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Evaluating the Knowledge of Computed Tomography Parameters between Radiographers and Undergraduate Students in Medina, Saudi Arabia

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Abstract. This study aims to evaluate employees (i.e., radiographers) and undergraduate students' knowledge of Computed Tomography (CT) parameters and their impact on image quality and radiation dose. A cross-sectional questionnaire study was conducted at four hospitals in Medina, KSA. The survey consisted of 12 close-ended multiple-choice questions related to computed tomography technical parameters. The survey was distributed with a comprehensive explanation to the respondents, and all of the responses remained anonymous with no questions related to identity were asked. Forty respondents were included in this study. Of those, 14 students were from level eight, 11 students were from level six, nine were interns and six were employees. There was a twofold difference in the answers between undergraduate students and radiographers despite the experience gap between both groups. Students were able to answer most of the questions correctly. Only few questions sparked controversy due to the major difference of answers when both groups were compared. The understanding level of the respondents varies among students and employees, where most of the correct answers were given by the former. The main reason for this could be due to the variation in the respondents' qualification. The employees in this study were only technicians with diploma degree.

***Keywords*:** Computed Tomography, Exposure parameters, ALARA, Radiation dose, Image quality

1. Introduction

Computed tomography (CT) technology has evolved over the last 50 years making it the modality of choice for different clinical questions. Nevertheless, the radiation dose from diagnostic CT is high owing to the long scan range acquired [1, 2]. As one of the largest contributors of ionizing radiation in the diagnostic medical field; concerns are rising regarding the potential harm that CT may cause on both individuals [3, 4], and respondents

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specifically when inappropriately used, in addition to CT carcinogenic risk [5].

All CT examinations must follow the "As low as reasonably achievable" (ALARA) principle, which means that the practice of dose deliverey to patients should ensure that the benefits always outweigh the potential risk [6]. As CT technology has undergone many recent developments, there are some difficulties for CT users to be familiar with all system-specific features, especially if operating multiple scanner models from various manufacturers. Thus, the radiology technologists' knowledge of the various parameters that control the output of CT is important. There are number of CT parameters that the technologist can control to produce images with different quality levels and radiation dose delivery. However, default settings and manufacturers recommended protocols tend to focus on the quality of the image regardless of delivered dose [7].

To ensure optimization, operators must tailor the CT parameters to better match the region being scanned and patient size [8]. The literature showed massive differences in the radiation dose delivered across sites and countries, even for similar-sized patients [9]. This may be attributed to differences in CT equipment and to the scan protocols. Such dose disparities may also point to a lack of knowledge on how to manipulate and adjust CT parameters, especially on an individual basis. A previous study has reported that up to 25% of radiologists are unaware of specific CT parameters used for their routine examinations [10].

In this study, we aim to evaluate employees (i.e., radiographers) and undergraduate students' knowledge about CT parameters to improve healthcare and the outcome that lead to a good practice in the working environment. We further test whether students know more about CT parameters, compared to radiographers. We hypothesize that the respondents will have different levels of knowledge regarding the technicality of CT.

2. Material and Methods

This is a cross-sectional questionnaire study conducted at four hospitals in Medina, Kingdom of Saudi Arabia (KSA); after obtaining ethical approval from the ministry of health (MOH). A copy of the ethical approval was addressed to each hospital manager. The questionnaire used was adapted from previously published and validated survey [11], after obtaining proper permission. The survey consisted of 12 close-ended multiple-choice questions (MCQs) related to computed tomography technical parameters and CT exposure factors such as pitch, slice thickness and reconstruction algorithm. The survey was distributed with a comprehensive explanation to the respondents, and all of the responses remained anonymous with no questions related to identity were asked. Recruitment involved employees, students and interns (i.e., in their fifth year of the study plan "level 10"). Questionnaires were given to each participant via hard copy or online using a web link. All respondents were asked to return the questionnaire with no longer than five days from the day of receipt. Descriptive statistics were generated to show the variations in responses, using SPSS version 22.

3. Results

Out of the 40 questionnaires given to both radiographers and undergraduate students, 35% of the respondents were from level eight, 27.5% were from level six students, 22.5% were from internship students and 15% were from employees (Table 1).

Only nine respondents chose the wrong answer related to the question of ALARA, one out of six of the employees chose the wrong answer, four out of nine interns chose the wrong answer probably due to the fact that most of the answers were close to each other and almost identical, two out of 11 students from level six missed the correct answer and two out of 14 students from level eight chose the wrong answer (Table 2). The highest percentage of respondents who answered the question correctly are level eight (85.7% or 12 out of 14 students).

The respondents of the survey were asked about CT protocols, 100% or six out of six employees answered "radiologist". Internship students had multiple answers, 44.4% chose "physicist", 33.3% chose "radiologist" and 22.2% chose "radiographer". Level six students 45.4% chose "radiologist", 18.1% chose "radiographer", 18.1% chose "application specialist" and 18.1% chose "other". Level eight students, 64.2% answered "radiologist", 21.4% answered "application specialist", 14.2% answered "radiographer" and 7.1% answered "physicist" (Table 3 and Fig. 1).

Table 1. Demographic distribution

		Frequency	Percent (%)
Employees		6	15
Students	**Internship (Level 10)**	9	22.5
	Level 8	14	35
	Level 6	11	27.5
Total		40	100

Table 2. Results of knowledge of the "ALARA" principle

	Frequency	Percent (%)
Alarm Loss Activated Radiation Activated	1	2.5
As Low As Really Acceptable	1	2.5
As Low As Reasonably Achievable	31	77.5
As Low As Responsibly Acceptable	7	17.5
Total	40	100

Also, when respondents were asked about "who decides if the patient should take contrast media?", (63.7% or seven out of 11) students from level six had no idea on who decides if the patient should take contrast or not and (21.4% or three out of 14) students from level eight chose different answers. Also, (55.5% or five out of nine) interns had mixed opinions about the question, while (83.3% or five out of

six) employees were familiar with department protocol and knew that the radiologist is the one who decides if the patient should take contrast or not.

Table 3. Results of knowledge about the responsibility of protocol selection

Who decides on the routine CT scan protocols in your department?			**Frequency**	**Percent (%)**
Employees		Radiologists	6	100
Students	**Internship (Level 10)**	Physicists	4	44.4
		Radiographers	2	22.2
		Radiologists	3	33.3
		Total	9	100
	Level 8	Application specialists	3	21.4
		Others	1	7.1
		Radiographers	2	14.3
		Radiologists	8	57.1
		Total	14	100
	Level 6	Application specialists	2	18.2
		Others	2	18.2
		Radiographers	2	18.2
		Radiologists	5	45.5
		Total	11	100

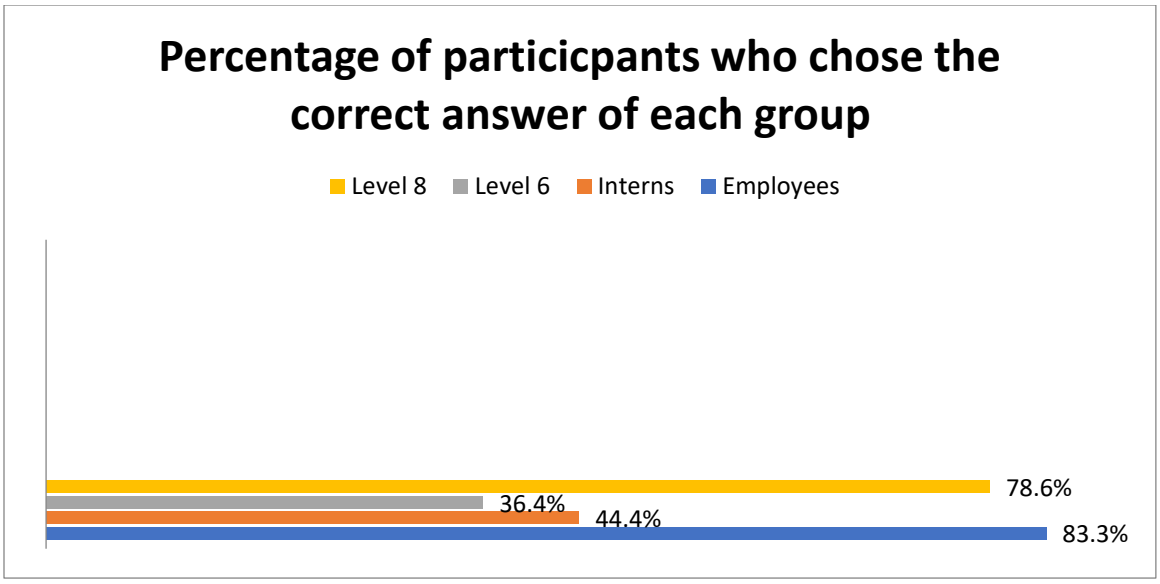

Fig.1. Who decides on the routine CT scan protocols in your department?

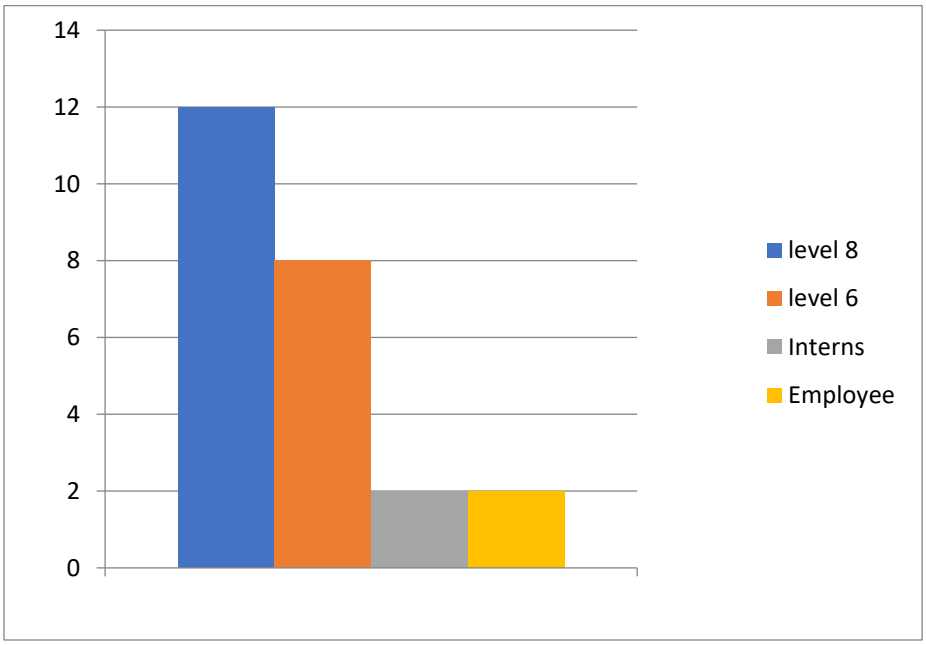

Fig.2. Total number of respondents answering the question correctly regarding ways to reduce dose in CT

They were also asked about what could happen when reducing kVp in CT scan, 47.5% answered “better tissue contrast” and 52.5% chose wrong answers. Table 4 shows the answers of the whole respondents when they were asked" reducing kVp in CT results in", only 47.5% of the whole respondents chose the correct answer which is "better tissue contrast" The answers varied because most CT users confuse kVp with mAs when it comes to which of these two improve tissue contrast.

When the respondents were asked about the optimal window for abdominal CT, one out of six employees chose the correct answer which is narrow window, six out of nine interns chose the correct answer, six out of 11 students from level six also chose the correct answer and finally five out of 14 students from level eight chose the correct answer (Fig. 3).

Also, when respondents were asked about what does narrow window improve, their answers varied, 30 respondents (75%) chose the wrong answer and 10 (25%) chose the correct one. 33.3% of employees chose the correct answer, 77.8% of interns chose the wrong answer, also 81.8% of level 6 chose the wrong answer and level 8 only 28.6% chose the correct answer. "Which of the following increases contrast resolution in CT" 18 (45%) respondents chose "higher mAs" which is the correct answer, 35% chose "thin slice thickness" and 20% chose "lower mAs". 26 (65%) chose "Window level" which is the correct answer when they were asked about "which of the following does not affect noise in CT scan". Similarly when asked about how to reduce noise a significant number of respondents (52.5%) answered "low pitch" would be beneficial. Two question were given to the respondents the first one is "which of the following does not affect noise in CT scan", 26 (65%) respond with "window level". The other question is "which of the following reduces noise", 21 (52.5%) correctly answered "low pitch

Table 4. Results of knowledge about tube potential

Results of reducing kVp			**Frequency**	**Percent (%)**
Employees		Better tissue contrast	4	66.7
		Reduced scan time	1	16.7
		Improved x-ray penetration	1	16.7
		Total	6	100
Students	**Internship (Level 10)**	Better tissue contrast	4	44.4
		Reduced scan time	5	55.6
		Total	9	100
	Level 8	Better tissue contrast	4	28.6
		Improved metal streak artifacts	6	42.9
		Reduced scan time	4	28.6
		Total	14	100
	Level 6	Better tissue contrast	7	63.6
		Improved metal streak artifacts	4	36.4
		Total	11	100

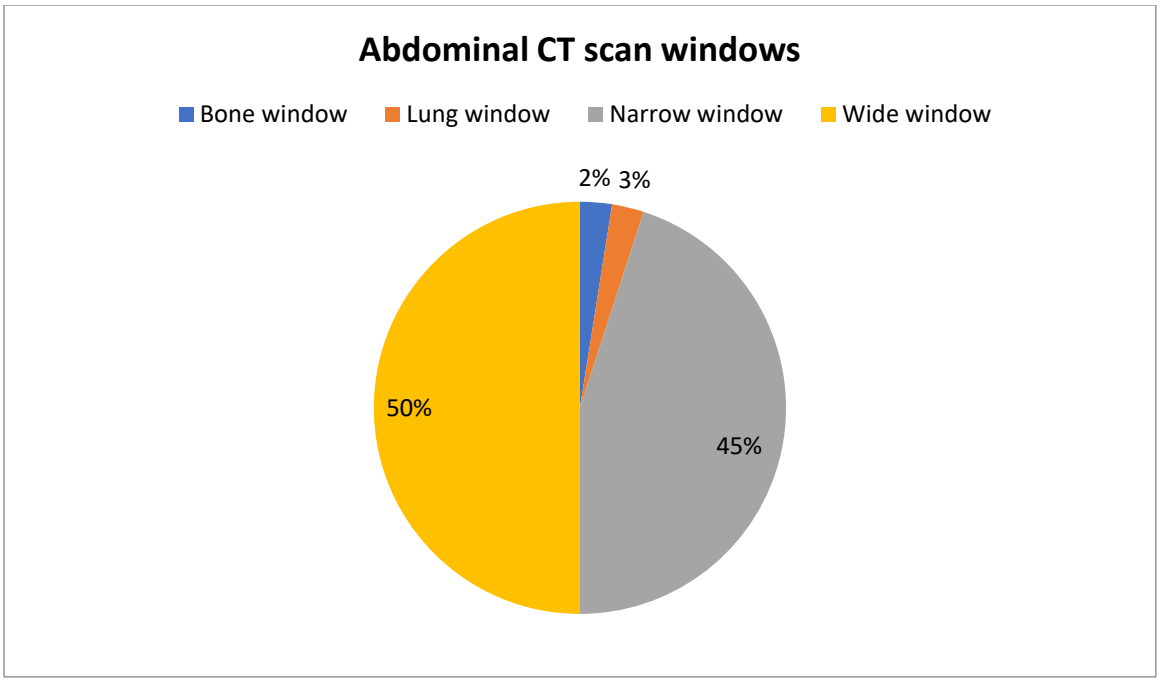

Fig.3. In Abdominal CT scan, what window will be better?

4. Discussion and Conclusion

There was a twofold difference in the answers between undergraduate students and employees despite the experience gap between both groups. Students were able to answer most of the questions correctly. Few of the questions sparked controversy due to the major difference of answers when both groups were compared to each other. Employees' answers greatly varied, most employees answered the ALARA and protocols related question correctly due to the guidelines of the radiology department they are working in. Among radiologists asked about CT protocols, 50% indicated they choose the protocols alone, the rest doing so in cooperation with a physicist (14%), a physicist and radiographer (14%), an applications specialist (7%), a physicist and applications specialist (7%) or with a combination of all (3%) of these individuals [11]. However, when employees were asked about technical parameters such as "optimum scan window", "pitch", "kVp" and "mAs" the majority answered incorrectly probably due to their academic status or most probably due to the fact the CT parameters are automated in the scanners they use. Based on this finding, radiographers should always update themselves and undergo in-house training. Also, raising their awareness about CT parameters can help minimize the radiation dose delivered to the patient. Ongoing education can be a critical point to be recommended to anyone working in the healthcare field especially radiologic technologists or clinical specialist radiographer due to the potential hazards of ionizing radiation.

The understanding of ALARA among the study respondents was almost understandable, due to the fact that the principle of ALARA is one of the radiation protection pillars. Indeed, more than 80% of all categories of respondents answered the meaning of ALARA correctly. The American College of Radiology (ACR)

recommends that all protocols should be designed by medical physicist, radiographer and radiologist [12]. The base of such designs is to maintain acceptable image quality and appropriate radiation dose [13]. Also, contrast media is widely used in CT scans to improve visualization of vessels [14]. Radiologists are the ones who decide whether the patient should be given contrast or not.

Most students answered the question about the impact of changing pitch factor in CT correctly. However, 28.5% from level eight chose the wrong answer and those, (18.1%) from level six answered wrongly, (44.4%) of interns did not understand how pitch works, while surprisingly four out of six (66.6%) employees showed lack of knowledge when it comes to the relationship of pitch factor in CT. This might be due to the fact that the relation between pitch and dose is relatively complicated to CT users and it is not as straight forward as mAs. Previous published studies have reported the potential harm caused to patients when they are exposed to high radiation doses during angiographic studies [12, 15]. Furthermore, the respondents were asked about certain parameters such as "kVp", "mAs", "scan length" and "pitch". Two out of six employees answered correctly, two out of nine internship students chose the correct answer, eight out of 11 level six students chose the correct answer and 12 out of 14 level eight students answered the question correctly which was the most respondents. This finding might be due to the fact that the dose reduction is confusing and can be implemented using different approaches based on the scan nature. Similarly, Foley et al discovered in their study that (14%) of radiographers believed that there is no reduction in patient dose when kVp is decreased from 120 to 100, and (38%) felt that image noise does not increase, while (48%) said that vessel enhancement does not improve during contrast examinations [11].

The respondents of the study was asked about the optimum scan window of the abdomen. Windowing is tricky question because it is being automated by the system. Although students from level eight should know the impact of changing windowing, they still could not answer this question correctly. This question is another proof that the concept of windowing is confusing. More than half of the respondents answered both of the questions above correctly due to the concept of noise being somewhat complex. These types of questions show lack of fully understanding CT parameter due to the fact that most of the parameters mentioned above are being automated by the system. Furthermore, lack of education or being unfamiliar with CT parameters could be another reason for the variation in the answers given.

The limitation of the study is the small sample size. Employees were not cooperative as much probably due to their duties in the hospital. Also, the duration of the study was not enough to collect as much responses as possible, students were busy with their studies and mid-terms.

A good recommendation for future research would be to repeat the study again with the next cohort of students and same cohort of employees (i.e., radiographers) after conducting continuing professional education training related to CT parameters utilization for various CT procedures in order to evaluate how such continuous training may enhance their knowledge level.

In conclusion, the level of understanding of the CT parameters varied among students and employees, due to the knowledge that most students have from their ongoing undergraduate studies while

the employees in this study are technologists with diploma degrees and with lack of continuing professional education. In addition, CT parameters are automated, and this could be a factor further contributing to the respondents' wrong answers. Surprisingly, there is a lack of awareness and knowledge regarding CT parameters among the internship students, despite the fact that they are expected to have the highest level of knowledge among the categories of students. On the other hand, there was a wide range of answers given by Level 6 students who were unable to fully comprehend CT and are still undergoing the CT course. Level 8 students answered fairly well, however there were some limitations that would require more education, more courses, or more online resources. In order to maintain the accuracy of CT parameters, the need for ongoing education is inevitable.

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Questionnaire

1) What level are you in :
A) Level 6.
B) Level 8.
C) Internship.
D) Radiographer.

2) Who decides on the routine CT scan Protocols in your department?
A) Radiologists ( )
B) Radiographer ( )
C) Physicist ( )
D) Application specialist ( )
E) Other ( )

3) Who decides if the patient should take contrast?
A) Radiographer.
B) Radiologist.
C) Physicist.
D) Clinical Physician.

4) In Abdomen CT scan what window will be better:
A) Narrow window.
B) Wide window.

7) Which of the following increase contrast resolution in CT?
A) Lower mAs.
B) Higher mAs.
C) Thin slice thickness.
D) Fast gantry rotation.

8) Narrow window width improves:
A) Temporal resolution
B) Spatial resolution
C) Contrast resolution
D) All of the above

9) which of the following does not affect noise in CT scan:
A) Window level
B) mAs
C) Slice thickness
D) kVp

10) The dose in CT scan can be reduced by which of the following parameters (assuming other factors are constant)
A) Increase kVp
B) Increase mAs

C) Bone window.
D) Lung window.

5) Which of the following describe the relationship between pitch and dose?
A) If pitch increase, dose increase.
B) If Pitch decrease, dose decrease.
C) If pitch increase, dose decrease.
D) Nothing happens.

6) What is "ALARA"?
A) As Low as Responsibly Acceptable.
B) Alarm Loss Activated Radiation Activated.
C) As Low as Reasonably Achievable.
D) As Low As Really Acceptable.

C) Increasing scan length
D) Increasing pitch

11) Reducing kVp in CT results in:
A) Better tissue contrast.
B) Reduced scan time.
C) Metal streak artifacts are improved.
D) X-ray penetration improves.

12) Which of the following reduces noise:
A) Decrease kVp.
B) Decrease mAs.
C) High pitch.
D) Low pitch.

تقييم معرفة معلومات التصوير المقطعي بين مصوري الأشعة وطلاب البكالوريوس في المدينة المنورة، المملكة العربية السعودية

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مستخلص. الهدف من هذه الدراسة هو تقييم فنيي وطلاب الأشعة التشخيصية من حيث معرفتهم بالعوامل المؤثرة على طرق التصوير باستخدام أجهزة الأشعة المقطعية وقياس مدى تأثير ذلك على جودة الصورة والجرعة الاشعاعية. قام المؤلفون بتوزيع استطلاع على الفئات المستهدفة في أربعة مستشفيات في المدينة المنورة واحتوى الاستبيان على ١٢ سؤالا في صيغة خيارات متعددة وكانت متعلقة بالجوانب التقنية المتعلقة باستخدام أجهزة الأشعة المقطعية. تم تزويد المشاركين بشرح تفصيلي عن الهدف من الدراسة وتم التأكيد على الحفاظ على سرية المشاركين وبدون الإفصاح عن هويتهم أو أسماءهم. شارك في هذه الدراسة ٤٠ شخص، ٣١ منهم من فئة الطلاب (١٤ من المستوى الثامن، ١١ من المستوى السادس، ٩ من طلبة الامتياز) بينما كان هناك فقط من فئة فنيي الأشعة. أثبتت النتائج تفوق الطلاب من حيث مقدرتهم على الإجابة على معظم الأسئلة بشكل صحيح وذلك6 بمعدل الضعف مقارنة بفنيي الأشعة بغض النظر عن الفارق في حجم الخبرة الذي يمتلكه الفنيين. السبب الرئيسي في التفاوت بين مستوى الطلاب وفنيي الأشعة فيما يخص الاستطلاع يعود الى الفوارق في مستوى التعليم بين الفئتين حيث أن الفنيين المشاركين في هذه الدراسة لا يحملون سوى درجة الدبلوم.

كلمات مفتاحية: الأشعة المقطعية، الجرعات الاشعاعية، جودة الصورة، تقنية الأشعة، مهارات التحكم بالعوامل التقنية لفحوصات الأشعة المقطعية

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