Differences between Saudi Arabian and Australian radiographers' knowledge and attitudes about paediatric CT doses

Abstract ***Introduction:*** Computed tomography (CT) is used extensively in diagnostic radiology for examination of human soft tissues, and is widely used in the paediatric population. Researchers and government regulators have expressed concerns about the cancer risk of CT radiation on children. The authors surveyed Saudi Arabian and Australian radiographers to enable comparison of their attitudes and knowledge towards paediatric CT radiation dose. ***Methods:*** Radiographers from all exclusively paediatric public hospitals in Australia and Saudi Arabia were sent a structured, purpose-designed questionnaire. Data were analysed using univariate statistics. ***Results:*** 56 of 71 eligible Saudi Arabian radiographers (79%) and 50 of 83 Australian radiographers (60%) participated. Australian participants were more highly educated and had longer work experience than their Saudi counterparts, and undertook most forms of ongoing training and education significantly more frequently. Australians' mean ratings of radiation risk for head and chest CT scans were similar to those given by Saudi respondents, but Australians' mean ratings for abdomen/pelvis CT scans were significantly lower. More Australians reported intervening to reduce paediatric dose (95.7% vs 72.7%, $P < 0.005$), and 88.0% believed that over 60% of CT scans are justified compared with 8.9% of Saudi participants. ***Conclusion:*** Australian and Saudi Arabian radiographers working in paediatric hospitals differ in their knowledge bases. Knowledge can be improved through enhancement of hospital protocols and continuing education and training, and will lead to reduced radiation exposure among paediatric patients.

Keywords: computed tomography, CT dose, diagnostic imaging, education of radiographers, paediatric imaging, radiographers' attitudes, radiation dose, radiographers' knowledge.

Al Mohiy H[1]
ADip, BSc, MSc

Sim J[1]
BSc, MSc, PhD

Seeram E[2]
BSc, MSc

Davidson R[1,3]
BBus, MSc, PhD

[1] Discipline of Medical Radiations, RMIT University, Bundoora, Victoria 3083, Australia

[2] Medical Imaging, British Columbia Institute of Technology, Burnaby, Canada

[3] School of Dentistry and Health Science, Charles Sturt University, Wagga Wagga, NSW 2650, Australia

Correspondence to
hussain.almohiy@rmit.edu.au

Introduction

Computed tomography (CT) is used extensively in diagnostic radiology, primarily for examination of human soft tissues. CT scans are widely used in the paediatric population due to short analysis time and ease of application to non-sedated, young, unwell and/or unco-operative patients.[1] A recent report estimated 6.5% of 62 million CT scans per year in the United States (US) involved paediatric patients,[2] of which one-third were unjustified scans.[3]

CT scanning delivers a dose of ionising radiation to the patient. The amount of ionising radiation needed for paediatric patients is typically scaled down from the adult dose.[4] It is evident from the literature that CT scans performed on children, who have higher organ radiosensitivity, are likely to receive higher effective radiation doses than adults or full-size patients – typically two to six times greater.[4–8] Exposure to ionising radiation in paediatric CT scans can induce long-term damage, such as carcinogenesis and genetic damage.[6,9–11]

Approximately 33% of all paediatric CT examinations conducted in the US are in children aged 10 years or younger, with 17% in children 5 or younger.[12] At these ages the organs and tissues are intrinsically more sensitive to the oncogenic effects of radiation as they have a high proportion of cells that are dividing and reproducing.[13,14] Radiation-induced risk is also higher in paediatric patients due to wider and increased cellular distribution of red bone marrow and their greater post-exposure life expectancy.[15,16] The effective radiation doses received by children are about 50% higher than those received by adults due to their smaller body size and related attenuation.[4] Various authors have reported that the 600,000 abdominal and head CT examinations undertaken annually in children under the age of 15 years in the US could result in 500 deaths from cancer attributable to CT radiation.[17]

The bio-effects associated with radiation exposure can be divided into two main groups: deterministic risk and stochastic effects. The deterministic risk is a function of radiation dose delivered to an organ or body region. Deterministic effects of radiation are seen above a threshold dose, with higher doses promoting more severe effects; they are rarely seen in diagnostic radiology, but may become a problem with angiographic procedures, including CT fluoroscopy.[18]

Stochastic effects are dependent upon a complex series of events, including cell transformation; they may appear as cancer in patients, or as genetic abnormalities in their children. The probability of stochastic effects increases with the absorbed radiation, but the severity of the effect is independent of the radiation dose.[19]

CT radiation exposes the subject to stochastic effects such as cancer, and is thought to be responsible for as many as 1 in 50 cancer cases reported each year in the US.[1] Analysis of data from Japanese cities exposed to atomic radiation at the end of World War II showed that the risk of developing cancer is much higher in people exposed when young.[20] At ages up to 10 years, children are up to three times more sensitive to radiation than adults.[21,22] Brenner, *et al.* found that a single 15 mSv CT examination, equivalent to 500 standard chest x-rays, has an impact on a child of twice that on an adult.[23] Children's lifetime cancer risk is increased due to both higher radiation sensitivity and longer expected life span.[21] A study from Israel estimated that 1 year of paediatric CT scanning generated 9.5 excess deaths from cancer.[24]

The National Cancer Institute (US) and the Society of Paediatric Radiology estimated the risk of dying from cancer to be 1 in 550 following abdominal CT and 1 in 1500 for a brain CT performed in infancy (using adult parameters), generating approximately 0.35% more cancer deaths than expected in the general population. Although the increased risk of cancer is small for each individual scanned, the impact on public health is substantial due to the increasingly large number of CT examinations being performed.[25]

The US Federal Drug Administration (FDA) recommends several measures to protect children and small patients from unnecessary exposures to CT, including optimising CT settings, reducing the number of multiple scans with contrast material and eliminating inappropriate referrals for CT.[8] International organisations, including the International Commission on Radiological Protection,[22] the International Atomic Energy Agency[26] and the European Commission,[27] made similar recommendations aimed at minimising CT doses, particularly in the paediatric population. To ensure optimisation of performance and patient protection in CT procedures, the European Commission established a set of quality criteria for adult CT examinations.[27]

In attempts to reduce dose from CT scans, several investigators have recommended the use of the lowest possible radiation dose without compromising diagnostic accuracy.[28,29] This recommendation is not always followed in practical settings for various reasons, such as lack of uniform protocols and the differing levels of knowledge and training of personnel involved in paediatric ionising radiation doses. Education and training of radiographers involved in paediatric CT is vital for ensuring the best radiological protection of the patient while preserving the necessary diagnostic information.[26]

Most hospital protocols involve explanation of CT radiation risk to patients and/or carers. A 2009 survey found that patients often have a poor concept of the radiation dose and risk associated with CT.[30] Physicians themselves are often little more informed than their patients with regards to CT examination dose.[31] In their 2004 paper, Lee, *et al.* showed that all patients and more than 70% of physicians underestimated the dose from one abdominal CT examination,[32] and reported that radiologists were unable to provide accurate estimates of CT doses regardless of their level of experience. In addition, a 2003 study of doctors (including consultant radiologists) indicated that only 2% of participants could accurately estimate the relative doses of common diagnostic procedures.[33] The degree of knowledge was inversely proportional to seniority, with consultants scoring less than junior colleagues.[33] Finally, a 2004 survey found that 53% of radiologists and 91% of emergency room physicians wrongly believed that CT scans did not increase lifetime risk of cancer.[32]

Knowledge of dose levels enhances understanding of the factors that affect patient doses in CT and is usually considered the first step in optimisation strategies.[7] Mettler pointed out that radiographers' basic education and training overlooks paediatric CT radiation doses.[34] The IAEA recommends education and training of radiographers involved in paediatric CT.[26] A recent survey of health professionals in Northern Ireland about awareness of the radiation doses imparted during common diagnostic imaging procedures and their long term impact on patients demonstrated a knowledge gap which could be improved with appropriate training.[35] Similarly, a 2006 survey in New South Wales, Australia showed the need for radiographers to participate in continuing education and protocol review, particularly in paediatric CT examinations.[36]

Aim

The literature reviewed above shows that although the need to control and reduce paediatric dose is recognised in some countries, paediatric CT dose is poorly understood in general. This article addresses the issue of radiographers' knowledge of paediatric CT radiation dose. The aim of this article is to compare Saudi Arabian and Australian radiographers in terms of their knowledge, attitudes and practices with respect to paediatric CT scans. Specifically, the study aimed to: quantitatively evaluate Australian and Saudi Arabian radiographers' knowledge of the radiation dose delivered by a range of paediatric CT scan protocols; and establish Australian and Saudi Arabian radiographers' attitudes toward paediatric CT dose.

Methods

Design and ethics

Australian and Saudi Arabian CT radiographers' knowledge and attitudes about paediatric CT dose were evaluated and compared using a quantitative survey. RMIT University's Human Research Ethics Committee (RMIT University, Melbourne) approved the study on 31st August 2009.

Recruitment

Radiology departments in all exclusively paediatric public hospitals in Australia (n = 7) and Saudi Arabia (n = 8) were contacted by telephone. The researcher contacted the heads of each radiology department, explained the purpose of the study, and assured confidentiality with respect to survey responses and participants' details.

Questionnaire design

No previous researchers in this field employed a questionnaire that was suitable for this study. The survey questionnaire was designed after an exploratory discussion with academic and clinical medical imaging professionals at RMIT University and a thorough review of the literature. The questionnaire had separate sections for background information (nine primary questions; demographics, qualifications, employment history) and CT information (14 primary questions; CT scan protocols, reject and repeat scan analysis records, perceived radiation doses, risks of CT radiation, dose intervention, continuing education and training). The survey questionnaire consisted mostly of closed-ended questions (for ease of response and analysis), but included some open-ended questions to permit the participants to respond freely when required. The design of questionnaire was aimed at eliciting simple, clear and concise responses; it was estimated that participants would complete the questionnaire within approximately 15 minutes.

Data collection

In October 2009, survey packages were posted to the heads of

Table 1: Years of experience in paediatric CT

Period	Country					
	Australia *n* (%)		Saudi Arabia *n* (%)		Total *n* (%)	
Less than a year	8	16 %	18	33%	26	25 %
1-5 years	20	40%	29	53%	49	47%
6-10 years	14	28%	7	13%	21	21%
11-20 years	6	12%	1	2%	7	7%
More than 20 years	2	4%	0	0%	2	2%
Total	50	100%	55	100%	105	100%

Table 2: Mean ratings of CT scan dose

	Country							
	Australia			Saudi Arabia				
Question	*N*	*M*	*SD*	*N*	*M*	*SD*	*t*	*P*
Do you think the radiation dose for a head CT scan in your department is (very low, low, medium, high, very high)?	49	3.6	2.21	56	5.1	2.04	-3.5	0.001
Do you think the radiation dose for a chest CT scan in your department is (very low, low, medium, high, very high)?	48	3.8	2.70	56	5.5	1.75	-3.6	0.001
Do you think the radiation dose for an abdomen/pelvis CT scan in your department is (very low, low, medium, high, very high)?	48	4.2	2.77	56	6.5	2.06	-4.9	0.001

Note. *N* = Number of participants; *M* = Mean, *SD* = Standard Deviation.

the CT departments of all 15 Australia and Saudi Arabian paediatric public hospitals with a request to distribute them to CT radiographers. Each package consisted of an invitation to participate in the survey, a plain language statement, the questionnaire, and a postage-paid return envelope. To ensure confidentiality, each participant was asked to return the completed questionnaire in the supplied envelope directly to the researcher.

Data analysis

Australian and Saudi Arabian CT radiographers' knowledge and attitudes about paediatric CT dose, and their demographics and other data, were compared in SPSS (version 18 – SPSS Inc., Chicago, USA) using *t*-tests for differences in means of continuous variables (for example, head CT scan dose) and Chi-squared tests for differences in proportions (for example, levels of qualification). Differences were judged to be significant if the *P*-value was less than 0.05.

Results

Participant characteristics

There were 71 radiographers working in public paediatric hospitals in Saudi Arabia in October 2009; 56 (79%) participated in the study. In Australia, there were 83 radiographers; 50 (60%) of them participated in the study. The participation rate among Saudi radiographers was significantly higher than the Australian rate ($P < 0.05$).

Forty-two per cent of Australian radiographers were aged 20–29 and 55% of Saudis; a higher proportion of Australian respondents was aged 40+ (28% vs. 9%, Chi-squared = 6.53, $P < 0.05$). An equal number of male and female Saudi radiographers participated in this study, but of the Australian radiographers, more women responded than men (31 of 49 participants – 63.3%); the gender difference is not significant (Chi-squared = 1.37, $P = 0.24$).

Australian participants were significantly more likely to hold a degree as their initial qualification than Saudi Arabians (69.4% vs 27.3%, χ^2= 13.03, $P < 0.001$); a diploma was the initial qualification for 49.1% of the Saudi radiographers surveyed. A large majority of Saudi Arabians (83%) had been practising CT radiographers for five years or less; 53% of Australian respondents had more than five years of experience (Chi-squared = 15.17, $P < 0.001$). Years of experience specifically in paediatric CT are shown in Table 1, which indicates that a higher proportion of Saudi Arabian than Australian respondents had been practising paediatric CT for less than five years (Chi-squared = 11.13, $P < 0.05$).

Continuing education

A significantly higher proportion of Australian (95.9%) than Saudi respondents (75.0%) reported participating in training and education at least once per year (Chi-squared = 8.854, $P < 0.005$). Australians were more likely to undertake in-house training (82.0% vs. 32.1%), self-directed study (52.0% vs. 21.4%), and postgraduate courses (16.0% vs. 1.8%). Saudi Arabian radiographers were more likely to report engaging in accredited professional courses (25.0% vs. 8%).

Informing carers

Saudi Arabians generally discuss the risks with the parent or carer more than Australian respondents (53.6% vs. 30.6%, Chi-squared = 9.896, $P < 0.005$). Nevertheless, similar proportions of Saudi Arabian and Australian

Table 3: Mean ratings of CT radiation risk (0 = very low, 10 = very high)

	Country							
	Australia			Saudi Arabia				
Question	*N*	*M*	*SD*	*N*	*M*	*SD*	*t*	*P*
How do you rate the risk to the patients of the CT radiation in paediatric examination of the head (very low, low, medium, high, very high)?	48	4.4	2.60	56	4.9	2.26	-1.1	0.30
How do you rate the risk to the patients of the CT radiation in paediatric examination of the chest (very low, low, medium, high, very high)?	48	5.1	2.47	56	5.3	2.01	-0.5	0.61
How do you rate the risk to the patients of the CT radiation in paediatric examination of the abdomen/pelvis (very low, low, medium, high, very high)?	48	5.5	2.41	56	6.5	2.12	-2.3	0.026

Note. *N* = Number of participants; *M* = Mean, *SD* = Standard Deviation.

Table 4: What percentage of paediatric CT scan requests do you think are justified?

	Country					
Period	Australia *n* (%)		Saudi Arabia *n* (%)		Total *n* (%)	
Less than 20%	1	2 %	15	26.8%	16	15.1 %
21–40%	0	0%	20	35.7%	20	18.9%
41–60%	5	10%	16	28.6%	21	19.8%
61–80%	24	48%	5	8.9%	29	27.4%
81–100%	20	40%	0	0%	20	18.9%
Total	50	100%	56	100%	106	100%

Table 5: Frequency of updating CT protocols

	Country					
	Australia *n* (%)		Saudi Arabia *n* (%)		Total *n* (%)	
Anytime	27	55.1%	11	19.6%	38	36.2%
Monthly	10	20.4%	9	16.1%	19	18.1%
Quarterly	5	10.2%	3	5.4%	8	7.6%
Half-yearly	3	6.1%	9	16.1%	12	11.4%
Yearly	4	8.2%	19	33.9%	23	21.9%
Never	0	0%	5	8.9%	5	4.8%
Total	49	100%	56	100%	105	100%

respondents (34.7% and 42.9% respectively, $P = 0.509$) reported that they discussed radiation doses with parents and carers.

Attitudes to paediatric CT

Australian participants' mean level of enjoyment related to working in paediatric CT was significantly higher than that of Saudi Arabians (measured on a 5-point Likert scale, where 1 = 'enjoy strongly'; 1.6 vs. 2.0, $P < 0.05$). There was no difference between the mean level of agreement of Australian and Saudi Arabian radiographers about having a future in paediatric imaging, level of familiarity with CT equipment, level of confidence when working with CT, extent to which they accessed resources (journals, books, websites) to improve their CT knowledge, and desire to advance their skills in paediatric CT.

Radiographers' knowledge

To assess radiographers' readiness to intervene, respondents were asked whether they kept reject and repeat CT scan analysis records. While the use of CT has minimised the need for reject/repeat of images due to over- or underexposure, images may be rejected/repeated for a variety of other reasons. Over half of Saudi Arabian respondents (51.9%) reported keeping reject and repeat CT scan analysis records, whereas few Australian respondents (20.9%) did – a significant difference (Chi-squared = 9.79, $P < 0.005$).

When asked to provide an opinion or rate the radiation doses given in CT scans on the head, chest, and abdomen/pelvis (from 0 = very low to 10 = very high), ratings given by Australian respondents were significantly lower than those given by their Saudi Arabian counterparts (Table 2).

After rating doses, participants were asked to rate the accompanying risks to the patient (from 0 = very low to 10 = very high). Table 3 shows that the mean ratings of radiation risk for CT scans on the head and chest given by Australian respondents were not significantly different from those given by Saudi Arabian respondents, but Australians' mean ratings for abdomen/pelvis CT scans were significantly lower (T-102 = -2.256, $P < 0.05$).

The next two questions focused on dose intervention. Significantly more Australian than Saudi Arabian respondents reported intervening to (for example) reduce paediatric radiation dose, discuss exam requests with radiologists and physicians, and update protocols (95.7% vs. 72.7%, Chi-squared = 9.67, $P < 0.005$). Eight-two per cent of Australians said they intervened to change paediatric CT dose 'every time'; Saudi Arabians reported intervening less frequently. The difference in the proportions of Australian and Saudi Arabian respondents who reported intervening 'every time' is significant (Chi-squared = 17.253, $P < 0.001$).

When asked whether CT scans increase the patient's risk of developing cancer, 78% of Saudi Arabian respondents agreed, as did a significantly greater percentage of Australian respondents (93.9%) (Chi-squared = 5.17, $P < 0.05$). Accordingly, the mean rating of cancer risk (from 0 = very low to 10 = very high) given by Australian radiographers was significantly higher than that given by Saudi Arabian radiographers (6.16 vs. 4.19, $p < 0.05$).

Respondents were asked to estimate the percentage of paediatric CT scan requests they thought were justified. The data shown in Table 4 indicate that 88.0% of Australian respondents believed that over 60% of CT scans are justified, whereas only 8.9% of Saudi respondents believed this; the difference between these proportions is significant (Chi-squared = 66.44, $P < 0.001$).

Finally, respondents were asked how often they updated their CT scan protocols; responses are shown in table 5.

CT protocols are updated more often in Australia, with significantly more respondents reporting they updated protocols 'anytime' (meaning frequently, as required, and to no fixed schedule) than in Saudi Arabia (Chi-squared = 24.71, $P < 0.001$).

Discussion

This research aimed to evaluate the existing knowledge and attitudes of radiographers in Australia and Saudi Arabia regarding CT doses for paediatric patients. The Saudi Arabian-Australian comparison was a practical choice due to the Saudi Arabian background of the first author, but was also viewed as a useful test of the general level of international consistency with respect to radiographers' training and experience. The primary research question was: what are the differences (if any) between Australian and Saudi Arabian radiographers in terms of training, experience, knowledge and attitudes towards CT doses in paediatric imaging? The results presented above show that there are many and sometimes substantial differences; these differences have implications for radiographers' training and practice worldwide.

Attitudes to paediatric CT

Survey results showed that the Australian radiographers enjoyed their work more than the participants from Saudi Arabia, but there were no significant differences in their attitudes towards particular aspects of their work that might have affected their practice toward paediatric CT imaging. The difference in enjoyment seems likely to be related to the participants' level of control over their work, as shown by the significant difference in intervention rates; it may also reflect the fact that Australian participants were older and can be assumed to have settled on paediatric CT as a career, in contrast to the younger Saudi Arabians.

Qualifications and experience

To begin to describe levels of knowledge, participants were asked about the qualifications they held when they commenced working as radiographers. Saudi Arabian radiographers were less qualified on beginning work than their Australian counterparts; ~50% held a diploma as their basic medical imaging qualification, but 69% of Australians reported a degree as their basic qualification. Thus, Saudi Arabian participants entered the workforce with adequate knowledge to perform their tasks, but potentially insufficient knowledge to assess the CT radiation risk for paediatric patients and to intervene. A similar pattern was observed with respect to work experience. Most (53%) of the Australian participants had working experience of more than five years, compared with only 16.7% of the participants from Saudi Arabia. This can be attributed to the fact that Saudi Arabian radiographers can enter the workforce earlier than Australian radiographers, who need to earn a degree before they can work.

Continuing education and training

Both groups indicated that workshops and seminars are the most frequent method of training. Self study was not considered a contributing factor to education, a finding supported by Scutter and Halketts' conclusion that practitioners do not have time to update their knowledge by reading journal articles.[37] Overall, Australian radiographers participate in training and education significantly more frequently than Saudi Arabian respondents; this finding may explain the apparent difference in the knowledge of radiographers in the two countries. Training and establishment of protocols are core components in improving the knowledge base of radiographers,[7] and the information about factors affecting dose in CT contained in protocols may help radiographers to intervene to reduce doses. The more frequent training and education received by Australian radiographers may be inferred to be a determining factor in their higher rates of dose intervention action and understanding of risk of cancer.

Perceptions of radiation dose

Estimates of radiation dosage during CT imaging are very important for assessing the risk to the patient. Australian respondents perceived radiation dose as lower for the head, chest, and abdomen than Saudi Arabian respondents. Furthermore, Australian radiographers gave similar scores for the radiation dose for head and chest CT imaging, as did Saudi Arabian radiographers, but both gave higher scores for the radiation dose for abdomen/pelvis scans. This is further evidence of radiographers' poor understanding of radiation risks, because the radiation dose received by the head is in fact several times greater than that received by the abdomen/pelvis during a CT scan.[38] Scores given by Saudi Arabian radiographers for the risk resulting from abdomen/pelvis scans were significantly higher than those given by Australians, further underscoring their need for greater education about the relative risks of scans on different regions of the body.

The Australian Institute of Radiography advocates for the welfare and safety of patients;[39,40] the influence of this advocacy is arguably manifested in Australian radiographers' perceived low dosage of radiation exposure for paediatric patients. In contrast, the absence of widely accepted guidelines regarding radiation dosage in Saudi Arabia may have influenced Saudi radiographers' perceived high radiation dosage for patients.

Dose intervention

Significantly more radiographers (95.7%) from Australia reported participating in dose intervention than radiographers from Saudi Arabia (72.7%). Referring to the previous discussion, Saudi Arabian radiographers perceived they give higher doses of radiation to patients on average than Australian radiographers. This means that relatively more Saudi Arabian radiographers should practice dose interventions for CT in paediatric patients because they encounter higher prescribed radiation doses.

Most Australian radiographers (81.8%) intervene with radiation dose 'every time', but only a minority of Saudi Arabians reported doing so; this can be attributed to the lack of policies on reducing radiation dosage in Saudi Arabia. Instead, the focus of their policies is awareness of radiation risks. Thus, even when Saudi radiographers are asked to give a dose they perceive as too high, they do not have the ability and knowledge (and perhaps confidence) to intervene to reduce it; there is a gap between evidence-based protocols and their translation into actual practice.[35]

The finding that Saudi Arabian radiographers intervene relatively infrequently despite perceiving relatively higher radiation doses is in line with Soye and Paterson,[35] who found that radiographers in Northern Ireland often overlooked paediatric radiation doses; this makes it difficult to change or lower doses for this population. Similarly, Lee, *et al.* revealed that radiologists were unable to accurately estimate radiation doses despite long experience,[32] consistent with the results of this study showing that length of experience does not determine expertise and knowledge regarding radiation risks.

Beliefs about cancer risk

Significantly more Australian than Saudi Arabian radiographers (93% and 78% respectively) believed that cancer is a health risk of CT imaging. Despite this difference, both proportions are higher than those measured by previous authors who found that very low percentages of physicians understand the ALARA (As Low As Reasonably Achievable) principle in CT imaging.[32,41,23] Radiographers need to have up-to-date knowledge regarding delivering the lowest amount of radiation that will produce correct images during CT procedures.

Australian radiographers' mean perception of cancer risk related to the CT scan was significantly higher than that of Saudi Arabian radiographers. This result conflicts with the earlier finding that a higher proportion of Saudi Arabians were able to inform parents and caregivers regarding radiation risks, suggesting that while Saudi Arabian radiographers explain radiation risks to parents or caregivers, they do not fully understand this concept. Minimising radiation exposure is best achieved through continuing education, as suggested by Muhogora, *et al.*[7] and other authors.

A large majority (88%) of the Australian radiographers believed that over 60% of their CT scan requests for paediatrics were justified, whereas the corresponding figure for the Saudi Arabians was 8.9%. The Saudi Arabians believed that most of their requests for CT paediatric imaging were not justified. In relation to the previous discussion on dose intervention, this indicates that Saudi Arabian radiographers recognise the inappropriateness of many prescribed radiation doses for paediatric patients but fail to act, resulting in a lower rate of dose intervention compared to Australians.

Limitations of the study

The survey data presented here deal with radiographers' perceptions of paediatric CT radiation dose rather than measurements of actual doses. It is possible that the respondents' perceptions of doses were poorly related to the protocols in use and the actual doses, and this could change the meaning of our results substantially. Dosimetry and in-depth interviews with radiographers in both countries are part of the next phase of this project and will be reported in separate articles.

Some Saudi respondents may have experienced difficulty in comprehending the English-language questionnaire; however, all Saudi radiographers must obtain qualifications which require studying in English, so major problems in comprehending the questionnaire were considered unlikely.

Conclusion

There are significant differences in the knowledge bases of radiographers from Australia and Saudi Arabia. This difference can be attributed to the protocols implemented in their hospitals, as well as the received training and activities for continuing education in both groups. Australian radiographers engage in more frequent dose intervention activity than Saudi Arabian radiographers; this may be related to their higher average level of initial training and greater work experience, and relatively frequent ongoing training and workshops. These findings are consistent with the results of the studies reviewed and discussed in the literature review, in which training of radiographers and establishment of hospital protocols are needed to improve the knowledge of these health personnel.

It was also found that there was no significant difference in the attitudes of Australian and Saudi Arabian radiographers towards paediatric CT imaging (level of confidence when working with CT, desire to advance their skills). This implies that the attitudes of radiographers are not strong influences on their knowledge and practice of CT imaging. Nonetheless, the findings suggest the existence of gaps in the knowledge base of both Australian and Saudi Arabian radiographers. These identified gaps in knowledge can be filled through enhancement of hospital protocols and encouragement to join activities for continuing education and training. As this research shows, radiographers do not update themselves independently, thus policies should be established which mandate attendance at workshops and training regarding updates on radiation doses.

Continuing education is a way to refresh and update the knowledge of workers, in this case radiographers, to continue being effective and competent professionals.[6] Radiographers can be involved in continuing education by keeping up to date with the protocols for CT scan dosage and imaging procedures that are implemented in their hospitals, and by being actively involved in the development of protocols. If not directly involved in protocol development, radiographers should at least keep themselves informed about updates. Workshops and seminars are useful ways to communicate recent updates and to solicit support and advocacy from radiographers themselves.

In summary, efforts should be directed at improving the knowledge base of Australian and Saudi Arabian radiographers in order to minimise radiation exposure among paediatric patients. The fact that positive and negative differences exist between radiographers in such disparate countries as Australia and Saudi Arabia suggests that the findings are applicable to radiographers working in paediatric hospitals worldwide.

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