

# Attitudes of medical imaging technologists on use of gonad shielding in general radiography

**Abstract Purpose:** Gonad shielding is an important way to address the 'as low as reasonably achievable' (ALARA) requirement in radiography. However, its use relies on the attitudes of medical imaging technologists (MITs) to consistently adhere to professional conduct requirements relating to the application of gonad shielding. The purpose of this study was to investigate the attitudes of Western Australian (WA) MITs to the use of gonad shielding in general radiography and also to explore the variables influencing these attitudes. **Methods:** A questionnaire regarding MITs' attitudes towards gonad shielding was developed based on relevant literature and distributed to MITs working in general radiography employed by public and private clinical centres in WA metropolitan and rural regions. Descriptive (percentage of frequency, mean and standard deviation) and inferential statistics (chi-square, t-test and analysis of variance) were used to analyse the responses of the multiple choice (MC) and 5-point scale questions from the returned questionnaires. **Results:** The questionnaire response rate was 44.6% (127/285). It was found that WA MITs perceived gonad shielding as important (mean: 3.8) and that adequate education had been provided (mean: 3.1). However, statistically significant attitude variations existed among MITs from different employment sectors ( $P < 0.01$ ), equipment awareness ( $P < 0.05$ ), genders ( $P < 0.005$ ) and educational qualifications ( $P < 0.05$ ). **Conclusion:** Overall, WA MITs have positive and appropriate attitudes to the use of gonad shielding in general radiography. However, statistically significant attitude variations existed among MITs. Possible directions for improvement include the provision of gonad shielding protocol in each x-ray room in clinical departments and the enhancement of education and training of shielding application. This potentially will lead to improved consistency in the appropriate application of gonad protective shielding.

**Keywords:** ALARA, attitudes, general radiography, gonad shielding, medical imaging technologists.

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## Introduction

General radiography is the most common radiological examination among a range of imaging modalities. Although only a relatively small radiation dose is associated with each procedure, its stochastic risk to the population should not be underestimated due to its wide application.<sup>1-3</sup> As low as reasonably achievable (ALARA) is one of the fundamental principles of radiological practice.<sup>4</sup> A range of techniques have been developed to address this requirement in general radiography such as gonad shielding, minimisation of repeat examinations and number of views, appropriate beam filtration, collimation and selections of projection, image receptor and exposure factors. As well as radiation protection, most of these techniques also potentially contribute to image quality improvement when used appropriately. However, it seems gonad shielding application does not necessarily add any additional value for diagnosis.<sup>3,5-8</sup> Inappropriate shield placement may compromise image quality though its dose reduction effect is significant, dose reduction of 95% in male patients and about 50% in female if gonads are within the primary beam.<sup>2,3,9</sup>

Omission of gonad shielding in cases which require protection is not rare in clinical practice<sup>9</sup> even though the necessity of shielding is noted in literature from influential publications such as The International

Commission on Radiological Protection (ICRP) Publication 34<sup>3</sup> and standard textbooks.<sup>10,11</sup> One of the common reasons for omission is due to a lack of confidence or skill in gonad shield placement of medical imaging technologists (MITs) and the attitude that gonad shielding not applied to patients does not affect the diagnostic process. Although some studies have suggested that the provision of departmental shielding protocol would reinforce its application, it was found to be lacking in some clinical centres.<sup>6,9,12</sup> The use of gonad shielding relies on the attitudes of MITs to consistently adhere to professional conduct requirements.<sup>13-15</sup>

There are a range of factors that may affect MITs' attitudes to the use of shielding including education and training,<sup>16</sup> patient age,<sup>17,18</sup> gender,<sup>17</sup> availabilities of protocols<sup>12</sup> and gonad shields.<sup>17</sup> Their attitudes may also vary among different workplaces and countries.<sup>15</sup> This paper presents a study of the attitudes of Western Australian (WA) MITs to the use of gonad shielding in general radiography and identification of variables influencing their attitudes. These variables can be used to indicate any gaps existing between the expectations of governing bodies and clinical situations. This would also inform stakeholders about the adequacy of current policies leading to any necessary improvements, which potentially would have a positive impact on individual MITs, clinical departments, governing bodies and the general public.

**Table 1:** Attitudes on the use of gonad shielding in general radiography.

Question		Mean (SD) <sup>a</sup>	Frequency (%)	
1. Likelihood of gonad shielding application for examination ( <i>n</i> = 126)	a. Pelvis	–	100 (79.4%)	
	b. Abdomen	–	56 (44.4%)	
	c. Spine	–	52 (41.3%)	
	d. Extremities	–	43 (34.1%)	
	e. Chest	–	20 (15.9%)	
2. Likelihood of gonad shielding application for imaging patient ( <i>n</i> = 123 <sup>b</sup> )	a. Male	i) 0–19 years	3.9 (0.9)	–
		ii) 20–39 years	3.2 (1.2)	–
		iii) 40–59 years	2.4 (1.1)	–
		iv) 60–79 years	1.6 (0.9)	–
		v) 80+ years	1.4 (0.8)	–
	b. Female	i) 0–19 years	3.5 (1.2)	–
		ii) 20–39 years	3.0 (1.2)	–
		iii) 40–59 years	2.1 (1.0)	–
		iv) 60–79 years	1.3 (0.6)	–
		v) 80+ years	1.2 (0.5)	–
3. Likelihood of not using gonad shielding when encountering: ( <i>n</i> = 127).	a. Potential of region of interest obscuring	–	123 (96.9%)	
	b. Uncooperative patient	–	57 (44.9%)	
	c. Not confident in shield placement	–	20 (15.8%)	
	d. Wheelchair patient	–	15 (11.8%)	
	e. Infertile patient	–	13 (10.2%)	
	f. Too busy	–	11 (8.7%)	
	g. Infectious patient	–	8 (6.3%)	
	h. Bed patient	–	7 (5.5%)	
	i. Embarrassed to palpate anatomy	–	5 (3.9%)	
	j. Non-English speaking patient	–	4 (3.2%)	
4. Likelihood of shield availability affecting usage ( <i>n</i> = 126) <sup>b</sup>		2.4 (1.4)	–	
5. Gonad shielding protocol available in workplace ( <i>n</i> = 127)	a. Yes	–	72 (56.7%)	
	b. No	–	31 (24.4%)	
	c. Unaware	–	24 (18.9%)	
6. Self-perception ( <i>n</i> = 127)	a. Education/training received for gonad shielding application <sup>c</sup>	3.1 (1.0)	–	
	b. Importance of gonad shielding <sup>d</sup>	3.8 (1.0)	–	

<sup>a</sup>SD: Standard Deviation

<sup>b</sup>Scale of 1 to 5; from never to always

<sup>c</sup>Scale of 1 to 5; from very poor to very good

<sup>d</sup>Scale of 1 to 5; from not important to very important

## Method

A total of 34 public and private clinical centres in WA metropolitan and rural areas were asked to take part in this study in May 2011. Within these centres only MITs who worked primarily in general radiography were invited to participate. A questionnaire regarding their attitudes towards the use of gonad shielding was distributed to each participant in person or by post depending on the locations of clinical centres and collected through the same channel four weeks later. Their participation was voluntary and they could withdraw at any stage.

This study was approved by the Curtin University Human Research

Ethics Committee (Approval Number SMEC-09-11).

Multiple choice (MC), five-point scale and open-ended questions were developed for the questionnaire to obtain participants' demographic information and their attitudes towards gonad shielding in various situations such as types of examinations, patients' medical conditions, workloads, and availabilities of shielding equipment and protocols. The contents of the questions were based on literature regarding the issue of gonad shielding. It was piloted with 10 people with a background of radiography prior to distribution.

Descriptive and inferential statistics were applied to analyse the

**Table 2:** Comparison of attitudes on the use of gonad shielding.

Question	Mean (SD) <sup>a</sup>				P-value / Post-hoc Test
1 Self-perception of importance of gonad shielding <sup>b</sup>	Male (n = 47)		Female (n = 80)		< 0.005
	3.4 (1.1)		4.0 (0.9)		
	Bachelors qualification (n = 99)	Masters qualification (n = 3)	Other qualification (n = 25)		< 0.05 / Bachelors qualification ≠ Other qualification
3.7 (1.0)	3.3 (0.6)	4.2 (0.9)			
2 Likelihood of gonad shielding application on males aged 0–19 <sup>c</sup>	Bachelors qualification (n = 99)	Masters qualification (n = 3)	Other qualification (n = 25)		< 0.05 / Bachelors qualification ≠ Other qualification
	3.8 (0.8)	4.0 (0.0)	4.3 (0.9)		
3 Likelihood of gonad shielding application on females aged 0–19 <sup>c</sup>	Metropolitan public hospital (n = 31)	Metropolitan private hospital (n = 29)	Rural hospital (n = 2)	Private clinic (n = 65)	< 0.01 / Metropolitan public hospital ≠ Metropolitan private hospital
	2.9 (1.4)	4.0 (0.7)	4.0 (1.4)	3.6 (1.2)	
4 Likelihood of gonad shielding application when:	Aware of gonad shield available in each X-ray room (n = 84)	Aware of gonad shield not available in each X-ray room (n = 29)	Unaware of gonad shield availability in each X-ray room (n = 14)		
a Males aged 0–19 <sup>c</sup>	4.1 (0.7)	3.8 (1.0)	3.2 (1.0)		< 0.001 / Aware of gonad shield available ≠ Unaware
b Males aged 20–39 <sup>c</sup>	3.4 (1.1)	3.2 (1.0)	2.4 (1.2)		< 0.01 / Aware of gonad shield available ≠ Unaware
c Females aged 20–39 <sup>c</sup>	3.1 (1.2)	3.1 (1.1)	2.2 (0.1)		< 0.05 / Aware of gonad shield available ≠ Unaware

<sup>a</sup>SD: Standard Deviation

<sup>b</sup>Scale of 1 to 5; from not important to very important

<sup>c</sup>Scale of 1 to 5; from never to always

**Table 3:** Relationship between gender and reason for not using gonad shielding.

Reason	Male (n = 47)	Female (n = 80)
	Frequency (%)	Frequency (%)
1 Potential for region of interest to be obscured	46 (97.9%)	77 (96.3%)
2 Uncooperative patient	20 (42.6%)	36 (45.0%)
3 Not confident in shield placement	8 (17.0%)	12 (15.0%)
4 Too busy	8 (17.0%)	3 (3.8%)
5 Wheelchair patient	7 (14.9%)	8 (10.0%)
6 Infectious patient	7 (14.9%)	1 (1.3%)
7 Bed patient	7 (14.9%)	0 (0.0%)
8 Infertile patient	4 (8.5%)	9 (11.3%)
9 Embarrassed to palpate anatomy	3 (6.4%)	2 (2.5%)
10 Non-English speaking patient	1 (2.1%)	3 (3.8%)

Pearson chi-square test,  $P < 0.005$

responses obtained from the MC and five point scale (closed) questions. Content analysis was applied to the open-ended questions. The frequency was obtained for each choice in the MC questions. Central tendencies of

the responses were established. Cross tabulations were used to determine any relationships between categorical variables. A chi-square test was applied to determine the significance of the identified relationships.

Means and standard deviations (SD) were calculated for interval data obtained from the five-point scale questions. Responses were also divided into cohorts based on the demographic information (e.g. male and female) to calculate the individual means and SDs for each grouping. Mean values between cohorts were compared through either a *t*-test (for two groups) or one way analysis of variance (ANOVA) (for three cohorts or more). GraphPad Instat 3<sup>+</sup> (GraphPad Software Inc, La Jolla, CA USA) and Microsoft Excel 2007 (Microsoft, Seattle, WA USA) were used in data analysis. A *P*-value less than 0.05 obtained from inferential statistics was considered statistically significant.

## Results

A total of 285 questionnaires were distributed to the identified WA MITs and 127 were returned yielding a response rate of 44.6%. Table 1 summarises the participants' attitude to the use of gonad shielding in general radiography. The top three examinations that gonad shielding would be used by these participants were the pelvis, abdomen and spine. Decreasing trends of shielding application are noted when patients' ages increase. The MITs are less likely to use shielding on female patients. The three main reasons of not using gonad shielding were the potential of obscuring the region of interest (96.9%, 123/127), dealing with uncooperative patients (44.9%, 57/127) and lack of confidence in shield placement (15.8%, 20/127).

Tables 2 and 3 demonstrate statistically significant variables that influence MITs' attitudes towards the use of gonad shielding including their gender, educational qualification, type of workplace and awareness of shield availability. Female MITs' perception of the importance of gonad shielding is higher than that of males (question 1, Table 2) and they are less likely to forgo shielding application due to difficult working situations (items 4–7, Table 3). The MITs with degree qualifications considered shielding less important when compared to those with other qualifications. Gonad shielding is less likely to be used by MITs who have graduated from degree programmes on male patients aged 0–19 (questions 1–2, Table 2). The MITs from metropolitan private hospitals tend to use shielding more frequently on female patients aged 0–19 than those working in metropolitan public hospitals (question 3, Table 2). Young children and adults are less likely to be protected by gonad shielding when their examinations are undertaken by radiographers who are not aware of shield availability (question 4, Table 2).

## Discussion

The findings presented in Table 1 demonstrate that WA MITs possess positive and appropriate attitudes towards the use of gonad shielding in general radiography. Their attitudes align with the guidelines of ICRP<sup>3</sup> and standard textbooks.<sup>10,11</sup> They tend to use shielding on examinations of the pelvis, abdomen and spine because the gonad would lie on or be very close to the primary X-ray beam (within 5 cm of it).<sup>3</sup> Shielding is particularly important for children and young adults as they are more sensitive to radiation.<sup>18,19</sup> The frequency of the use of gonad shielding on female patients should be lower than that on male since diagnostically important structures are always present in the gonadal area. These issues were reflected in the response to question 2. The top three reasons suggested by the respondents to forgo shielding match the guidelines noted in the ICRP Publication 34.<sup>3</sup> The gonad shielding availability in the departments would only rarely affect the respondents' intention to use it (mean: 2.4, question

4). This could be considered as a positive attitude. Nearly all MITs (81.1%, 103/127) were aware of the issue of gonad shielding protocol existence. They believed they received adequate education and training on shielding, and perceived shielding as an important issue overall.

However, statistically significant attitude variations existed among MITs in different employment sectors, equipment awareness, genders and educational qualifications. These issues should be highlighted especially the findings that gonad shielding is less likely to be used by radiographers working in metropolitan public hospitals (mean: 2.9, question 3, Table 2) and unaware of shield availability (mean: 3.2, 2.4 and 2.2, question 4, Table 2). Also, MITs are professionals. They should always provide best practice for every patient.<sup>13</sup> By exploring the influences underpinning differences in practice, directions for improvement of the current situation can be identified.

There is a significantly different likeliness of gonad shielding application on 0–19 years old female patients between metropolitan public (mean: 2.9, Table 2) and private hospitals (mean: 4.0). This may be due to more trauma cases presenting at public hospitals<sup>20</sup> where gonad shielding may be deemed inappropriate in some cases because of the potential for obscuring important pathology especially for female patients. Shielding should only be used in follow-up studies.<sup>3,12</sup> Also it is possible that it is due to increased quality assurance processes implemented in the private sector due to a more competitive environment.

Only 11.0% (14/127) of participants indicated they were not aware of the existence of gonad shielding in each x-ray room and were less likely to use it on males aged 0–19 (mean: 3.2, Table 2), 20–30 male (mean: 2.4) and female patients (mean: 2.2). Though the relationship between equipment awareness and likeliness of application is obvious and this situation only happens in the minority, ways should be sought to increase awareness.<sup>9</sup>

The perception of female radiographers on the importance of gonad shielding is higher than that of males (question 1, Table 2) and they would not forgo shielding in many difficult situations such as being too busy, imaging patients in wheelchairs, beds and with infectious diseases (items 4–7, Table 3). One possible explanation would be female tending to be more caring and empathetic of patients' situations. They would try their best to ensure their patients receive as low as reasonably achievable radiation dose to the gonadal area by using shielding.<sup>21</sup>

The radiographers with qualifications other than bachelor and masters degrees consider shielding to be more important and tend to use it more frequently on males aged 0–19 when comparing with other groups. Bachelor and masters degrees in medical imaging / diagnostic radiography are the current pathways leading to professional entry to radiography in Australia.<sup>22</sup> Other qualifications are represented mainly by the previous requirement of a diploma. The MITs with diploma qualifications normally have extensive practical experiences.<sup>23</sup> A study suggested that this group of MITs tend to have a greater awareness of the importance of gonad shielding and more confidence to use it properly.<sup>14</sup> This may explain their higher tendency to use shielding (question 2, Table 2).

Although positive findings are noted in this study, further improvements could be put in place for better patient radiation protection. These would include the provision of gonad shielding protocol in each x-ray room in clinical departments and the development of education and training relating to shielding application. It is noted in question 5 of Table 1 that not all workplaces provide shielding protocols. Though MITs are professionals and departments should assume they would apply shielding

if appropriate, provision of protocols would provide a clear message of its importance to every radiographer and increase their awareness. The governing bodies could also play a more proactive role in this process by recommending / requiring every workplace to comply.<sup>2,6,12</sup>

To develop the education and training in gonad shielding, medical imaging programmes should emphasize the issue of gonad shielding application more in curricula especially for undergraduate courses as the respondents indicated their education and training in this area was only adequate (question 6a, Table 1). Clinical departments, governing bodies or academic institutions should also organize refresher workshops on gonad shielding regularly.<sup>13</sup> In this way, the attitudes of MITs on gonad shielding would be further improved and practice variations among MITs could be minimised. Better patients' gonad protection would be the expected outcome.

This study only investigated the attitudes of WA MITs on the use of gonad shielding from their own perspective. However, a more complete picture would be obtained if views from others such as radiologists, clinicians and patients are sought. Also, the study could be extended to other Australian states. Other possible directions for further studies include attitudes of MITs on the use of shielding in computed tomography (CT) and diagnostic reference levels (DRLs). This is because CT has been identified as the greatest source of patient dose compared to other imaging modalities. The DRLs practice in general radiography will be required by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) in the near future.<sup>1</sup> However, discussion on DRLs practice is not the focus of this paper. Further information is available in other published articles such as the study conducted by Ng and Sun.<sup>24</sup>

## Conclusion

The participants' responses indicated that they have positive and appropriate attitudes to the use of gonad shielding in general radiography. However, statistically significant attitude variations exist among MITs due to different employment sectors, equipment awareness, genders and educational qualifications. Governing bodies could play a more proactive role to recommend / require clinical departments to provide gonad shielding protocol in each x-ray room so as to further increase the MITs' awareness and improve their attitudes on this issue. Apart from emphasizing gonad shielding importance in the undergraduate medical imaging education, refresher workshops could be provided to MITs regularly in order to ensure they are always aware of this important aspect of their practice. These recommendations would potentially lead to consistent practice in gonad shielding for patients.

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