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Assessment of the professional practice knowledge of computed tomography preceptors

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A R T I C L E I N F O

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A B S T R A C T

Objectives: This study aimed to assess the knowledge and practice of computed tomography (CT) clinical practice preceptors in terms of CT parameters affecting patient dose and image quality.
Material and methods: A self-administered questionnaire that surveyed the participants' demographic information and knowledge about CT parameters and radiation doses was distributed to 60 CT preceptors.
Results: The response rate of the invited technologists was 92 %. 38 (69 %) males and 17 (31 %) females aged between 24 and 59 years, with a mean age of 37.8. The participants' experience ranged between 2 and 24 years, with a mean of 15.5 years. The average knowledge score was 72.2 %, with a range of correct answers of 9–18 and a mean (± SD) of 13.1 ± 2.1. The participants showed a low awareness of diagnostic reference levels (DRLs). However, they demonstrated good overall knowledge, with a potential for improvement and confidence in practice.
Conclusions: Continuous medical education and professional development are a priority for improvement to ensure reliable delivery of health care and best practice. The findings of this study can be used by education institutes and health organizations when designing educational programs to ensure the highest training and performance of their technologists.

1. Introduction

Computed tomography (CT) technologists play an essential role in the training of undergraduate radiography students by serving as role models who apply appropriate practice and ensure optimum patient safety [1,2]. Computed tomography (CT), which is a technologist's task, includes the operation of the CT scanners, patient positioning, radiation protection, determination of the parameters for performing procedures, and image reconstruction [3,4]. Training in theory and clinical practice are recommended by national and international professional organizations, such as the American Registry of Radiologic Technologists (AART), the Canadian Association of Medical Radiation Technologists (CAMRT), and the Society of Participants (SORs), UK, to fulfil the CT graduate profile [5].

The undergraduate radiography degree has been offered in the UAE by the University of Sharjah since 1997. Graduate qualifications include the ability to perform CT imaging procedures, and the graduate competencies range from the operation of the scanners to patient "positioning, preparation, and protection," protocol "planning, selection, and modification," and image "analysis, processing, and reconstruction" under supervision. Technologists play a critical role as preceptors in the training of undergraduates and are recognized and appreciated for their ability to bridge the gap between theory and practice. Transferring knowledge and skills from the technologists to the students improves the level of education and directly achieves patient safety [6,7].

The extensive knowledge and practice of the technologist ensures proper training and the strength of the preceptorship. Technologists should therefore be familiar with all the essential aspects of CT image formation, factors affecting image quality, and methods for reducing exposure factors to reduce patient doses [8,9]. Hence, the knowledge, skills, and practice of the CT technologists should be properly evaluated

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for assessment and improvement of education plans.

The aim of this study was to investigate the current knowledge and practice of CT technologists who serve as preceptors for undergraduate radiography students at the University of Sharjah, UAE. The results will be used to identify deficits and to formulate plans for improvement in CT training at our institution.

2. Materials and methods

This was a descriptive cross-sectional study that used a self-administered questionnaire. The questionnaire was distributed to CT technologists who worked on clinical training sites utilized for student training by the medical diagnostic imaging department of the University of Sharjah. All invited technologists who agreed to participate in the study received a questionnaire, together with an information sheet and an informed consent form. Participation in the study was voluntary, and anonymity and confidentiality were maintained by not requesting any personal information.

The list of 60 CT technologists represented the target population. The required sample size of 53 was calculated based on a 95 % confidence level, a 5 % margin error, and a 50 % response distribution, (http://www.raosoft.com/samplesize.html).

The questionnaire used in this study was a modified version developed earlier in three different studies [10–12]. The questionnaire was reviewed by three senior CT technologists (with 20, 22, and 25 years of clinical experience) to ensure understandability. Feedback was used to enhance and reward the questions for better clarity.

The questionnaire was developed in two sections: the first section collected the participants' demographic information, qualifications, training, and the current protocol used in their facilities. The second section (18 questions) queried the participants' knowledge on the effects of the CT scan parameters, (including kilovolt peak [kVp], milliampere/second [mAs], automatic adjustment of the tube current [ATCM], pitch, slice thickness, and image noise) on the image quality. The participants were also queried on their knowledge of the current practice for diagnostic reference levels (DRLs).

2.1. Data collection

Three research assistants were recruited for data collection after obtaining approval. All three had relevant experience and had been trained to ensure a high quality of data collection. The assistants approached the participants in person, directly after receipt of department approval.

After the assistants explained the study objectives and the agreement to participate, the participants signed the informed consent form and completed the questionnaire. The average completion time ranged from 15 to 20 minutes.

2.2. Data analysis

Data were analyzed using Excel and the Statistical Package for Social Sciences software version 25 (SPSS, Inc., Chicago IL, USA). We used descriptive statistics to look at frequencies, percentages, averages, and standard deviations (SD) for knowledge points and background variables.

The questions in our survey had only one correct answer option, so closed questions were used with either the right or wrong answer. The maximum score for the knowledge questions was 18, with correct answers given a score of 1 and incorrect answers a score of 0. This means that a higher score meant better knowledge. Accordingly, scores were categorized as low (≤60 %), moderate (61–70 %), good (71–80 %), and excellent (≥81 %) [13].

Table 1
Characteristics of the participants.

	No. (%)
Gender	
a Male	38 (69)
b Female	17 (31)
Experience	
a 1–3 years	(34.5)
b 4–8 years	(14.5)
c 8–12 years	(23.6)
d More than 15 years	(27.2)
Qualification	
a Diploma	3 (5.5)
b B.Sc.	49 (89)
c M.Sc.	3 (5.5)
Nationality/country degree obtained	
a UAE	3 (5.5)
b Expatriate	52 (94.5)
Who build the protocols in the scanner	
a Vendor Clinical Specialist	34 (62)
b Radiologists	10 (18)
c CT Technologists	11 (20)
Confidence to modify CT protocols to reduce the patient radiation dose.	
d Yes	49 (89)
e No	6 (11)
Allowed to modify any CT protocols that were requested just to reduce the patient dose	
a Yes	52 (94.5)
b No	3 (5.5)
Attended specialized CT training course	
a Yes	36 (66)
b No	19 (34)

3. Results

3.1. Participants' characteristics and CT protocols

The 60 potential participants from across the hospital were technologists who had involvement in student CT training. Of these, 55 (92 %) responded to the survey. All the respondents completed every question in the survey. The responses came from technologists with different educational backgrounds, workplace settings, and preceptorship experience (Table 1).

The first part of the survey collected information about the technologists' demographics, including age, gender, qualifications, country of qualification, experiences, training, current CT protocol status, and confidence to modify the protocol. The respondents included 38 (69 %) males and 17 (31 %) females aged between 24 and 59 years, with a mean age of 37.8 (SD 8.9) years.

The participants' experience ranged between 2 and 24 years, with a mean of 15.5 (SD 8.9) years. Overall, 27.2 % had more than15 years of experience, 23.6 % had 8–12 years of experience, 14.5 % had 4–8 years of experience, and 34.5 % had 1–3 years of experience. The majority of the respondents possessed a B.Sc. degree (n = 49; 89 %); only three (5.5 %) technologists had completed their master degree, and another three (5.5 %) still working on their diploma qualifications. Most (94.4 %) of the participants were expatriates from ten different countries and had obtained their degrees outside UAE. The majority of the participants were from India (25 %), Egypt (20 %), and Sudan (20 %), with the remainder divided between Jordan, Lebanon, Palestine, the Philippines, South Africa, Syria, and Tunisia.

In total, 36 (65.5 %) of the participants had attended a specialized CT course after graduation. The CT protocols in the current practice were designed by the vendor's clinical specialists in 62 % of the cases, with 20 % and 18 % involvement of the technologist and radiologists, respectively. However 94.5 % of the participants stated that they were allowed to modify the CT protocol to reduce the patient's dose, and 89 % felt confident in practicing radiation dose reduction.

3.2. Participants' knowledge and dose practice

A total of 18 questions were asked, and the total score obtained by each respondent was calculated. The average knowledge score was 72.2 %, with a range between 9–18 correct answers and a mean (± SD) of 13.1 ± 2.1. Only three participants scored 18 correct answers.

The scores showed no significant differences based on gender. The group with 1–3 years of work experience (n = 18) had an average of 12.5 correct answers; the group with 4–8 years of work experience (n = 8) had an average of 11.9 correct answers, the group with 8–12 years of work experience (n = 13) had an average of 13.5 correct answers, and the most experienced group (n = 16) had an average of 13 correct answers. A Mann-Whitney *U* test conducted on the most and least experienced groups showed no statistical difference (p = 0.519).

The participants who had completed additional CT courses had an average of 14 correct answers, whereas the participants who did not have further education had 12 correct answers. The Mann-Whitney *U* test showed a statistical significance (p = 0.021) between these two groups of participants.

The participants were further asked if reducing the **kVp** reduced the contrast resolution; 39 (70.9 %) participants responded correctly. The participants were asked if increasing kVp by 50 % was equivalent to doubling the mAs, and more than half the respondents (30; 54.5 %) answered incorrectly. When asked if kVp must be increased for patients with metallic implants or objects, 38 (69.1 %) participants answered the question correctly, Fig. 1.

A question on **mAs** was answered correctly by 52 (94.5 %) of the participants, who thought that doubling of mAs doubled the dose. In total, 49 (89.2 %) participants agreed that mAs should be increased as the body part thickness increases.

The participants' knowledge about **ATCM** was also queried. When asked if ATCM is affected by improper patient positioning, 49 (89.1 %) participants answered correctly, with 47 (85.5 %) of the respondents answering that incorrect positioning decreased the patient dose on average. However, only 39 (70.9 %) patients answered correctly that incorrect positioning increased the dose to obese patients.

The questionnaire also contained questions about **pitch** and how it affects the dose and image quality. In total, 36 (65.5 %) of the participants answered that increased pitch reduces the patient dose, while 36 (65.5 %) agreed that decreasing the pitch did not degrade the image quality, Fig. 2.

The participants were also asked about the effect of **slice thickness** on the dose and partial volume artifacts. Overall, 41 (74.5 %) of the respondents agreed that increasing the slice thickness decreases the dose. The number of correct responses was slightly reduced (40; 72.7 %) when the participants were asked if increasing the slice thickness increases the partial volume artifact. Most participants (45; 81.5 %) indicated that image **noise** was reduced with an increase in the mAs, and 36 (65.5 %) agreed that image noise was also reduced with an increase in the kVp. In total, 39 (70.9 %) participants answered correctly that an increase in pitch decreased the image noise; 37 (67.3 %) answered that increasing slice thickness did not increase the image noise; and 43 (78.2 %) answered that image noise increases with increasing patient size, Fig. 3.

A large percentage (73 %) of the participants stated that DRLs were established and implemented during their current practice. The participants were asked to state the DRLs for 3 common CT procedures: brain, chest, and abdomen-pelvis and their answers were compared to the UAE initial National Diagnostic Reference Levels (NDRLs) published in 2018. Analysis of the responses showed that 11 (20 %), 15 (27 %), and 7 (13 %) participants estimated the dose close enough to the NDRLs for the brain, chest, and abdomen-pelvis, respectively.

4. Discussion

The aim of this study was to evaluate the level of knowledge of CT technologists who work as preceptors for the undergraduate radiography students at the University of Sharjah. Evaluation of the preceptors' knowledge will ensure the delivery of training objectives, filling of the gap between the theory and practice, and improvement of the graduate profile. In addition, definition of any knowledge deficiencies will help the educational institute to design appropriate continuous education programs for the preceptors.

The results presented here show that the participants have a good knowledge of CT parameters. The average score was 13.7 ± 4.7 out of a maximum of 18 points.

The knowledge findings in our study (72.2 %) were better than those presented in previous studies. For example, Norwegian radiographers showed a moderate knowledge of CT parameters, at 59.6 %, while Jordanian radiographers had better knowledge related to the effects of the CT parameters related to image quality and radiation dose, at 68.3 % [10]. Irish CT specialist participants concluded that they had good knowledge of CT parameters (70.3 %), but low knowledge regarding changing the parameters related to radiation dose reduction [11]. Iranian and Malaysian studies showed very low knowledge scores about scan parameters affecting patient radiation dose and image quality; these low findings were justified by the low level of participant CT experience and the participation of personnel other than CT technologists in the studies [12,14].

Despite the mixed academic background of the participants in the present study, they showed good knowledge about the exposure parameters related to the patient dose, which was reflected in their confidence regarding changing the parameters when required. The other reasons could be that a substantial percentage of the participants (66 %) had attended specialized CT courses after graduation and had more experience. The participants showed good knowledge and confidence to modify the protocols, but they clearly had not had much involvement in the design of CT protocols. The explanation for this low participation could be their responsibilities, as well as any maintenance contracts between the vendors and the health institutes that might prohibit.

Establishment of DRLs is relatively new in UAE. The initial NDRL report was published online in 2018, and the Federal Authority of

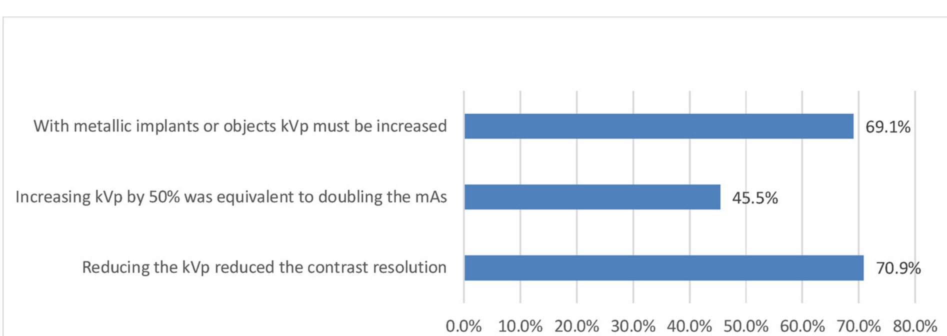

Fig. 1. kVp correct knowledge Response.

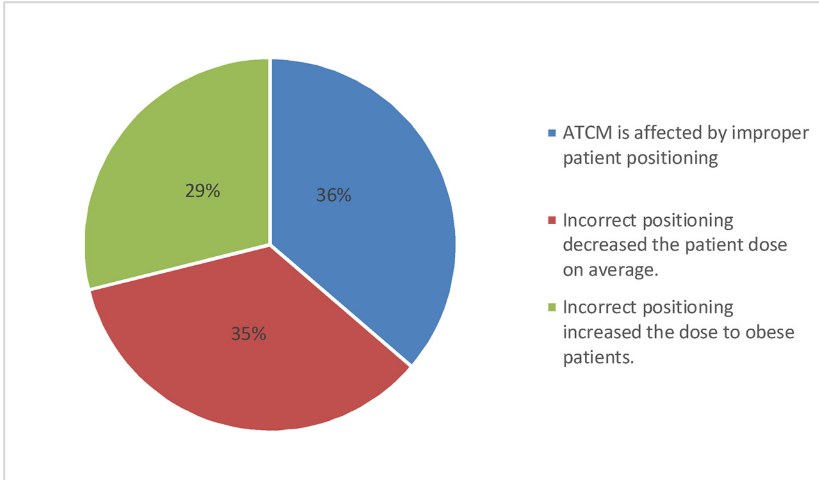

Fig. 2. ATCM correct knowledge Response.

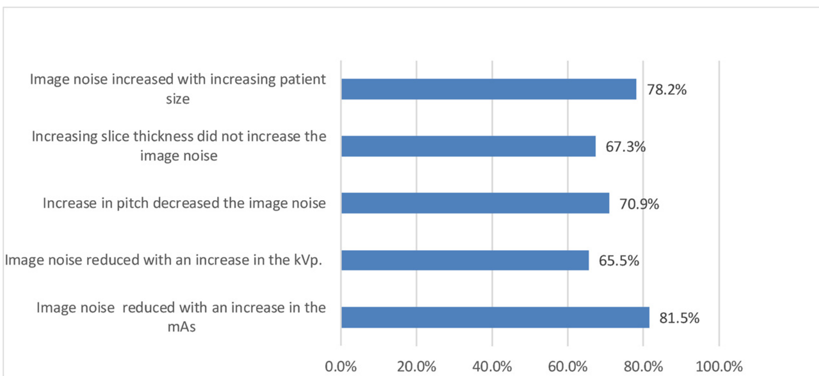

Fig. 3. Noise correct knowledge Response.

Nuclear Regulation (FANR) encouraged the hospitals and health organizations to establish local DRLs accordingly [15]. The DLRs in CT are used as a basis when the radiation dose exceeds the recommendation level and for radiation dose optimization [16]. The technologist is considered the first line for review of the radiation dose and for investigating the condition of high doses received by the patients. In CT, the radiation dose should be considered seriously not only because high doses pose patient health risks, but also because a high dose will result in overexposed images that will not always be rejected like they are in general radiography [17]. The participant's knowledge about DRLs was much lower than expected in relation to their knowledge about CT parameters. This could have reflected an unawareness or an underestimation of the importance of DRLs.

5. Conclusion

The study results showed good knowledge with the potential to improve. Knowledge-based practice and training can fill the knowledge gap. Participation in research activity will enhance evidence-based practice. As the establishment of DRLs were relatively new in UAE, efforts to strengthen the technologist's knowledge about the importance and utilization of in practice should be made. Direct involvement by the educational institutes in training and education courses will enhance technologist's practice and preceptorship role.

Declaration of Competing Interest

Authors declare no conflict of interest.

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