Evaluation of the Quality Parameters of Mobile X-Ray Units Equipment Used for Radiodiagnostic in Public Institutions of Sergipe

Celso A. Oliveira*; Lucas R. dos Santos, Fábio. A. R. Silva and Divanizia N. Souza
Departamento de Física, Universidade Federal de Sergipe, São Cristóvão, SE, 49100-000, Brasil

Abstract. This project was started having as main objective to observe the diagnosis quality offered by mobile x-ray units utilized in a health care institution. In this work we are reporting the first results obtained from three equipment used by a public institution inspected on the state of Sergipe, Brazil. During the verification visits at institution the radiology technicians were questioned about specific maintenances performed on the equipment and the operating procedures used. Moreover, some beams parameters were verified as dose, dose rate, and peak voltage and exposition time. The obtained results showed a good index of reproducibility and linearity of the operation parameters, of the kerma air rate and exposition time. However, to the kVp tests were observed variations up to 20% between the nominal value used and the value measured on the x-ray units. The test results of the focal point are in accordance with the acceptable standards. The analyses of equipment and the answered questionnaire showed that have not been performed periodic maintenances in the equipment, therefore some of the equipment do not present satisfactory requirements of operating, their do not make use of luminous field nether collimator or the scale meter to checking the source to surface distance. The main factor that can explains the negative results is the absence of a continue quality program associated with the unsatisfactory maintenances. The health care institutions evaluated are introducing a permanent quality program to the x-ray devices.

KEYWORDS: radiodiagnostic, control quality

1.Introduction

The periodical verification of the technical parameters of the X-ray equipment and image registration systems aims to improve the image quality, reduces the patient exposure and eliminates any radiation that does not contribute for the obtaining of useful images.

One of the main reasons of rejected radiological plates is the lack of applying quality control programmes (PQG) at the radiology centers. In addition, this leads to increased expenses and unnecessary exposure to radiation, which consequently increases the risk to develop diseases in patients [1].

A quality control program to radiographic images, equipment and procedures related to these processes avoids wrong and non-conclusive diagnoses that could lead to further exposures of the patient and to an increase costs due mainly to the radiography repetition, besides the overuse of x-ray facilities.

With the expansion of the use of ionizing radiation in medicine, came the need to standardize the operational aspects of radiological protection to the medical services that use medical x-ray beams. For this reason, several regulations have been established. In Brazil, the Order (Portaria) SVS/MS 453 of 1998 of the Ministry of Health establishing the basic guidelines for radiation exposure protection in medical and odontological x-ray facilities [2].

Among the many factors that impact the performance of a radiodiagnostic service (SR), certainly the more important are the problems deriving from mechanical or electronic failure of the equipments, sometimes due irregular maintenance, either by lack of calibration. Other causes include the films processing, and accessories used in the examinations, and the individual protection equipments, beyond others.

Another point that should be taken into consideration regarding the deployment of a PGQ is that it considers the creation and expansion of a philosophy of work based on radiological protection, since it

became the primary factor to the inclusion and the establishment of radioprotection protocols and norms. Achieving a significant improvement in the radiological quality performed by a health service in order to obtain images with the appropriate standards is the main way to get more accurate diagnoses with radiation doses to the patient as low as possible.

In this work we are reporting the first results that are been obtained in a project that has as the main objective to observe the diagnosis quality offered by mobile x-ray devices utilized in three public health care institutions inspected on the state of Sergipe, Brazil. Also, through results we trying to shows the members of the institution visited about of the importance of having in their establishment a professional staff dedicated to dosimetry of x-ray facilities and radiological protection.

2. Experimental

The analyses were performed in the emergency care service (ECS), cardilological intensive care unit (CICU) and in the general/adult Intensive Care Unit (GICU). To measures in this public institutions inspected were used criteria established in the Resolution Nº 64 of the Agência Nacional de Vigilância Sanitária [3] which describe the methods to execution of quality control tests in x-ray beams used in medical diagnostic radiology, this resolution complements the order "Portaria 453/98" [2]. The checks were performed using a kVp meter (Unfours, 582L), an ionization chamber (Radcal, 2025), a plastic rule, and a tape measure and focal point meter.

3. Results

3.1 .Air Kerma Reproducibility

To study the reproducibility of the dose and air kerma rate it was applied a 70 kVp x-ray tube voltage and a current of 60 mA. To each exposition time the analyses was repeated four times. Table 1 shows the data of values obtained to air kerma and air kerma rate. To the same operational conditions of the mobile x-units we can observe that the rate changed when the time exposition was changed.

Table 1 – Air kerma and air kerma rate

Nominal Exposition time (s)	Service	Air Kerma (Gy) $\times 10^{-6}$	Air kerma rate (Gy/s)$\times 10^{-3}$
0.1	ECS	200.60	1.989
	CICU	250.40	2.445
	GICU	163.60	1.797
0.2	ECS	384.40	1.911
	CICU	320.00	1.678
	GICU	373.40	1.972
0.3	ECS	549.60	1.839
	CICU	487.50	1.561
	GICU	594.10	1.927

3.2. Accuracy and reproducibility of x-ray tube voltage

Four values of nominal voltage in the devices and the appropriate currents values to these tube voltages were selected, in accordance with the clinical application of each service. The kVp meter was located at 1,0 m from the x-ray focus. For each voltage were performed four expositions. We elaborated the table 2 with the average values of the collected data.

Table 2. Results of measurements of voltage and air kerma

Nominal Voltage (kVp)	Nominal Current (mA)	Service	Voltage Measured (kV)	Air Kerma (Gy)×10^{-3}
65	60	ECS	58.48	293.15
		CICU	56.40	247.80
		GICU	56.50	173.60
60	80	ECS	54.53	685.45
		CICU	55.18	157.70
		GICU	53.45	206.43
55	80	ECS	52.48	344.43
		CICU	51.90	351.40
		GICU	51.75	517.65
50	100	ECS	47.00	184.70
		CICU	47.93	289.40
		GICU	47.65	290.20

3.3. Accuracy and reproducibility of exposition time

In order to obtain the values of exposition time four values were selected among those used clinically. The kVp meter and the ionizing chamber were placed at 1.0 m of the detector and carry through four expositions for each exposition time. Table 3 shows the exposition time measured for each set of parameters.

Tabela 3. Comparison between nominal exposition time and exposition time measured

Current (mA)	Nominal exposition time (s)	Service	Exposition time measured (s)
60	0.2	ECS	0.178
		CICU	0.173
		GICU	0.169
80	0.1	ECS	0.095
		CICU	0.091
		GICU	0.095
80	0.3	ECS	0.314
		CICU	0.274
		GICU	0.297
100	0.2	ECS	0.162
		CICU	0.177
		GICU	0.177

4. Discussion

In the air kerma rate analysis the devices showed acceptable values of reproducibility, the maximum deviation observed was 4.98%. This result is in accordance with the established by Portaria 453/98 [2] because is a variation lower than 10%.

About air kerma linearity was observed that only for the device used at the cardilological intensive care the linearity was not adequate, the measurements showed a variation of up to 57.4% when the acceptable is 20%.

The x-ray devices showed a good agreement between nominal and measured values when were choice values of nominal time exposition between 0.1 s and 0.3 s; however, when was applied a nominal exposition time of 0.2s, independently of the mA selected, the devices did not present a desirable performance since was observed a variation of above 10% between the nominal voltage and voltage measured. The exposition time reproducibility was adequate.

When studying the x-ray tube voltage could be observed that the increased of nominal voltage result in a reduction of the voltage accuracy as be observed to 65 kVp, to this nominal value all the devices had shown data in disagreement to ANVISA [2]. It is possible which the high voltage generator of the equipments it is not operating properly.

Although it has already spent 10 years from publication of the order 453 [2] there are institutions that do not develop a quality control program to x-ray equipments. The previous results had shown that is necessary the immediate implantation of a quality control program in the radiological services of this institution. From the report the institution is establishing new association with qualified professionals in order to instruct their workers occupationally exposed and to adequate the maintenance of the x-ray devices. The team responsible for these analyses is following the process of adaptation.

Acknowledgements

The authors wish to thank CNPq for partial financial support.

REFERENCES

[1] AGHAHADI1, B., et al. Impact of quality control on radiation doses received by patients undergoing abdomen X-ray examination in ten hospitals. Iran. J. Radiat. Res, (2006); 3 (4): 177-182

[2] MINISTÉRIO DA SAÚDE. Diretrizes de proteção radiológica em radiodiagnóstico médico e odontológico. Portaria 453. Diário Oficial da União, Brasília, 1º. de junho de 1998. MS/SVS, 1998.

[3] AGÊNCIA NACIONAL DE VIGILÂNCIA SANITÁRIA. Uma orientação técnica sobre guia de procedimentos para segurança e qualidade de imagem em radiodiagnóstico médico, Resolução - RE, No. 64 de 04 de abril de 2003.