ARTICLE IN PRESS

Radiation Physics and Chemistry xxx (xxxx) xxx–xxx

Contents lists available at ScienceDirect

Radiation Physics and Chemistry

journal homepage: www.elsevier.com/locate/radphyschem

Assessment of medical radiation exposure to patients and ambient doses in several diagnostic radiology departments

A. Sulieman[a,*], T. Elhadi[b], E. Babikir[c], M. Alkhorayef[c], M. Alnaaimi[d], M. Alduaij[d], D.A. Bradley[e,f]

[a] Prince Sattam bin Abdulaziz University, College of Applied Medical Sciences, Radiology and Medical Imaging Department, Alkharj, Kingdom of Saudi Arabia
[b] North Kordofan State, Ministry of Health, Medical Equipments Engineering Department, Alobied, Sudan
[c] Radiological Sciences Department, College of Applied Medical Sciences, King Saud University, Kingdom of Saudi Arabia
[d] Nuclear Medicine Department, Kuwait Cancer Control Center (KCCC), Kuwait
[e] Department of Physics, University of Surrey, Guildford, Surrey GU2 7XH, UK
[f] Sunway University, Institute for Health Care Development, Jalan Universiti, 46150 PJ, Malaysia

ARTICLE INFO

Keywords:
Radiation dosimetry
X-rays
ESAK
Quality control
Patient exposure

ABSTRACT

In many countries diagnostic medical exposures typically account for a very large fraction of the collective effective dose that can be assigned to anthropological sources and activities. This in part flags up the question of whether sufficient steps are being taken in regard to potential dose saving from such medical services. As a first step, one needs to survey doses to compare against those of best practice. The present study has sought evaluation of the radiation protection status and patient doses for certain key radiological procedures in four film-based radiology departments within Sudan. The radiation exposure survey, carried out using a survey meter and quality control test tools, involved a total of 299 patients their examinations being carried out at one or other of these four departments. The entrance surface air kerma (ESAK) was determined from exposure settings using DosCal software and an Unfors -Xi-meter. The mean ESAK for x-ray examination of the chest was 0.30 ± 0.1 mGy, for the skull it was 0.96 ± 0.7 mGy, for the abdomen 0.85 ± 0.01 mGy, for spinal procedures 1.30 ± 0.6 mGy and for procedures involving the limbs it was 0.43 ± 0.3 mGy. Ambient dose-rates in the reception area, at the closed door of the x-ray room, recorded instantaneous values of up to 100 μSv/h. In regard to protection, the associated levels were found to be acceptable in three of the four departments, corrective action being required for one department, regular quality control also being recommended.

1. Introduction

Radiation exposures resulting from medical diagnostic procedures typically form the largest anthropological source of public exposure, year by year the collective effective doses from these activities continuing to grow. In no small part, this is due to the introduction of new imaging modalities, some of which involve high-dose imaging procedures, and more generally to improvements in healthcare the target of which is to promote quality of life, life-extension being a possible consequence. With diagnostic medical exposures making a large contribution to the public exposure to ionizing radiation one estimate is that during the past decade medical imaging has contributed about 50% of the overall radiation dose to modern populations, compared with about 15% in 1980 (Mettler et al., 2009; UNSCEAR, 2000). Although, the use of medical imaging has increased the ability to diagnose many pathological conditions, to be associated with this is a possibly avoidable and perhaps non-trivial potential for reduction of radiation risk. Such risks would include an increased probability of carcinogenesis, depending on radiation dose, gender and age at exposure (ICRP 103, 2007).

For medical diagnostic procedures, measures for radiation risk reduction find their basis in application of the principles of justification and optimization. Additionally, in some countries for each radiological procedure, guideline doses based on best practice have been established. One of the requirements of the associated optimization process is regular periodic monitoring of performance of the radiological equipment and assessment of techniques employed in their use. The focus of such monitoring serves to maintain standards once these have been developed, in regard to equipment performance, image quality and importantly, in regard to the present emphasis, that of patient dose.

Monitoring surveys seek to establish values of measured quantities above which corrective action may need to be taken. Radiation protection of the patient is now practiced to the extent that internationally several regulatory bodies have carried out studies leading to

* Corresponding author.
E-mail address: abdelmoneim_a@yahoo.com (A. Sulieman).

http://dx.doi.org/10.1016/j.radphyschem.2017.04.015
Received 15 April 2017; Accepted 17 April 2017
0969-806X/ © 2017 Elsevier Ltd. All rights reserved.

establishment of standards, guidelines (including guidance doses) and regulations to guide practice. Although doses in radiology are typically low and the chance of late effects are typically minimal it is generally accepted that radiation exposure to the radiation workers and the patient should be As Low As Reasonably Achievable (ALARA).

In the North Kordofan State (NKS) of Sudan, radiology services and access to these have increased to a great extent in recent years. The motivations for the present study stem from the increasing frequency and variety of examinations together with anecdotal reports of relatively high radiation doses to patients in the conduct of routine X-ray examinations; by association, absorbed doses to technologist and other medical staff have also been suggested to be significant. To our knowledge, in North Kordofan this is the first such study regarding patient dose monitoring. As such, in respect of the stated concerns, the objectives of present study have been to evaluate the radiation protection status in four radiography departments in NKS, primarily in assessing the entrance surface air kerma (ESAK) during conventional X-ray examinations.

2. Materials and methods

2.1. X ray machines

The data of this study were collected from four radiology departments in the western area of Sudan: Elobied Diagnostic Center (A), Elobied-National Fund for Health Insurance (B), Elnihoud Radiology Clinic (C) & Elnihoud Hospital (D). Table 1 provides the associated X-ray machines data of interest herein.

2.2. Patient populations

A total of 299 patients were examined in the four identified hospitals within NKS. Table 2 shows the number and type of examination conducted per department. For all of the patients whose exposures were included in this study, to maintain consistency of the information data were collected using an agreed data collection sheet. The following parameters were recorded: age (in y), weight (in kg), height (in cm) and body mass index (BMI), the latter derived from weight (kg)/(height (m^2)), and exposure parameters.

2.3. Imaging technique

No prior preparations were necessary in advance of the routine x-ray investigations included herein. Thus said two simple measures were taken; a hospital gown was used to replace all clothing on the upper part of the body and all jewelry was removed from the area surrounding the examined area. Routine x-ray examinations typically consist of two views, the frontal view (referred to as posterior-anterior PA) and/or conversely the anterior-posterior view (AP) and the lateral (side) view. In x-ray imaging, the exposure parameters used are selected according to patient weight and organ size. For all routine examinations other than for chest x-ray imaging which for geometrical reasons uses a focus to film distance (FFD) of 180 cm (suiting the large format demanded of the chest), the standard distance of 100 or 115 cm was used (note that the imaging device is now more popularly referred to as the image receptor, a more inclusive terms to allow for the variety of passive or active 2D detectors that are now available, the acronym FFD nevertheless being popularly retained, otherwise sometimes referred to as focus to detector distance, FDD).

Table 1
X-ray Machines.

Center	Manufacturer	Year of installation	Max kV	Max mA	Max time (s)	Total Filtration (mm Al)
A	G.E	2008	150	200	100	1.5
B	Shimadzu	2007	150	500	2.2	1.5
C	GE	2002	150	–	5	1.5
D	Toshiba	2005	150	640	6	1.5

Table 2
QC tests results.

Test/hospital	A	B	D	C
kVp Accuracy	0.15	0.5	N.A	27.00[a]
Timer Accuracy	0.15	0.5	N.A	10.8[a]
kVp reproducibility	0.02	0.15	N.A	N.A
Time- reproducibility	0.11	0.17	N.A	N.A
Exposure linearity	$0.9 \le 10.3$	$2.0 \le 9.7$	N.A	N.A
Collimator/ light field Coincidence	Acceptable	Acceptable	Acceptable	Acceptable

N.A: not available.
[a] unacceptable.

2.4. Entrance Surface Air Kerma (ESAK) calculations

ESAK is defined as the absorbed dose to air at the center of the beam, including backscattered radiation (ICRU 74, 2006). The exposure to the skin of the patient during standard radiographic examination or fluoroscopy can be measured directly or obtained via estimation, the latter calculation accounting for the exposure factors used and the equipment specifications, applying the formula provided below, using DosCal software and an Unfors -Xi-meter, RaySafe Xi R/F, Billdal, Sweden (Fig. 1).

$$ESAK = OP \times \left(\frac{kV}{80}\right)^2 \times mAs \times \left(\frac{100}{FDD}\right)^2 \times BSF$$

Here, OP is the X-ray tube output in mGy/(mAs), assessed at 80 kV at a focus to detector distance of 1 m (FDD), normalized to 10 mAs. Here kV represents the peak tube potential (kVp), mAs is the product of the tube current (in mA) and the exposure time (in s), FDD is measured in cm, and BSF is the backscatter factor (Fig. 2). Normalization is made to the ESAK observed at 80 kV and 10 mAs, the potential across the X-ray tube and the tube voltage and current being recognized to be highly stable at this point. After all input data are entered, the BSF is then calculated automatically, obtained in use of the Dose Cal software from the onboard database of BSF values manually into the software. The tube output, the patient anthropometric data and the radiographic parameters (kVp, mAs, FDD and filtration) are all initially inserted in the software, the kinds of examination and projection being subsequently selected. Fig. 2 illustrates the experimental setting of ESAK

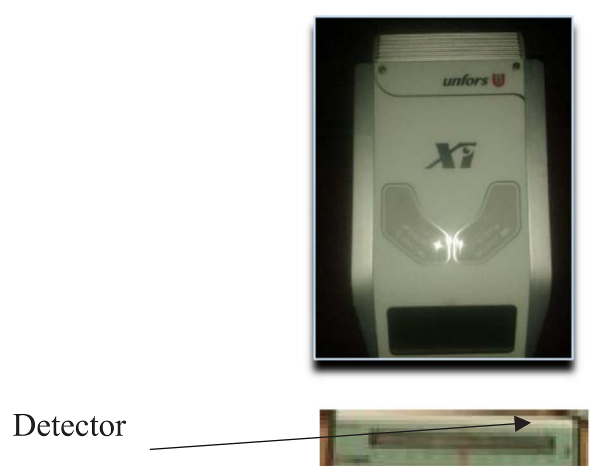

Fig. 1. Unfors Xi Base is a solid state detector with external detector with energy response from 40 to 150 kVp and accuracy ± 5%.

Download English Version:

https://daneshyari.com/en/article/5499079

Download Persian Version:

https://daneshyari.com/article/5499079

Daneshyari.com