole, H.O. "Environmental assessment, instrumentation-quality tests of radiological equipment and human health implications." Sci. Res. Essays 8(46), 2276-2280 (2013).