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Dose levels in medical staff at hemodynamics services in Minas Gerais State, Brazil—Preliminary results

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Abstract

Medical staff during interventional radiology could be exposed to radiation conditions that may cause very high dose levels depending on the X-ray machine operational conditions. The dose levels received by medical staff during interventional radiology are very high depending on the operational conditions and the patient trunk thickness. Dose levels could reach a factor of 30 for fluoroscopy or cine modes. The ALARA principle, which emphasizes the adoption of techniques and procedures to keep dose levels as low as reasonably achievable, should be followed to minimize the risk of radiation exposure to medical professionals. Dose reduction could be achieved by persuading the medical staff to wear protection devices (lead apron, thyroid protector, eyeglasses and gloves). Additionally, medical staff should also be persuaded that they should not be submitted to very high doses, above the acceptable limits for occupational workers. Dose levels at hemodynamics services in Minas Gerais State, Brazil, were analyzed. Due to the equipment characteristics or the exam type and conditions X-ray machines were used with 70–120 kV, 2.5–699 mA and 80–2880 s. Annual individual doses were estimated based on measured doses during a specific exam taking into account the workload. Maximum doses varied from 0.05 to 0.70 mSv per exam. The results projected for one work-year period show that all annual individual doses would be higher than the annual dose limit of 20 mSv/y with only a few values lower than 50 mSv/y. Dose levels measured at medical staff positions during hemodynamic exams showed that if the protective devices are not used professionals could be exposed to dose values higher than annual dose limits.

Keywords: Interventional radiology; Fluoroscopy; Dose levels at hemodynamics

1. Introduction

Dose monitoring of workers who are exposed to ionizing radiations during their work is done with the aim to monitor exposures and to certify that the radiological protection principles are followed. In hemodynamics practice, due to different specificity of the exams, the medical staff is often exposed to high levels of radiation. According to published data, interventional cardiologists are the most exposed group (Vãnó et al., 2006).

The International Commission on Radiological Protection—ICRP analyzes and proposes some recommendations to the situations in which human beings are exposed to ionizing radiations. In 1990, the ICRP published the Report 60 (ICRP, 1991), which introduced new general radiation protection recommendations that are to be applied for all practices and interventions. Due to the need of specific recommendations for medical area, the Report 73 "Radiology protection and medical safety" was published (ICRP, 1996). In Brazil, the Ministry of Health through the Secretariat of Sanitary Vigilance has established mandatory guidelines for radiation protection to be followed in medical and dental radiodiagnostic practices. (Brazil, 1998). This Brazilian legislation has established procedures and reference parameters for controlling occupational, medical and the public exposures. The Brazilian radiation protection framework is based on international recommendations given in the Basic Safety Standards (IAEA, 1996).

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In the last few years, radiation protection concerns on fluoroscopy and interventional diagnostic procedures have increased, mainly due to the advances related to new technology and sophisticated procedures (Bushong, 2004). The radiometric surveys in hemodynamic services present a very peculiar situation in relation to the other types of X-ray image. The medical procedure named "catheterization" uses an arch X-ray machine that has the cutter head and the image intensifier at opposite arch extremities. The arch can rotate 360°around the table plan where the patient is. During the exam, the medical staff (usually one responsible and one auxiliary doctor and a nurse) stay close to the patient.

The medical procedure consists in introducing and guiding a catheter in a vein or artery of the patient to a region of interest (often close to the heart). X-ray machine is used in radioscopy mode to allow a real time image of the catheter position; cine mode is used after reaching the desired region. In average, the radioscopy mode takes about 9 min and cine mode is done in 90 s.

Scattered radiation levels close to the patient are very high during the medical procedure. It means that if the medical staff does not wear protective accessories he/she could receive high dose values (ICRP, 2000). Deterministic effects like lesions in the lens of the eye have been reported in such practices (Vãnó et al., 1998; Faulkner et al., 2000). Drexler and Panzer (1990) reported that somatic and late biologic effects were observed during a mortality study of English and American radiologists. Headaches, dizziness, lack of energy and palpitation were also reported by Yu et al. (2000).

In Minas Gerais, Brazil, radiation protection professionals are accredited by the National Sanitary Vigilance (NSV) to perform radiation surveys and quality control tests at radiology services. Analysis must be done according to the national standard for radiation protection in medical X-ray diagnostic (Brazil, 1998). The Centro de Desenvolvimento da Tecnologia Nuclear (CDTN) provides the NSV with technical expertise for the accreditation of professionals and to analyze reports issued by them (Da Silva et al., 2000). The aim of this work is to investigate the radiation dose levels that could reach the cardiologists during hemodynamic exams in Minas Gerais State, Brazil.

2. Materials and methods

Dose levels reported by NSV accredited professionals at 21 hemodynamic services were analyzed. X-ray machines were used with 70–120 kV, 2.5–699 mA and 80–2880 s according to the equipment characteristics or the exam types.

Area dose measurements in terms of ambient dose equivalent were carried out free-in-air at 160 cm height with calibrated ionization chambers at each specific point where medical staff would be in the surgery room. Annual individual doses in terms of personal dose equivalent were estimated based on the measured doses during a specific exam and the workload. To make the measurement conditions closer to reality, the radiation beam was pointed to a scattering phantom simulating a patient abdomen at the 100 cm height table. The focus-phantom distance was of 100 cm, the radiation beam incidence angle was 30°off the vertical direction and the diaphragm was kept fully opened.

Measurements were done in fluoroscopy and cineangiography exposure modes at four usual incidences that were more significant from radiation protection point of view.

3. Results and discussion

Fig. 1 shows the maximum area dose value in a specific exam at a determined point in the surgery room for 21 X-ray machines. Results showed that maximum doses varied from 0.05 to 0.70 mSv per exam and only five machines showed values higher than 0.30 mSv.

Fig. 2 shows the individual doses projected for one year working period in all 21 X-ray machines. Results showed that if one medical staff would carry out all exams at such specific machine, without any protective accessory, his/her annual individual dose would be higher than the annual dose limit of 20 mSv; under this condition, the highest annual dose value would reach 864 mSv. It must be emphasized that such dose values would be at the surface of the trunk lead apron; they would be reduced by a factor of about 10 if a typical apron is worn. Concern is raised if one considers that non-protected parts of the body are also exposed (hands and face).

Fig. 3 shows maximum annual individual dose measured at typical position of the medical doctor and assistants in each hemodynamic service. Results show that all annual individual doses would be higher than the annual dose limit of 20 mSv; the highest annual dose value would be 2260 mSv. Again, this dose value is to be reduced by wearing a suitable lead apron and by reducing the number of exams each doctor and assistant would perform.

Fig. 4 shows the medical workload values provided by some of the 21 services in the fluoroscopy and cine modes; it strengthens that doses are directly related to both.

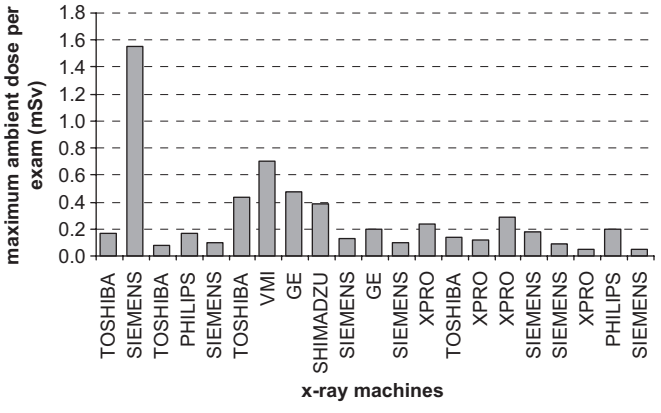

Fig. 1. Maximum doses measured at the medical staff position during a specific hemodynamics exam.

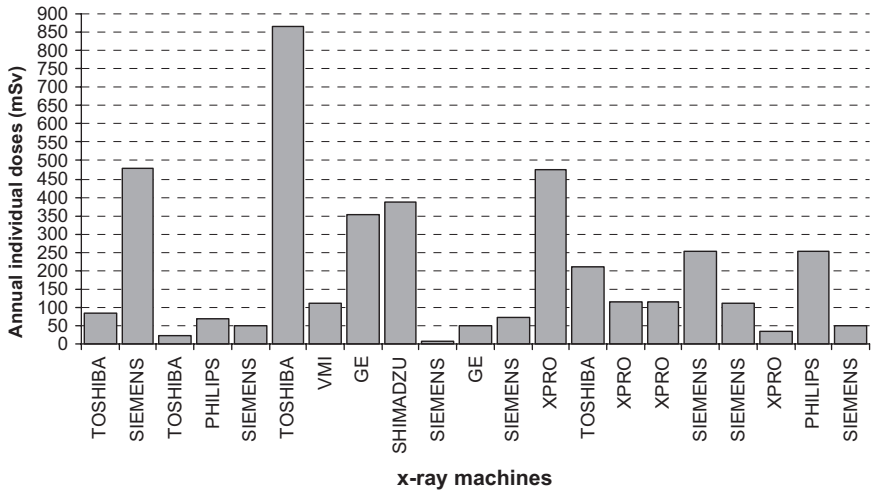

Fig. 2. Annual individual doses on the surface of the lead trunk apron of medical staff during hemodynamics exams.

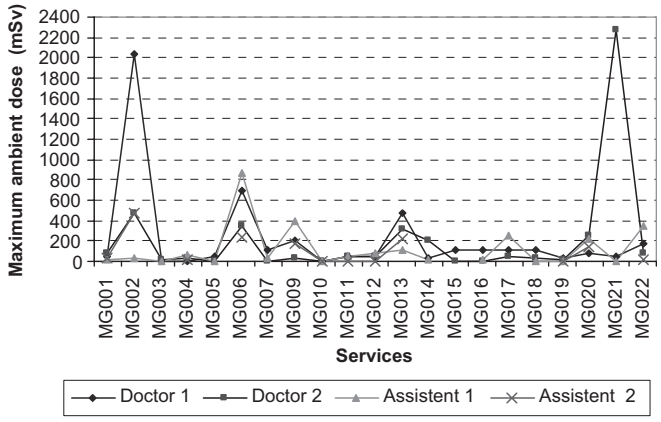

Fig. 3. Maximum doses measured at the medical staff in such service specific hemodynamic exam.

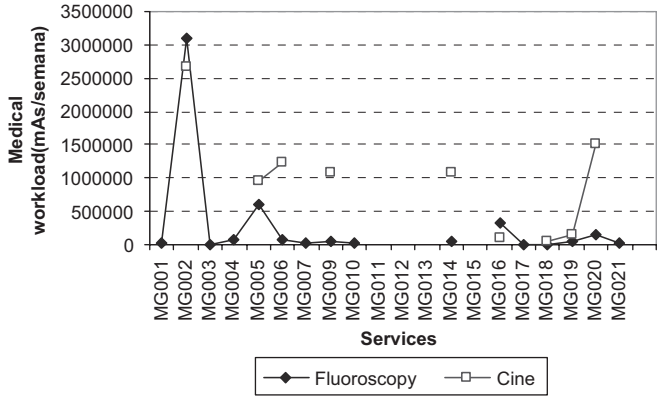

Fig. 4. Maximum doses measured at the medical staff in such service specific for fluoroscopy and cineangiografy modes.

4. Conclusions

Dose levels measured at medical staff positions during hemodynamics exams showed that if protective devices were not used and a proper workload is not defined to each one, professionals could be exposed to dose values higher than annual dose limits.

The adoption of optimization procedures at the hemodynamic services should be encouraged in order to avoid risk to the health of the workers. The quality control measurements of the X-ray machines, besides the proper use of individual protective equipments play an important role to reduce dose in workers.

This work allowed understanding the quality of the hemodynamic services and to observe that many radioprotection actions are still possible to be adopted.

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