RESEARCH ARTICLE

Awareness and knowledge of diagnostic reference levels in computed tomography among radiographers in public and private hospitals in Selangor

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Abstract:

Diagnostic Reference Level (DRL) is an efficient tool for optimising patient protection in medical exposures during diagnostic and interventional procedures without jeopardising the diagnostic information in the image. DRLs have limited value without awareness and knowledge. The purpose of this study was to determine awareness and knowledge of DRL in CT among radiographers in public and private hospitals in Selangor. An online questionnaire survey was administered to radiographers (n=98) in the selected seven public and seven private hospitals in Selangor via social media platforms. The study demonstrated that radiographers working in the private hospitals (61.2%) had high level of awareness than those working in public hospitals (32.7%). Additionally, it was discovered that public hospital radiographers (63.3%) had a higher degree of knowledge than private hospital radiographers (36.7%). Although most of the radiographers have a good level of awareness and knowledge of DRL in CT, enhanced training and re-training should be performed to improve the current practice and update the radiographer's knowledge of the current issues and topics on dose optimization in CT. This two-tier health care system should work as a team when involving with patients' safety to provide a good service to the community.

Keywords: awareness, computed tomography, diagnostic reference level, knowledge, radiographer

1. INTRODUCTION

Computed Tomography (CT) is recognized as a modality with a high radiation dose, with the concern that the doses given may be clinically unjustified in some cases (Holmberg et al., 2010). The introduction of multidetector array technology and the development of advanced protocols has broadened the variety of possible applications, resulting in a large growth in CT usage (Tonkopi et al., 2017). Because of the potential hazards of ionizing radiation and the importance of patient safety, the rising demand for CT examinations has become a serious concern.

Diagnostic Reference Level (DRL) was introduced in 1996 in Publication 73 by the International Commission on Radiological Protection (ICRP). To identify unusually high dose levels, DRLs should be used as a type of investigation level. When DRLs are consistently exceeded, a local review is usually conducted. DRLs are not intended for regulatory or commercial purposes, and they do not represent a dose constraint. They are also not linked to limits or constraints (Paulo et al., 2020). DRL is an effective tool that helps in optimisation of protection in medical exposures in diagnostic and interventional procedures for patients without jeopardising the diagnostic information in the image (Vañó et al., 2017). Malaysia has established a guideline on DRL in 2013 which contains various types of modalities such as general x-ray, fluoroscopy, CT scan, and mammography but only limited to the adult population and there are no recent updates on this guideline. Due to the vary of equipment and procedure protocols between facilities in countries or regions, the establishment of national or regional DRL is considered as good practice (Vassileva & Rehani, 2015).

Knowledge and awareness of the radiographers regarding dose optimisation will help in achieving good image quality to help in diagnostic with an optimisation dose given to the patient. Without awareness and knowledge, DRLs themselves have only limited value. Few studies had shown that radiographers have limited knowledge regarding CT doses optimisation (Karim et al., 2016; Abdulkadir et al., 2021; Mahmoudi et al., 2019). Radiographers' practices and knowledge of DRLs are directly related to training and strength of preceptorship (Bawazeer, 2022) that might be

different according to the type of hospital which might influence the degree of radiographers' awareness and knowledge. However, there has been little research comparing the knowledge and awareness of DRLs in CT among public and private radiographers. Thus, the purpose of this study is to analyse the level of awareness and knowledge of diagnostic reference level (DRL) in CT among radiographers in public and private hospitals in Selangor, where radiology departments are vast and equipped with a variety of imaging modalities.

2. MATERIALS AND METHODS

2.1. Study population and design

This study included 98 English-speaking radiographers, 49 from public and private hospitals each in Selangor. Radiographers from teaching hospital are excluded.

The online survey/self-administered questionnaire was distributed for four months (April until July 2022) among radiographers working in public and private hospitals in Selangor via social media platform (e.g.: Whatsapp) and Malaysian Society of Radiographers facebook group. The online questionnaire, which was adapted and adopted from Abdulkadir et al., (2021), Hawarihewa et al., (2021) and Paolicchi et al., (2016), consists of three sections including sociodemographic data in section 1; awareness of essential general radiation protection and optimisation in CT in section 2; and knowledge and awareness about DRLs and their application as an optimisation tool in section 3. Correct answers for each question were given a score of 1, while incorrect or blank answers were given a score of 0. The score obtained for awareness questions were grouped into high level (5 - 6 score), middle level (3 – 4), and low-level (0 – 2 scores) and for knowledge questions, high level (7 - 9 score), middle level (4 – 6), and low-level (0 – 3 scores).

2.2. Validity and reliability

The questionnaire reliability was assessed in terms of consistency by using Cronbach's alpha (α) coefficient at a 95% confidence interval with a threshold for statistical significance set at $p < 0.05$. The resultant Cronbach's alpha is 0.714. A pilot study was carried out with 12 radiographers before actual data were collected and minor modifications were made based on the feedback received from the pilot study participants.

2.3. Ethical consideration

This study was approved by the Universiti Teknologi MARA (UiTM) research ethics committee (FERC/FSK/MR/2021/0055).

3. RESULTS

The sociodemographic characteristics of the radiographers are presented in Table 1. Most radiographers (69.4%) were females between the ages of 25 and 35 (61.2%), 69.4% were diploma holder and 41.8% have 5 to 10 years of working experiences.

Table 1. The sociodemographic data of the respondents

Characteristic	n	%
Gender		
Male	68	69.4
Female	30	30.6
Age		
< 25	24	24.5
25 – 35	60	61.2
36 – 45	14	14.3
46 – 55	0	0
>55	0	0
Type of Hospital		
Public Hospital	49	50.0
Private Hospital	49	50.0
Academic Qualification		
Diploma	68	69.4
Bachelor's degree	26	26.5
Master's degree	4	4.1
Doctoral degree		
Working Experience in CT		
No experience	15	15.3
< 5 years	38	38.8
5 - 10 years	41	41.8
10 - 15 years	4	4.1
15 – 20 years	0	0
>20 years	0	0

This study demonstrated that 48 and 38 radiographers from the private and public hospitals were aware about the dose display on the CT console, with 84.7% selecting a distinct scan procedure for adult and paediatric scans and 87.8% taking DRL into consideration to maximise patient protection. The radiographers' responses to awareness of DRL in CT is shown in Table 2.

Table 2. Radiographers' responses to awareness of DRL in CT

Yes		**No**	
n (%)		**n (%)**	
Public	**Private**	**Public**	**Private**
n=49	**n=49**	**n=49**	**n=49**
38 (77.6)	48 (98)	11 (22.4)	1 (2)
44 (89.8)	39 (79.6)	5 (10.2)	10 (20.4)
38 (77.6)	48 (98)	11 (22.4)	1(2)

In addition, most of the of radiographers (60.2%) and (81.6%) were aware on the types of patients who are most sensitive to ionising radiation and the types of tissues that are highly vulnerable to ionising radiation. When asked about the quantity used to express CT dose, 91.8% of respondents correctly responded that it consisted of 41 and 49 public and private radiographers, respectively. Additionally, 99% of respondents agreed that scan protocols are important for CT dose optimization. However, 61 of 98 radiographers get the notion of dose optimisation wrong. The radiographers' responses to knowledge of DRL in CT is shown in Table 3.

Table 3. Radiographers' responses to knowledge of DRL in CT

Correct n (%)		**Incorrect n (%)**	
Public n=49	**Private n=49**	**Public n=49**	**Private n=49**
25 (51)	34 (69.4)	24 (49)	15 (30.6)
42 (85.7)	38 (77.6)	7 (14.2)	11 (22.4)
25 (51)	12 (24.5)	24 (49)	37 (75.5)
41 (83.7)	49 (100)	8 (16.3)	0
48 (98)	49 (100)	1 (2)	0

This research also revealed that 48 and 35 radiographers of the public and private hospitals, respectively and 35 public radiographers claimed that they were aware of the DRL in CT. However, when asked if they had ever conducted a CT dose survey or engaged in an evaluation scan protocol as a result of the reported abnormal dose, only 56 and 40 radiographers had participated, respectively. The radiographers' responses to the awareness of DRL in CT is shown in Table 4.

Table 4. Radiographers' responses to the awareness of DRL in CT

Yes n (%)		**No n (%)**	
Public n=49	**Private n=49**	**Public n=49**	**Private n=49**
35 (71.4)	48 (98)	14 (28.6)	1 (2)
25 (51)	31 (63.3)	24 (49)	18 (36.7)
14 (28.6)	26 (53.1)	35 (71.4)	23 (46.9)

Furthermore, 60.2% of radiographers correctly answered the purposes of DRLs. Regarding the dosage quantities utilised for establishing DRLs in CT for $CTDI_{vol}$ and DLP, respectively, 91.8% and 88.8% of radiographers provided accurate responses. However, more than half of radiographers (54.1%) give the inaccurate response that Size Specific Dosage Estimates (SSDE) are not the dose amounts used to determine DRLs in CT as shown in Table 5.

Table 5. Radiographers' responses about knowledge of DRL and its application as an optimisation tool

Correct n (%)		**Incorrect n (%)**	
Public n=49	**Private n=49**	**Public n=49**	**Private n=49**
27 (55.1)	32 (65.3)	22 (44.9)	17 (34.7)
42 (85.7)	48 (98)	7 (14.3)	1 (2)
43 (87.8)	45 (91.8)	6 (12.2)	4 (8.2)
32 (65.3)	13 (26.5)	17 (34.7)	36 (73.5)

Moreover, this study revealed that 30 and 16 radiographers from private and public hospitals, respectively, displayed high levels of awareness, while middle level awareness of radiographers in public hospital (61.2%) and private hospital (36.7%) was discovered. Three public radiographers and one private radiographer indicates a low level of awareness.

As for the knowledge, only 18 private radiographers have high level of knowledge compared to 31 out of 49 public radiographers. There were 18 public radiographers and 31 private radiographer with middle or intermediate level knowledge and no radiographer has a limited amount of understanding. The level of awareness and knowledge is showed in Table 6.

Table 6. Frequency and percentage of level of awareness and knowledge based on type of hospital

	Awareness Level		
Hospitals	**High level n (%)**	**Middle level n (%)**	**Low level n (%)**
Public	16 (32.7)	30 (61.2)	3 (6.1)
Private	30 (61.2)	18 (36.7)	1 (2)
	Knowledge Level		
Public	31 (63.3)	18 (36.7)	0
Private	18 (36.7)	31 (63.3)	0

4. DISCUSSION

The national guideline on DRL has been established in Malaysia in 2013 and consist of various type of imaging modalities such as general x-ray, fluoroscopy, CT scan, and mammography that only focus on the adult population with no recent updates (*Malaysian Diagnostic Reference Levels in Medical Imaging (Radiology)*, 2013). The recommended DRLs are reported to efficiently reduce the radiation dose to the patient (Brenner et al., 2001). Consequently, radiographers' knowledge should be strengthened with continuous education about the importance of utilizing DRLs as their knowledge will reflect on their scanning performance.

4.1 Awareness and knowledge about essential general radiation protection and optimisation in CT

In this study, the general knowledge regarding the general radiation protection and optimisation in CT shows that most of the radiographers who account for more than half of the participants answered most of the questions correctly. However, when asked about the concept of dose optimization, 62.2% (61 out of 98) participants answered it incorrectly that might be due to the inclusion of this theoretical definition of dose optimization in most of the educational and training courses. In addition, radiographers had shown good practical experience concerning the protection optimization as most of them were aware of the dose display on the CT console and select different scan protocols between adults and children.

Existing studies have demonstrated fluctuations in the awareness and knowledge of radiation protection and dose optimization. Some of the studies reported good knowledge (Hawarihewa et al., 2021; Rawashdeh et al., 2018; Almohiy et al., 2020) while others reported poor knowledge (Abdulkadir et al., 2021; Zekioğlu & Parlar, 2021; Alhasan et al., 2016; Portelli et al., 2016) about the radiation protection of CT parameters. This might be due to the difference in education courses or level of qualifications and training that different between each institute and country.

4.2 Knowledge and awareness about DRLs and its application as an optimisation tool

This section demonstrated that a large proportion of the radiographers 84.7% (83 of 98) declare awareness of DRL in CT but cannot describe the function of DRLs. Besides that, around more than half of the participants do not choose SSDE as the suitable dose quantity for establishing DRLs. SSDE is not a direct dose quantity that mostly used for setting the pediatric DRLs as the dose are predominantly depends on the body size. Thus, this might the factor why the majority of radiographers does not familiar with the dose quantity.

The previous survey-based studies show that most radiology personnel (radiographers, radiologists, CT technologists) declare awareness of the DRL (Mahmoudi et al., 2019; Abdulkadir et al., 2021; Hawarihewa et al., 2021). Despite their awareness, it is found that the knowledge regarding CT DRLs was lacking. It is stated that a low level of knowledge of CT DRLs may be caused by a lack of local and national DRLs and proper training for the radiology personnel (Mahmoudi et al., 2019).

The normalized nature of CT data will always make the image appears properly exposed, unlike traditional radiographic imaging. Thus, the radiographer should be aware of the DRLs and optimise the protocols to prevent the patient's overexposure. DRLs can help reduce patient dose from CT examinations after the scanning protocol has been changed or improved following a review (Tonkopi et al., 2017). As a result, DRLs have proven to be a useful tool in optimising CT practice over the years and should be repeated periodically (Vañó et al., 2017; Ogbole & Obed, 2014). Hence, cooperation from the medical physicist and radiologist together with the radiographers' knowledge and skills regarding strategies for reducing the dose received by patients is essential (Tsapaki, 2020; Bwanga & Chanda, 2020).

4.3 Level of awareness and knowledge between radiographers of publics and private hospitals.

In this study, radiographers' level of awareness and knowledge regarding DRL in CT shows a significant difference between the public and private radiographers. Lack of ionising radiation and safety training is one of the factor that cause the discrepancy in awareness and knowledge between public and private radiographers. It has been demonstrated that monthly or annual ionising radiation and safety training improves radiographers' awareness and knowledge (Rawashded et al., 2018; Farajollahi et al., 2014). However, the organization or funding of the courses has a significant impact. According to the study by Evripiotis et al. (2013), the majority of radiographers who participate in extensive training acknowledge the support of their hospital's management in the planning of the training programme.

In Malaysia, continuing medical education (CME) is necessary annually for licence renewal and is mostly funded by the institution and healthcare technology businesses, which explains for the zero or no respondents who indicated that their level of knowledge was low.

Several limitations were identified in this study. The variables in this study were based on self-reports rather than on objective assessment, potentially causing bias and only included radiographers who are working in Selangor state which may not a representative of the entire population of CT radiographers in Malaysia. Furthermore, this study also only focuses on the basic DRLs knowledge without any targeted examination (e.g CT abdomen) or type of patient (e.g pediatric).

5. CONCLUSION

This study strives for a better CT practice through the emphasis on the DRLs among the radiographers in the public and private hospitals in Selangor. The radiographers from both public and private hospitals exhibited good knowledge regarding radiation protection and dose optimization.

As a recommendation, assessment of radiographer's skill objectively could be done to see their competency and adherence level before doing any intervention program. Training and re-training programs among the radiographers should be implemented to improve the current practice and update their knowledge of the current issues and topics on dose optimization in CT. This two-tier health care system should work as a team when involving with patients' safety to provide a good service to the community. Besides that, undergraduates also should be trained to increase their level of awareness and knowledge regarding DRL. Hence, this will reduce the patient dose received according to the ALARA principle of radiation protection.

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