ORIGINAL ARTICLE

ASSESSMENT OF THE IMPLEMENTATION OF RADIATION DOSE LIMITING STRATEGIES IN RADIOGRAPHY PRACTICE, IN LAGOS, NIGERIA.

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ABSTRACT

Background: Technical faults represent one of the most potent limiting factors in optimizing pediatric radiography. These faults not only affect the technical quality of the radiographs produced but have far reaching consequences.

Objectives of the study. Satisfactorily completed questionnaires (survey forms) by the researchers were collated and analyzed using Epi info version 3.5.1 data processing package.

Results and Conclusion: full radiation beam collimation was achieved in only 10% (n=900) of all the procedures monitored while standard grades (medium speed) of film/screen combinations were in use in all the x-ray units, instead of rapid or extra-rapid grades that lower radiation dose to patients. Most of the hospitals, (90%; n=9) had no quality assurance programme for their x-ray machines, necessitating servicing only on breakdown. These therefore suggest suboptimal implementation of radiation dose limiting strategies in radiography practice in most of the hospitals studies.

INTRODUCTION

In Nigeria and indeed the world over, the importance of X-ray imaging in diagnosis and treatment of diseases cannot be over-emphasized. This importance was noted as early as a month after the discovery of X-ray by Conard Roentgen, when its application in medical practice was instituted.1 Today, X-rays are used for visualizing bone structures, opacified blood vessels and other dense tissues such as tumours2. X-ray departments have become one of the busiest ports of call for patients in the hospitals because the reports of body images captured with ionizing radiation are important for all specialists in the hospital for proper diagnosis of patients' conditions, as well as determine the prognosis and treatment options2. In 2006, Americans were exposed to more than seven times as much ionizing radiation from medical procedures as was the case in early 1980s3. This quantum increase was attributed to the growth in the use of other newer imaging modalities, especially CT scan and nuclear medicine3. The use of X-ray has also extended to Pathology, as in forensic Radiography4. Pathologists regularly use radiographic images during the course of autopsy to assist in the identification of foreign bodies or determination of deaths5.

Though, radiation exposure from diagnostic medical examinations are generally low and area almost always justified by the benefits of accurate diagnosis3, the radiation administered to patients at any point must be of the required dose for the examination requested, in accordance with the ALARA principle6. In Lagos State, Nigeria, public hospitals operate full scale X-ray departments where large numbers of patients are examined with ionizing radiation on daily basis. Radiation dose reduction in Radiography practice required appropriate control of several factors6. In many circumstances these factors are neglected, resulting in increased dose to patient

during radiographic procedures. Some of these factors are the effective collimation of the radiation beam size to the region of interest before exposure, use of high speed x-ray film/screen combination, application of 10-day/28-day rule for females of child bearing age, regular implementation of quality assurance and appropriate combination of exposure factors. These factors were selected due to their regular application and as ethical requirements in radiography practice. This study, therefore sought to identity the level of implementation of radiation dose limiting methods in radiography practice among public hospitals in Lagos. The findings would enable X-ray departments make the necessary adjustments that will conform to the standard radiation administration guidelines. This will in turn reduce to the barest minimum, the stochastic and non-stochastic effects of ionizing radiation to patients7 and the global exposure level. The salient areas for Government intervention; in view of limited resources will also be identified.

Materials and Methods

This study involved Ten (10) Public Hospitals in Lagos State, Nigeria, with a total of twenty six (26) conventional x-ray rooms. The ten Public Hospitals were spread across ten Local Government Area of the State. The Public Hospitals comprised both Federal and State-owned hospitals and were selected by convenient sampling. However, centres with patients daily turn-over less than twenty were excluded. Only Conventional X-ray services were assessed. Fifty two Radiographers and Thirty Intern-Radiographers in the employment of these hospitals were observed in their daily practice, without their knowledge. The different radio-diagnostic procedures were monitored (secretly) by the researchers as they were being carried out for compliance to standard radiation protection practices.

Each Hospital recorded an average of 30 Conventional X-ray cases; including special investigations daily, during the time of the research, which spanned from May-July 2012. A total of 9000 procedures were monitored by the researchers, whose mission was not disclosed to the Radiographers, who were on their regular clinical posting to the respective hospitals. They received training on the minimum radiation safety requirements and how to complete the survey forms.

The radiation dose limiting methods, rules and parameters assessed were the implementation of radiation beam collimation, application of 10-day/28-day rule, use of radiation intensification accessories (type of film/screen combination), proper combination of exposure factors and implementation of quality assurance program, and X-ray machine servicing. These factors were studied because they are ethical radiation dose limiting mechanisms which are in regular application radiography practice and are sometimes taken for granted. Radiation beam collimation was rated over 100% where evidence of collimation depicted by a 'silver-line' on the four sides of a radiograph is scored 100%; three sides = 75%, two sides = 50%, one side = 25%, while absence of any silver-line =0%.

The appropriate combination of exposure factors of kilo-voltage and mill amperage/time were determined by the chief radiographers or designated senior radiographers in charge of image quality assessment of radiographs produced. Other exposure factors such as focus film distance, focus object distance and object film distance were assessed within the diagnostic rooms by the researchers of their representative.

The data collected by the researchers were complemented by further clarifications obtained from interviews with the Director of Radiography services or the Chief Radiographers where necessary. The verification of evidence of quality assurance and frequency of x-ray machine servicing were also sought from them. Satisfactory completed questionnaires (survey forms) were collates and analyzed using Epi info version 3.5.1 data processing package. Permission was obtained from the director of Radiography services/Chief Radiographer of the respective hospitals before the commencement of the research. Two of them insisted on the anonymity of their hospitals and hence, the names of all the hospitals are not

mentioned in this study.

RESULTS

Full radiation beam collimation was achieved in only 10% (n=900) of all procedures monitored in this study. In 70% (n=6300) of all the cases, 75% degree of collimation was achieved, while degree of collimation was 50% and below in the rest of the 20% (n=1800) of the case, as shown in Table 1. The full application of 28-day rule for women of child bearing age was noted in all the hospitals. However, only 30% (n = 3) of the hospitals practiced the 10-day rule in special investigations involving the pelvic region, such as hysterosalpingogram (Table 1). Standard grades of film/screen combination were in use in all the conventional x-ray units under this study, contrary to the use of rapid/extra-rapid or slow-speed grades as may be indicated in different diagnostic circumstance (Table 3). All the hospitals used rare-earth brand of intensifying screen. The appropriate combination of exposure factors of kilovoltage, milliamperage/time, focus film distance, object film distance etc were achieved in over 75% (n=6750) of all the cases carried out in all the hospitals. Most of the hospitals 90% (n=9) had no quality assurance programme for their X-ray machines (Table 1). Only two conventional x-ray units in one hospital had proof of implementing quality assurance program every six months. Routine servicing of radiological equipments was non-existent in 90% (n=9) of the hospitals involved in this study (Table 2). Equipments were only serviced on breakdown. One hospital (10%) had a servicing programmer of twice a year.

Table 1: Application of radiation protection parameters and Technique modifiers.

Table 2: Assessment of hospital x-ray machine serving

Table 3. Assessment of other hospital radiation parameters

DISCUSSION

Full degree of collimation (100%) was recorded in only 10% (n=900) of procedures monitored in this study. However, 75% degree of collimation was achieved in 70% of all the cases, while degree of collimation was 50% or less in the rest of the 20% (n=1800) of the procedures. The collimation of radiation beam size is a professional tool for dose reduction to patients, staff and the environment in radiography practice. Degree of collimation was assessed by establishing evidence of collimation at the different sides of a radiograph. A radiograph with evidence of collimation – silver line, in all four sides/margin is 100% collimated. A light source demonstrates the area of exposure emanating from the collimator. A collimator is effective if the area visualized by the light from the collimator (light field) and the actual area exposed by the x-ray (radiation field) is congruent8. The precision of this congruency is achieved by regular quality assurance testing of light beam diaphragm alignment; which was almost non-existent in the x-ray units studied. This possibly accounted for the poor rate of appropriate beam collimation noted in the study however; this congruency was not evaluated during this study.

The application of radiation protection rules such as 10-day and 28-day rules for women of child bearing age were also evaluated in this study. All the hospitals applied the 28-day rule while only 30% applied the 10-day rule in addition. Ten-day rule were applied in special pelvic related investigations such as the hysterosalpingogram. It is important to protect females of child bearing age by applying these rules in order to protect the embryo in case of early pregnancy9, 10. On the use of radiation dose reduction accessories, it was discovered in the study that all the conventional x-ray units made use of the standard grade of film/screen combination; instead of rapi/extra-rapid, or slow-speed grades as may be required in different diagnostic circumstances. The film/screen combination speed is a major factor in radiation dose control in general. Radiography practice: For purpose of radiation dose reduction to patients, rapid or extra-raped film/screen combination

is recommended; though this goes with the price of reduced image definition. This agrees with Yu et al in his study to determine the major dose contributors in Barium Enema examinations. He found that by using a fast film/screen combination, the average radiographic dose-area product was significantly reduced and therefore concluded that a major source of increased radiation dose in Barium Enema examination is the speed of the image receptor11. However, since image quality deteriortates in resolution with increased film/screen speed, caution must be exercised in selecting the film/screen combination of choice in any examination. The appropriate combination of exposure factors in kilo-voltage, milli-amperage, time, Focus-Film-Distance, Object-Film-Distance, etc were achieved in over 75% of the cases carried out in the hospitals studied. Most repeat exposures arising from poor exposure factors combination could be attributed to fluctuating unpredictable machine output and sub-optimal performance due to lack of regular servicing and re-calibration.

A major factor which possibly contributed to higher radiation dose to the patients in 80% of all the diagnostic rooms investigated was the absence of quality assurance program. Only two conventional x-ray units had proof of carrying out quality control tests every six months. Quality assurance programme is useful in evaluating staff and equipment performance especially in ensuring proper control of radiation administration in radio-diagnostic departments. Quality control tests ensure equipment performance such as accurate exposure timing, kilo-voltage compensation, milli-amperage filament boost, rectifier functioning etc.

Another significant importance of quality control test is in ensuring the safety of the environment. An environmental survey of an x-ray facility in Nigeria by Oluwafisayo et al showed dose rates of 4.0msv/hr and 5.0msv/hr at the patients' reception and outside the entrance door respectively12. This implies that for facilities with no quality assurance programme, the possible radiation leakage is not established and can be in the range of the aforementioned study by Oluwafisayo et al or more.

Similarly, it was discovered in this study that x-ray equipment servicing, which is a component of quality assurance programme is non-existence in 90% (9) of the hospitals/x-ray units covered in this study. Equipments were only serviced on breakdown and sometimes only the cause of the breakdown is addressed. Only one hospital (10%) had a servicing programme of twice a year for its two conventional x-ray units. This is the agreement with Simpkin and Dixon13 who advocated in their study that servicing and calibrating x-ray machine at least twice a year ensure that the machines maintain standard output and functions optimally; which reduces repeat exposure rate and hence radiation dose to patients. The reasons for this poor attitude to equipment maintenance were attributed to paucity of fund, bureaucracy and dearth of competent engineers and medical physicist who can be readily engaged as the need arises. Poor advocacy for equipment maintenance and need for implementation of quality assurance by the Radiographers – the users, were cited as reasons for inadequate funding.

CONCLUSION

Full radiation beam collimation was achieved in only 10%(n-900) of all the procedures monitored while standard grades (medium speed) of film/screen combinations were in use in all the x-ray units, instead of rapid or extra-rapid grades that lower radiation dose to patients. Most of the hospitals, (90%; n=9) had no quality assurance programme for their x-ray machines, necessitating servicing only on breakdown. These, there suggest suboptimal implementation of radiation dose limiting strategies in radiography practice in most of the hospital studied.

RECOMMENDATION

There should be effective implementation of Quality Assurance Programmes in the radio-diagnostic facilities. Quality control tests in form of reject film analysis, light beam alignment, equipment servicing

and re-calibration, spinning top tests, radiation leakage survey etc are practical steps that can aid reduced radiation dose to patients staff and the environment.

All radio-diagnostic departments that have not embraced digital image processing technology or filmless radiography should insist on the use of rapid or extra film/screen combination for reduced radiation dose to patients.

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