RADIOLOGICAL SAFETY IS A GROWING CONCERN: AN INCLUSIVE REVIEW IS DONE GIVING EMPHASIS ON COMMONLY PERFORMED RADIOLOGICAL EXAMINATIONS IN BANGLADESH.

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ABSTRACT

Based on the importance of radiological examinations, the number of diagnostic x-ray facilities is expanding every year all around the country but not simultaneously radiation safety framework is becoming developed convincingly according to national standards. The present study has been carried out underlying the analysis of safety infrastructure to pinpoint structural weaknesses and substantiate the implementation of regulatory standards. To perform precise analysis various radiation safety aspects including structural shielding conditions, radiation dose rate at different points, machines quality and operators' skill have been investigated comprehensively. In order to investigate radiation safety aspects in the far reaching areas in Bangladesh, the current study randomly selected 17 diagnostic x-ray facilities of two remote districts namely Jessore and Cox's Bazar. There are 09 most widely performed radiological examinations such as Chest x-ray, Lumbar Spine, Kidney,ureter and bladder(KUB), Hand, Thoracic, Skull, Neck, Knee and Peripheral Nervous System (PNS) have been considered in the study to analyze radiation levels. During this study, radiation dose rates at different locations of inertest were measured using GM tube-type dosimeter calibrated against gamma ray. In the x-ray facilities of Jessore district maximum dose rate at entrance door (ED) were recorded 70µSv/h (permissible level 0.5 µSv/h) and occupational workers were also found exposed to higher than their permissible level (10 µSv/h).On the other side, the radiation protection aspects of x-ray

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facilities of Cox's Bazar district were observed mostly terrible both for public and occupational workers with respect to Jessore district.

Keywords: Radiation Safety, Radiological examinations, GM tube, Permissible dose limit, National standard, Radiation dose rate.

INTRODUCTION

Uncontrolled use of ionizing radiation (such as x-ray) may cause harm to occupational workers, physicians, patients and public at large and the environment. The detriments may be deterministic (short term) and stochastic (long term) like changes in genetic code and induction of fatal cancer[1,2]. But most people are not aware or often forget that there is no threshold of radiation dose for the stochastic effects. In the develop countries, the radiological safety and protection, therefore, are ensured from fifties of last century, through stringent regulatory control to keep the risks of the concerned people and the environment within the internationally acceptable levels [3]. X-ray is one of the very old yet powerful modalities of diagnostic radiology. Bangladesh has a history over 80 years of using x-ray for medical diagnostic purposes. But it is a matter of great regret that people don't care radiation safety of ionizing radiation till today even its wide ranges of applications demands proper attention in many respects in order to ensure safety of the people being exposed to either intentionally or unintentionally.[4]. For the first time in Bangladesh, Nuclear Safety and Radiation Control (NSRC) Act 1993 and Nuclear Safety and Radiation Control Rules 1997 were promulgated to control the use as well as import and export of radioactive materials and radiation emitting devices in the country with a view to ensuring safety of radiation workers and the members of the public. Afterwards, Bangladesh Atomic Energy Regulatory (BAER) Act was published in 2012 including various provisions to regulate Nuclear Power Plant as well as other nuclear and radiation facilities throughout the country [5]. In this connection, on behalf of Bangladesh Atomic Energy Commission (BAEC), the then Nuclear Safety and Radiation Control Division (NSRCD) has shown a commendable drive and determination in pursuits of its goal to implement the NSRC Act and Rules noticeably in 1999 - 2002.However, the development of NSRC and BAER standards only contribute to limit deterministic consequences of biological effects of radiation. But the standards hardly play a role to control stochastic effects of radiation[6.] During investigation, it was found that in many

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radiation facilities of Jessore district, occupational workers were exposed to radiation level within their permissible limit but still they have health risk due to low level of exposure since there is no threshold dose for occurrence of stochastic effects [6, 11]. In most of the x-ray facilities of both district cities public were being exposed to significant amount of radiation doses which may cause both deterministic and stochastic effects. Infrastructural faults existing in many locations permit radiation to penetrate through different shielding barriers. The parameters related to structural design, protection and safety of radiation workers and the members of public are mainly studied and reported in this article. The outcome of the present study particularly the weakness of shielding structure in the facilities are more or less consistent with earlier study carried out in different parts of the country[5].

MATERIALS AND METHODS

Performing analysis of radiation safety structure, first of all a comprehensive investigation checklist was prepared in a way that it contains a wide range of radiation safety aspect parameters including detail information of academic and professional experience of radiation workers. The following are some of the key information that a checklist comprises: name of radiological examinations, Radiation Dose Rate, Machines 'input parameters, no. of patients, shielding materials and thickness, room size, shape and operators academic qualifications and experience, personal monitoring devices, machines 'model and aluminum filtration.

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DOSE RATE MEASUREMENTS

The radiation safety aspects both for occupational workers and public were investigated considering all radiological examinations performed for patients referred by concerned radiologist. In this connection, at every facility radiation dose was measured for 09 radiological examinations including Chest x-ray, Lumbar Spine, Kidney,ureter and bladder(KUB), Hand, Thoracic, Skull, Neck, Knee and Peripheral Nervous System (PNS). To evaluate radiation dose level at the locations of interest were determined considering points where public and occupational workers need to stay during exposure according to clinical protocol. But it is surprising; in some cases it was observed that public was become so much reluctant to remain in safe location instead. In the present study, GM tube-type dosimeter calibrated against gamma ray

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was utilized for measuring radiation dose level although Ion chamber-type dosimeter could be an ideal device to measure dose rate of x-ray. Hence, because of the factors of calibration and response time, there may be a little discrepancy between the measured dose rate and the actual rate at the locations of interest. This discrepancy still carries a meaning but has little influence on the significance of the overall result[7].

RESULTS AND DISCUSSION

General observations about the radiation safety issues in the radiology facilities in Jessore district in Bangladesh are not quite up to standard. Fig1.represents radiation dose rates at different locations of diagnostic x-ray facilities. It shows that public receives radiation dose level in 06 facilities more than their permissible limit (0.5µSv/h) out of 09 facilities studied in the present work. The highest dose rate is recorded at entrance door (ED) 70 µSv/h. During operation of x-ray machine, occupational workers were also exposed to radiation level which is adequately higher than their limit. Operating x-ray machines in 09 radiological facilities, occupational workers exposed to more than their limit in 06 facilities and the maximum dose received by them 100 µSv/h which is 10 times higher their permissible limit (10 µSv/h) according to national standard.[8].

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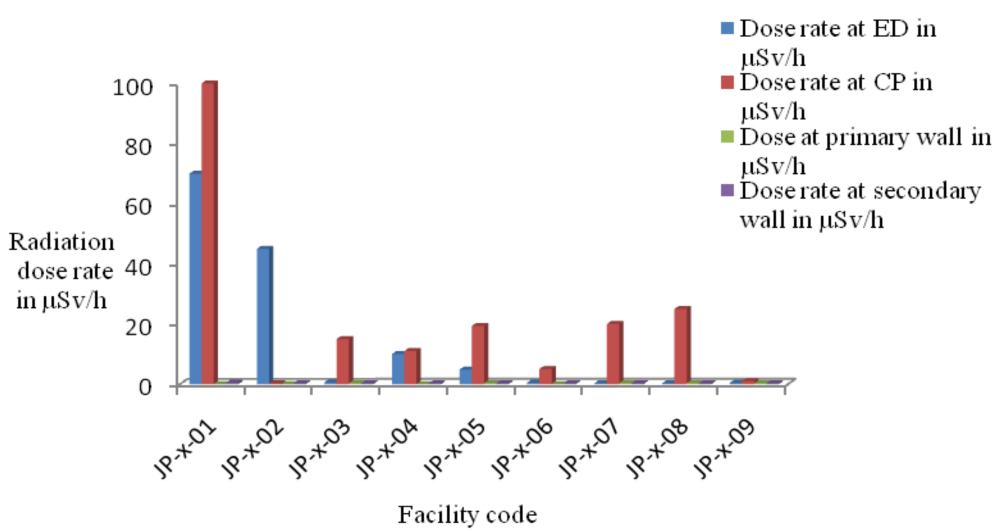

Fig.1 . Radiation dose rate across different barriers of x-ray facilities in Jessore district

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The undesired amount of radiation doses might have been recorded in different locations in and around the facilities due to many reasons for example chest stands are not appropriately located, patient waiting areas are not adequate or provided properly, any types of caution symbols are seldom displayed, protective equipments are not available and most importantly the shielding structure of control panel (CP), entrance door (ED) and the surrounding walls of x-ray room don't comply as well with minimum standard of regulatory requirements.[7].

Fig.2 is representing equivalent thickness of aluminium in mm in x-ray tube. According to national standard, the minimum required thickness is 1.5 mm Al[4]. But the present study highlights, most of the facilities do not implement regulatory standards. It is worth mentioning that in the old Chinese machines having inputs parameters less than 50 mA usually lacking aluminium filters which is the most important part of x-ray rube to ensure filtered out low energy x-rays that doesn't contribute producing diagnostic image rather than contributing extra exposure to patients [4]. Furthermore, faulty design of old x-ray tube housing allows leakage radiations to spread out in the x-ray room which provides unwanted radiation dose to occupational workers including patients positioned under x-ray tube [9].

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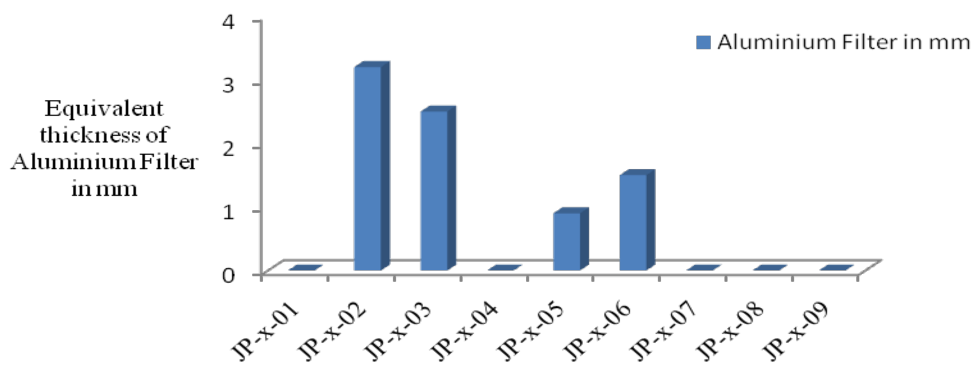

Fig 2. Facility Code

In Bangladesh there are 09 radiological x-ray examinations most commonly carried out by conventional x-ray machines according to the demand of referring physicians for investigating any fracture occurred in internal organs. Fig.3 depicts the analysis of radiation dose level during

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delivery of exposure to patients for various diagnostic imaging studies based on the selection of machines inputs (mA,kVp & time) parameters. According to study, during diagnostic imaging of lumbar spine (LS), occupational workers exposed higher amount of radiation than the other examinations. The LS imaging requires larger machines' input (kVp) depending on the patient size. X-ray operator were exposed up to 50 µSv/h during LS study and hence if an x-ray operator runs a machine for large number of patients every day obviously he will be in risk from radiation safety point of view [10,11]. With regards to other imaging studies including KUB, Skull and PNS also provide higher amount of exposure to operators which is totally unexpected. Here it should be mentioned that sometimes lack of operator' education and skill they frequently make mistake to select proper input parameters of machines to deliver exposure which is ultimately increasing considerable amount of radiation levels in and around the facility. In the present study, only 03 x-ray operators out of 15 comply with regulatory requirements having three years diploma degree and necessary experiences to operate machines. Appointment of a radiation control officer (RCO) is another vital requirement for supervision of radiation safety matter in an x-ray facility but here in Bangladesh in most of the facilities x-ray operator is playing role as a RCO which straightforwardly violates the standards.[12].

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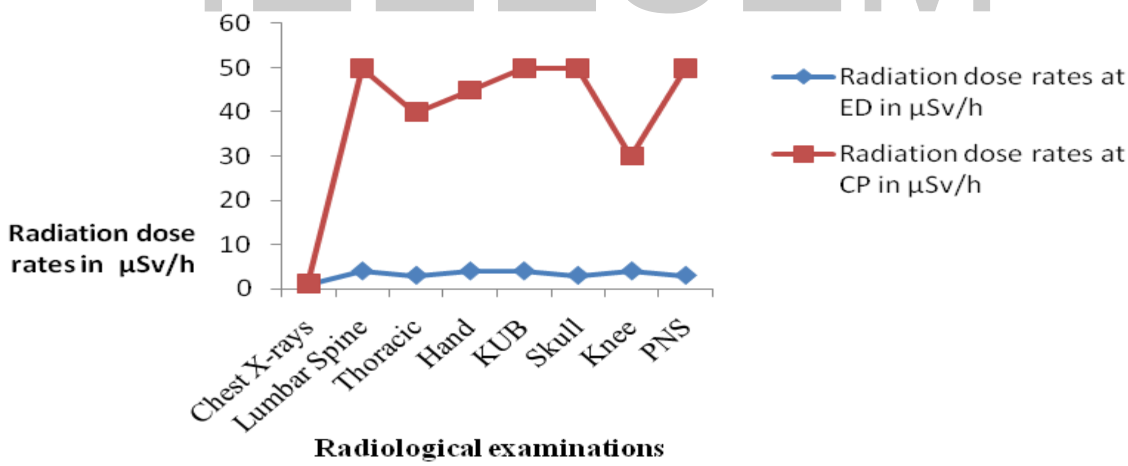

Fig.3. Dose rate variations with radiological examinations performed in Cox's Bazar district

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Fig.4. provides necessary information highlighting shielding materials most frequently used in the radiological facilities of Cox's Bazar district. Due to lack of knowledge, some radiological facilities they are using non Pb based shielding materials without following any standard and this material couldn't play any role to protect radiation level from penetrating through different barriers established in the facilities. Sometimes they are using recommended shielding materials but missing proper equivalent thickness of lead. In addition, the materials chosen by themselves were also found useless to ensure radiation safety for all corners [12, 13,14].

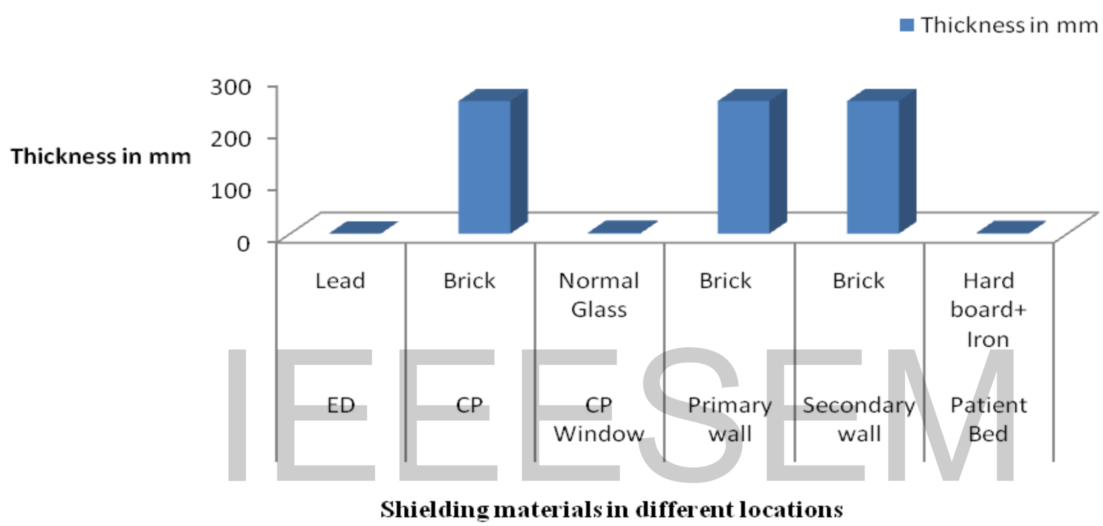

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Fig.4. Shielding materials used in radiological facilities of Cox's Bazar district

CONCLUSION AND RECOMMENDATION

The analysis of radiation safety aspects in diagnostic radiological facilities warrant immediate step for strengthening radiation safety infrastructure by national competent authority in order to avoid or minimize the undesirable hazardous effects that might have caused serious health concerned to patients and public along with relevant professional worker involved in the sector contributing to overall management of radiological diagnostic imaging procedure. Apart from this, radiation awareness program should be launched in a large scale including public and radiation workers to make them understand about the consequences of radiations which may cause at any time to anyone depending on the amount of radiation exposure received.

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