Research Article

Assessment of the Knowledge of Radiology Technicians on the Use of Dose Reduction Software Called Automatic Exposure Control (AEC) During a CT Scan

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Abstract

Background: To optimize the absorbed radiation dose during a CT examination, manufacturers of CT Scanners have equipped their units with built-in softwares called Automatic Exposure Control (AEC).

Purpose: Evaluate the knowledge of radiology technicians on the use of dose reduction software and the concept of patient radiation protection.

Materials and methods: Descriptive and analytical transversal study from January 1 to December 1, 2020, conducted in the radiology and medical imaging services of Cameroon's public and private hospitals with a CT-scanner. It was the first study on this topic that was conducted in Cameroon. This study was conducted from a questionnaire distributed to all medical imaging technicians in 10 hospitals relating to the notions of dose reduction software and patient radiation protection.

Results: 80 questionnaires were distributed and analyzed. The average age of medical imaging technicians was 30 years old. There were 32 women and 48 men. Most of the medical imaging technicians worked in private centers (n = 6). 75% of medical imaging technicians had been in practice for more than 5 years. 75% of medical imaging technicians gave the wrong answer regarding the use of dose reduction software. Finally, only a third of the practitioners had received training in patient radiation protection.

Conclusion: Although the majority of medical imaging technicians declares to take into account the dangers related to ionizing radiation during CT scan examinations, a radiation protection training, particularly during the initial curriculum are mandatory. The use and knowledge of dose reduction softwares from CT-scanners could be one of the solutions to reduce absorbed dose during a CT examination. So the importance of training technicians in handling of CT-scanners is beneficial.

INTRODUCTION

The medical imaging service must offer reliable and safe clinical outcomes while maximizing patient safety. In terms of radiation, the Alara Principle (as Low As Reasonably Achievable), which consists of applying the lowest dose while still providing diagnostic image quality, is fundamental. Medical imaging technicians must master the CT-scanner they use on a daily basis to better perform patient examinations. Since examinations of children are performed on adult CT-scanners, medical imaging technicians must adjust exposure parameters according to the age of the patients. It is true that each manufacturer ensures that his CT-scanner is the best in terms of radiation protection, but the realities in certain developing countries require each CT-scanner's user to adapt his device to his environment. Manufacturers introduce software to optimize doses received by patients. Siemens has long been at the forefront of reducing radiation. Its constant involvement and exclusive technological advances have made it the leader in low CT dose [1]. There is no dose suitable for all patients on the same CT-scanner. Hospitals do not have pediatric protocol in their CT-scanners. All pediatric exams are done on adult CT-scanners. Some pediatric hospitals don't have pediatric protocol in their CT-scanners. In order to do this, the radiology technicians should adjust the protocols to pediatric patients based on either national DRL or their workplace guidelines. The parameters of the CT-scanner must be adopted specifically for the small body size of the patients. This is why the dose must systematically be adapted on a case-by-case basis, because each clinical case and each patient require, indeed, a personalized and precise level of dose. It is therefore important to determine the ideal dose to simply reduce doses. The ideal dose is defined as the right balance between irradiation and image quality.

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Today, practically all CT systems are delivered with automatic exposure control (AEC) systems operating with tube current modulation in three dimensions [2]. AEC systems have many advantages: they give better control of the dose absorbed by the patient, improve image quality in patients, reduce some image artifacts and reduce the load on the x-ray tube [3-7]. Hence, to decrease the amount of radiation dose, Siemens uses Care Dose 4D [8,9]. In addition, some AEC systems were designed mainly by modulating the tube current to compensate for variations in attenuation of the patient's body [10,11]. Furthermore, CARE kV combined with CARE Dose 4D techniques not only promises high quality images, but also decreases radiation dose [12-15]. All major CT vendors have dose reducing software in their CT-scanners. Toshiba, Philips and General Electric (GE) use software such as Sure Exposure, Care Right and Auto or Smart mA respectively to reduce the dose absorbed.

In this country we usually use GE, Toshiba, Neusoft, Hitachi and Siemens CT-scanners. Some are older generation CT systems (4, 8, 16 and 64 slices). Currently we only have 3 CT-scanners of 128 slices in this country. This is the reason why, reduction in radiation dose is important. In medical practice, reduction in dose should not be considered alone but in conjunction with its impact on image quality.

Radiology technicians must know that the automatic exposure control (AEC) system has a notable impact on dose delivery, CARE is an AEC technology, SAFIRE is an iterative reconstruction post processing technique not an AEC technique. AEC can used to control KV such as in CARE kV or to control mAs such as in CARE Dose 4D.

The impact of the correct use by radiology technicians of such systems is the reduction in radiation dose. To achieve this purpose, they must have knowledge in AEC technology, iterative reconstruction post processing technique, radiation protection and developed knowledge of optimization methods and scanning protocols (adjusted exposure conditions). They must also avoid to using the same technique for children and adults with small parts of the body and applying appropriate dose modification methods.

The purpose of this study was to assess the knowledge of radiology technicians on the use of dose reduction software and the concept of patient radiation protection during a examination on CT-scanner.

MATERIALS AND METHODS

Population

An observational prospective study from January 1 to December 1, 2020 was conducted. Eighty questionnaires were handed over to all radiology technicians (radiologist, technicians or engineers) in January 2020 in the 10 radiology and medical imaging services of Cameroon's public and private hospitals with a CT-scanner. Each hospital in this country have only one CT-scanner within the same hospital. The questionnaires were distributed at their place of service and were filled by themselves. Radiology technicians who have never carried out a CT scan examination have been excluded from this study. These radiology technicians were classified into 4 groups. Masters have a Master

Degree (MD) in radiological techniques, superior technicians in radiology and medical imaging (BD) have a Bachelor Degree in radiological techniques, and technicians (T) are those who have no university degree but have received training in the service in radiological techniques and radiologists who are doctors in radiology (PhD). Study was carried out in accordance with relevant guidelines and regulations. Written informed consent was obtained from all participants.

Questionnaire

The questionnaire was developed from the data of the literature, in consultation with a radiologist and a medical physicist. He had three large parts. A first part analyzed the demographic data of the radiologist technicians (age, sex, internal or senior, years of experience, belonging service, qualification, and country of training) and the risks associated with the use of X-rays in the CT-scanner (Do you know the risks related to the use of ionizing radiation ?, How can we reduce the risk of patient exposure?); A second part assessed the knowledge of radiology technicians on the use of dose reduction software (AEC) during a computed tomography examination (Do you know the dose reduction software called automatic exposure control (AEC)?, Have you received specific training on the use of dose reduction software?, Do you often use the dose reduction software for your CT-scanner during an examination?, What is the impact of the dose reduction software on the dose received by patients) and a third party assessed if medical imaging technicians had already received patient radiation protection training (Do you know the basic principles of radiation protection?, Have you received specific training in radiation protection?, What are the radiation protection means?).

Statistical analysis

The questionnaire was due to be returned to the medical imaging department by the end of April 2020. The results were analyzed anonymously. The processing of the data collected was done using Excel software. The significance of the difference in terms of continuous variables in which respond assumptions were provided between the groups was evaluated by Student's t-test. A P-value < 5% was considered significant.

Ethical considerations

Ethical approval was obtained from the Ethical Review Board of University of Dschang and facilities of this study.

RESULTS

Socio-demographic characteristics of CT operators

Eighty questionnaires distributed, eighty were retrieved and analyzed, for an overall response rate of 100%. The average age of the radiology technicians was 30 ± 5 years old. There were 32 women and 48 men, ie a sex ratio of 1.5 in favor of men. Most of the radiology technicians (n = 56/80) worked in private centers (n=6/10 hospitals). 75% of radiology technicians had been in practice for more than 5 years. Those with more than 10 years of professional experience were 24 (30%). There were mainly 41 superior technicians (BD) or 51.25%. The number of masters was 20 or 25%, that of technicians 2 or 2.5% and 17 radiologists or 21.2%.

Questionnaire results

The questionnaire was divided into two main themes. The first topic had 17 questions on knowledge of CT-scanner dose reduction software. The second topic had 7 questions on knowledge of the concept of radiation protection.

Table 1 show that knowledge of risks related to the use of ionizing radiation is favorable (96,8%) while, knowledge of the CT-scanner dose reduction software is 85,7% unfavorable. Nobody has received specific training on the use of dose reduction software during their initial curriculum training. 14,2% state use the dose reduction software during a CT examination. 96,8% know the principles of radiation protection bases. 85,7% have not received specific training in radiation protection. 96,8% practice the radiation protection during a CT examination. None of the hospitals studied did not have the information sheet of patients on the use of X-rays at the CT-scanner room (Table 1). 75% of CT operators did not give the correct answer regarding the use of dose reduction software. On the other hand, only one-third of radiology technicians (26.6%), had received patient radiation protection training. There were more women who answered wrongly and had no training. There were more in the private of public sector who answered wrongly and had no training. Many of them were interns. All questions asked to radiologists were favorable.

L'AEC is a generic name for any technique aimed at optimizing

dose utilization by adjusting the tube current in real time to accommodate differences in attenuation due to patient anatomy, shape, and size [10]. Proportion of favorable responses according to the qualification of the CT operator and professional experience of the CT operator are presented in Table 2 and 3. Tables 2 and 3 show that with more training and practical experience, a more favorable response to the questions is found.

The four most common strategies use in our CT-scanners are presented in Table 4. These AEC trade names in table 4 represent the dose reduction software's used in these different types of CT-scanners.

DISCUSSIONS

The main results of our study were the following; The 10 hospitals studied did not have an information sheet of patients on the use of X-rays at the CT-scanner room and the notion of patient radiation protection during an examination; Regarding the use of dose reduction software, 75% of medical imaging technicians had not given the correct answer; One-third of radiology technicians had benefited from patient radiation protection training during their academic training. All questions asked to radiologists were favorable.

This study shows that efforts should be provided for improving clinical practice in medical imaging services in our hospitals. The use of this software during an exam can reduce

Table 1: Responses from radiology technicians about dose reduction software and radiation protection.

Questions	Results	
Do you know the risks related to the use of ionizing radiation ?	Yes Non	61 (96,8%) 2 (3,1%)
Do you know the dose reduction software called automatic exposure control (AEC)?	Yes Non	9 (14,2%) 54 (85,7%)
Have you received specific training on the use of dose reduction software?	Yes Non	0 (0%) 63 (100%)
Do you often use the dose reduction software for your CT-scanner during an examination ?	Yes Non	9 (14,2%) 54 (85,7%)
Do you know the principles of radiation protection bases	Yes Non	61 (96,8%) 2 (3,1%)
Have you received specific training in radiation protection?	Yes Non	9 (14,2%) 54 (85,7%)
Do you make the radiation protection?	Yes Non	61 (96,8%) 1 (85,7%)

Table 2: Proportion of favorable responses according to the qualification of the radiology technicians.

Questions	T (n=2)	BD (n=41)	MD (n=20)	PhD (n=17)
Do you know the risks related to the use of ionizing radiation ?	1 (50%)	41 (100%)	20 (100%)	17 (100%)
Do you know the dose reduction software called automatic exposure control (AEC)?	0 (0%)	0 (0%)	0 (0%)	17 (100%)
Have you received specific training on the use of dose reduction software?	0 (0%)	0 (0%)	0 (0%)	17 (100%)
Do you often use the dose reduction software for your CT-scanner during an examination ?	0 (0%)	20 (48,7%)	10 (50%)	17 (100%)
Do you know the principles of radiation protection bases	1 (50%)	41 (100%)	20 (100%)	17 (100%)
Have you received specific training in radiation protection?	0 (0%)	10 (24,3%)	5 (25%)	17 (100%)
Do you make the radiation protection?	2 (100%)	10 (24,3%)	20 (100%)	17 (100%)

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Table 3: Proportion of favorable responses according to the professional experience of the radiology technicians.			
Questions	**All population**		
	Less than 5 years (n=5/80)	**5-10 years (n=20/80)**	**Over 10 years (n=38/80)**
Do you know the risks related to the use of ionizing radiation ?	4 (80%)	20 (100%)	38 (100%)
Do you know the dose reduction software called automatic exposure control (AEC)?	0 (0%)	0 (0%)	0 (0%)
Have you received specific training on the use of dose reduction software?	0 (0%)	0 (0%)	0 (0%)
Do you often use the dose reduction software for your CT-scanner during an examination ?	0 (0%)	5 (25%)	10 (26,3%)
Do you know the principles of radiation protection bases	4 (80%)	20 (100%)	28 (73,6%)
Have you received specific training in radiation protection?	1 (20%)	5 (25%)	10 (26,3%)
Do you make the radiation protection?	4 (80%)	20 (100%)	20 (100%)

Table 4: Four most common dose reduction software in CT scanner.		
Manufacturer	AEC trade name	Image quality reference
Toshiba	SureExposure	Target image quality level
General Electric	Auto mA, Smart mA	Noise index
Siemens	Care Dose 4D	Quality reference effective mAs
Philips	DoseRight	Reference image

the dose. Manufacturers offer these technologies not only to sell their device better but also to protect patients against the harmful effects of ionizing radiation. The balance between the dose and the quality of the image is this during an imperative in medical imaging. The particular attention we carried to the low dose is no longer enough. Our efforts must now focus on a good understanding of the ideal dose. The right dose is the reasonable balance between applied radiation, image quality and patient care. In order to help customers achieve this balance, Siemens Healthiness has introduced CARE Right. Toshiba, Philips and General Electric (GE) use respectively software such as Sure Exposure, Care Right and Auto or Smart mA to reduce the dose absorbed. To help customers achieve this balance, Siemens offers Care Right that is based on three aspects: technology for an ideal dose, ideal dose levels and ideal dose management[1]. Radiology technicians must know to use dose reduction software (AEC) present in their CT-scanner. They must know that the dose reduction software has a notable impact on dose delivery. CARE is an AEC technology, SAFIRE is an iterative reconstruction post processing technique not an AEC technique. AEC can used to control KV such as in CARE kV or to control mAs such as in CARE Dose 4D. For some time now, iterative reconstruction has been a promising method of sensitive reduction of the dose without compromising on image quality. For innovation in the iterative reconstruction for obtaining an ideal dose, Siemens proposes Admire (Advanced Modeled Iterative Reconstruction), SAFIRE (Sinogram affirmed Iterative Reconstruction) that makes it possible to take advantage of iterative reconstruction while reducing the dose up to at 60%. This percentage surpasses even that offered IRIS (Iterative Reconstruction in Image Space). Iris also provides excellent image quality at a reduced dose. Several other techniques are untied to reduce the dose to the scanner. CARE DOSE 4D makes it possible to adapt the dose according to the anatomy of the patient and its position during the acquisition. Care KV automatically determines the appropriate voltage and acquisition parameters to obtain the ideal dose for the relevant review and user-defined image quality [1].

The CT-Scanner is the most significant contributor to radiation dose on radiological examination, although the frequency of the examination is far below other modalities [16]. Dose reduction software comprises a series of dose-saving technologies in which the tube current is adapted according to patient size, shape and density, whilst maintaining a user-defined reference image quality [17]. When optimizing the CT radiation dose and image quality, the projection angle of the localizer, patient centering, protocol selection, scanning direction and the use of protective devices requires special attention [18].

With respect to radiation protection, the relation between absorbed radiation dose and damage, in particular the effects of ionizing radiation in cells, is of the greatest importance. Sensitive parts of the body with respect to external radiation sources are the hematogenous organs, the gonads, and the eyes. X-ray is ionizing radiation that can cause health damages in the case of exposure of the human body. Therefore, it is necessary to apply radiation protection principles. For that reason, there are specific regulations in every country to protect people from ionizing radiation damages; however, they are different in every country. Each radiology technician must be use it in their facility in order to improve their daily clinical practice.

The manipulation of CT-scanner in medical imaging services should be taken seriously. Each radiology technician must master the technology present in the CT-scanner it uses on a daily basis. Each CT-scanner to its specificity in dose reduction procedures. More of our CT systems are old generations (4, 8, 16 and 64 slices). All these CT-systems have dose reducing software. More of them have not pediatric protocols. Pediatric examinations are make on adult protocols. So, greater doses absorbed by patients could be related to non-adjusted exposure conditions, insufficient

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experience of radiology technicians, using the same technique for children and adults with small parts of the body and not applying appropriate dose modification methods.

As 75% of medical imaging technicians had not given the correct answer, the possible explanations for this result could be related to their academic training. A medical imaging technician who does not master the software on the CT-scanner that he uses on a daily basis will always work with the acquisition parameters proposed by the CT-scanner. Which will lead to patients from non-optimized doses. Training on CT-scanner technology installed in your service will allow medical imaging technicians to better contribute to dose optimization during an examination. The training of radiology technicians in handling of CT-scanners would be beneficial in their clinical practice.

After installing a CT-scanner in their hospital, they should be taught how to change the scan parameters. For example, for a pediatric patient less than 1 year old, they should be able to change the kV from 120 to 80kV. They should be able to reduce scan length, mAs, slice thickness depending on patient age when using adult protocols. If the CT-scanner has the pediatric protocol and is a new generation that has dose reduction software (AEC) and iterative reconstruction techniques, parameter adjustment is no longer mandatory. They can use the settings offered by the CT-scanner.

It is necessary to note that the absence of similar surveys to compare with this study limits this study.

CONCLUSIONS

The present study reported responds of the assessment of the knowledge of radiology technicians on the use of dose reduction software and the concept of patient radiation protection. Owning to the results, the knowledge of radiation protection principles and knowledge of the CT-scanner dose reduction software's are favorable. There were more in the private of public sector who answered wrongly and had no training in AEC technology. So, the correct use of such systems is the reduction in radiation dose. Then, radiology technicians must have knowledge in AEC technology, iterative reconstruction post processing technique, radiation protection and developed knowledge of optimization methods and scanning protocols (adjusted exposure conditions).

ACKNOWLEDGEMENTS

The authors wish to thank radiology technicians for their valuable assistance in data collection.

COMPETING INTERESTS

The authors declare that they have no financial or personal relationships which may have inappropriately influenced them in writing this article.

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