DOSE REDUCTION IN TRAUMA PATIENT'S PERFORMED USING PORTABLE EQUIPMENTS AT KENYATTA NATIONAL HOSPITAL, KENYA

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ABSTRACT

This study gives results of preliminary studies of medical radiation exposures due to chest examinations of patients examined using portable equipments at the Kenyatta National Hospital, under Kenyan IAEA project "RAF/9/033: Strengthening Radiological protection of patients and medical exposure control". Moving X ray equipment, and not patients, is the idea behind portable radiography. The study was undertaken as an initiative of dose reduction measures without compromising image quality using seven portable X ray equipment in the hospital. A questionnaire was used to collect data per equipment. Radiation doses were calculated from patient parameter and exposure factors. Quality control tests on all the X ray equipment were performed prior to the study using calibrated Unfors XI equipment. The two hundred and forty patients considered in the study were neonates 15%, infants 25%, 13-60 months 48%, and 61-120 months 12%.The results showed the average dose received: neonates 0.12 mGy, infants 0.12 mGy, 13-60 months 0.16 mGy, and 61-120 months 0.19 mGy. Image quality analyses were: A 63%, B 32% and C 5%. The patient doses compare well with the international reference dose levels. The findings have significant value to the radiology community, and furthermore provide basis for the establishment of DRLs for diagnostic radiology.

1. INTRODUCTION

Diagnostic X rays are used extensively in medicine such that they represent by far the largest man-made source of public exposure to ionizing radiation. Although radiation exposure from the several diagnostic procedures cannot be avoided; there are means to reduce exposure as much as possible. Today, quality assurance and safety have become hallmarks for efficient and successful application of any medical procedure [1]. During recent years, patient dose has become a major issue largely and because of the increasing awareness of the effects of ionizing radiation, X ray users are now demanding more information on dose exposure, and measures to mitigate exposures and reductions. The medical use of ionizing radiation is a dynamic field in which new imaging techniques are introduced such as multislice CT and digital imaging, which may result in a lower dose per image compared with other devices and uses photo stimulable storage phosphor [2].

The two basic principles in radiation protection of patient as recommended by the ICRP are justification of practice and optimization of doses usage protection [3]. In diagnostic radiology, periodic dose assessments are made in order to encourage the optimization of the radiation usage of the patients. Dose measurements are done in order to compare different radiological techniques for compliance with some international guidelines and regulations. These studies have reported wide variations in patient dose from specific X ray examinations.

The study was carried out at Kenyatta National Hospital (KNH) the largest referral hospital in Kenya and the entire East and Central Africa region. It is situated about 3km west of Nairobi. On average, it caters for 80,000 in-patients and over 500,000 out-patients annually. It has a bed capacity of 1800, 50 wards, 22 out-patient clinics, 24 theatres and an accident & emergency unit. It offers quality specialized services to the patients; the Radiology Department offers diagnostic imaging services to more than 200 patients daily and has in addition the following imaging modalities: magnetic resonance imaging, ultrasound, computed tomography, dental imaging, mammography, fluoroscopy, interventional and theatre imaging.

Portable radiography forms an important imaging modality in medical diagnostic radiology. Portable X ray imaging requires that the X ray equipment unit ~~to~~ be moved to the patient sites in order to take a radiograph for diagnosis. This is particularly required when the patient is immobilized due to debilitating illness, trauma or after surgery [4]. Examples of the patients X rayed using portable equipment include those patients on traction, life support machine, on dialysis machine, under seal drainage tube, and those with contagious diseases. They are situated in different locations of the hospital units, namely, Intensive Care Unit, New Born Unit, orthopaedic wards, paediatric wards, surgical ward, private wing and the Radiology Department for emergency examinations. Without good radiation safety measures, the use of portable X ray radiography may result in increased radiation exposure to patients and the public.

A total of 240 patients were surveyed in this study for non bulky chest examinations procedures for patient dose exposures using the seven portable X ray equipment that include; three Philips Practix 160 equipment with total filtration 2.0mm Al at 75 kVp, three Philips Practix 400 equipment with total filtration 2.9 mm Al at 75 kVp, and one Philips practix 300 equipments with total filtration 2.0mm Al at 75 kVp. For normal diagnostic work, the ICRP recommends a total beam filtration equivalent to 2.5mm Al at 75 kVp with 1.5 mm of this being permanent.

The patient radiation doses exposures levels were determined from exposure data and patient data details for all chest examinations. The patient distribution was: neonates (28 days after birth) 15 % (36 patients), infants (ages of 1-12 months) 25% (60 patients), 13-60 months 48% (115 patients) and 61-120 months 12% (29 patients). This study was limited to in-patients for chest examinations during the period between August 2011 and February 2012. The data obtained was statistically analyzed.

2. SPECIFIC OBJECTIVES

1) To measure and analyze the patient radiation dose exposure for portable X ray equipment for chest examination procedures;
2) To determine the accuracy of portable X ray units' outputs that influence the image quality;
3) To identify the problems related to quality control of portable X ray units; and
4) To identify the problems related to image processing.

3. METHODOLOGY

The purpose of quality assurance programs in diagnostic radiology is to establish procedures for monitoring periodically and continuously the performance of radiological facilities.

The equipment were surveyed for compliance with the following quality control parameter, in accordance with the procedures outlined in [5].

1) Reproducibility of exposure (<2%);
2) kVp accuracy (<5%);
3) Timer accuracy (<5%);
4) Light/radiation beam alignment (< 1% FFD); and
5) Half value layer –HVL (mm Al) (>2.3 mm Al).

For check on the accuracy of X ray machines output, several kilovolt peak (kVp) values were selected randomly in the range from 40-100 kVp, milliampere time product (mAs), and focus-to-film distances (FFD) for measurements as quality control tests, prior to the study. The output was measured using Unfors Xi Digital Dosimeter. However, routine quality control tests and servicing of equipment are done in March, July and October by Philips Company. The hospital bio-medical engineers also ensure that the equipment are in good working condition. For this study a questionnaire and a checklist were used to collect patient data and exposure details pertaining to chest examinations, for example age, sex, ffd, height and weight.

4. RESULTS AND DISCUSSION

The results showed the average dose received: neonates 0.12 mGy, infants 0.12 mGy, 13-60 months 0.16 mGy, and 61-120 months 0.19 mGy. In this study the following local dose reference levels were therefore established as: 0.1 mGy for chest PA, 0.22 mGy for chest LAT. Although in this study only chest AP examinations were considered, the findings have significant value to the radiology community and furthermore provides basis for the establishment of DRLs for diagnostic radiology.

Results of the X ray output measurements for accuracy comply for most parameters tested in respect to kVp, reproducibility, timer accuracy, beam alignment and HVL in this study. However, there was failure in reproducibility for unit in Paediatic ward (3B) and surgical ward (4B), and for beam alignment for units in the ICU, paediatric ward (3B), surgical ward (4B) and in the radiology department. This was as a result of electrical faults, improper equipment usage without following the operational instructions, improper maintenance schedules and heavy workloads.

The results of the other quality control parameters, such as image quality analyses, indicated image grading results as follows: grade A 63% (considered good), grade B 32% (satisfactory), and grade C 5% (rejected). The ICU unit contributed significantly to grade B (satisfactory) due to faulty equipment outputs and film fogging.

All the 13 protective wears were scanned and checked physically for possible cracks, wear and tear. The results showed that some gowns were torn and dirty with blood stains. This poor hygiene could be a result of careless handling and lack of proper storage.

Other tests showed that movement related problems were associated with 56%, worn out covers casing and defective support with 14%, power supply failures with 14%, and faulty beam collimation with 16% of the studied cases. The defective power supply was due to faulty cabling.

Film processing condition was tested for the following: light fog, safe light, wattage of the bulb and white light. The results indicated that the majority of the films rejected (9%) had high proportion due to fogging 65% and 26% which was due to light leakage in the darkroom. A number of cassettes were found faulty as there was presence of light leakage in the casing.

The diagnostic reference levels from this study are comparatively with those set up by most countries. The table below shows the DRL doses for different countries.

TABLE I. DRL~~s~~ DOSES FOR DIFFERENT COUNTRIES

Exam	This study	Brazil	UK	Iran	IAEA	IAEA	IAEA	Ireland	Italy	CEC	NRPB
Date of settings DRL		2009	2005	2008	2004	2008	1996			2000	2000
Chest AP	0.19 mGy	0.35 mGy	0.15 mGy	0.41 mGy	0.40 mGy	0.33 mGy	0.2 mGy	0.3 mGy	0.25 mGy	0.3 mGy	0.2 mGy
Chest lat		0.96	0.60	2.07	1.50						

5. CONCLUSION

Based on the findings of the study, the results of patient exposure doses were found to be within the reference levels, comparable to those set up by most countries. In general, the measured ESAK levels were within the recommended reference dose levels. In addition, the majority of the countries have gone fully to digital radiography and computed radiography which produce~~s~~ low exposures and the numbers of retakes are minimized and radiation is also optimal. The results will therefore help optimize exposure parameters in portable equipment~~s~~. In this study, cassettes with blue/green sensitive films of speed 400 were used and majority of the patients underwent more examinations as a result of follow ups especially in orthopaedic wards and the Intensive Care Unit. The radiation exposure output would therefore be minimized with the introduction of digital imaging.

We hope through this project to establish reference dose levels in the hospital and improve image quality by establishing other causes of unnecessary patient exposure and implementation of corrective measures**.**

This study will also provide additional data that will help the regulatory authority to establish reference dose level for diagnostic radiology department and for reference by other professionals. However, more studies are recommended using digital or computed radiography for comparison.

6. RECOMMENDATIONS

This study recommends the following:

1) Development of an X ray exposure chart for each of the units;
2) Appropriate film storage and processing conditions;
3) Proper use of protective safety wears;
4) Improvisation of disused protective wears for other protection measures; and
5) Adherence to care and maintenance and repair schedules of the units.

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